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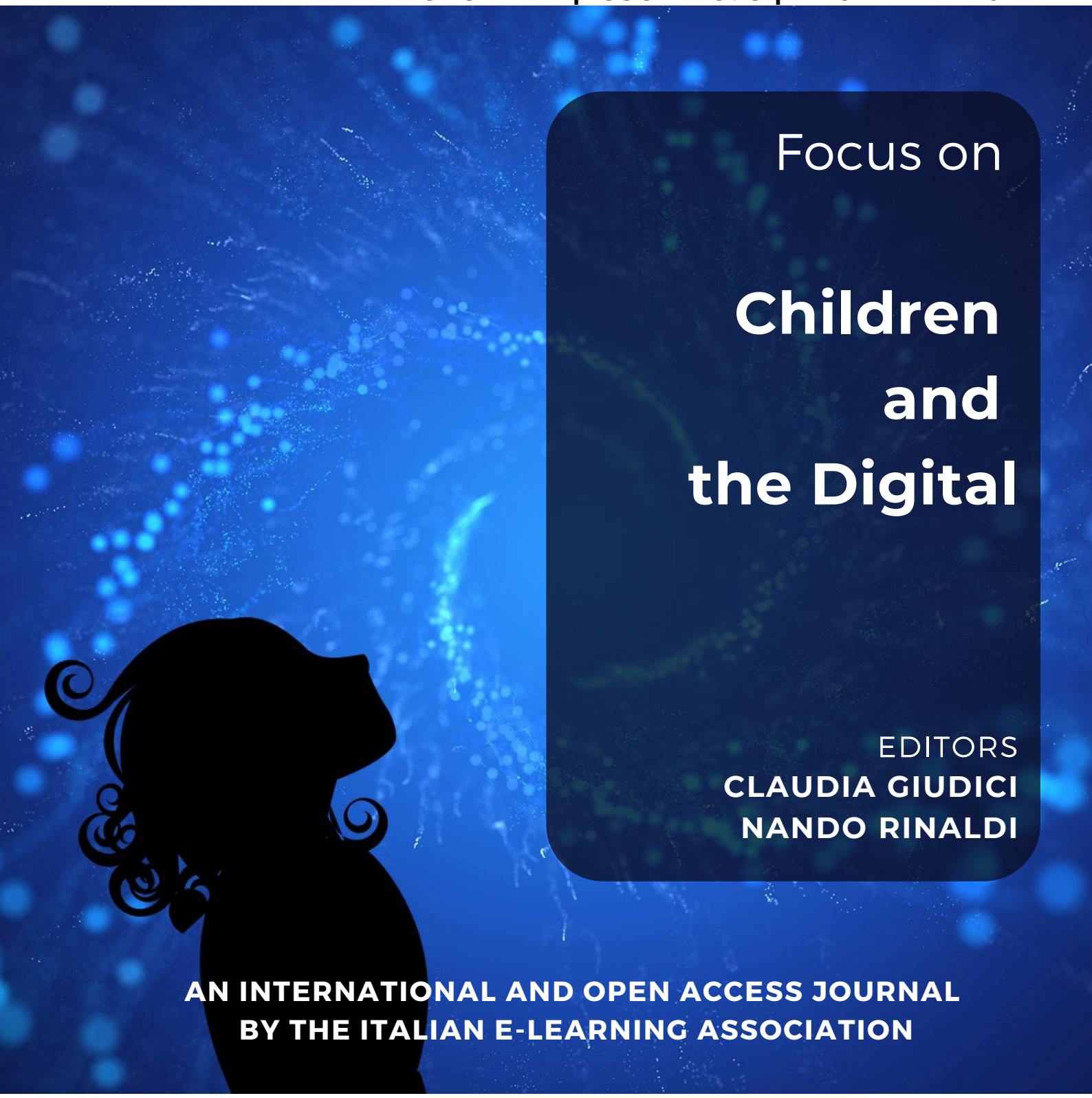



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# JOURNAL OF e-LEARNING AND KNOWLEDGE SOCIETY

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Focus on

## Children and the Digital

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**CLAUDIA GIUDICI**
**NANDO RINALDI**

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## SPECIAL ISSUE ON CHILDREN AND THE DIGITAL

JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
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# EDITORIAL

# Children and the Digital

Claudia Giudici
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> *No-one, least of all those whose work it is to educate the younger and youngest generations, can be permitted to avoid reflection on the changes and the questions in culture and life that social behaviours and scientific and technical innovations are suggesting.*
>
> *Loris Malaguzzi*
> *(Cagliari et al., 2016, p. 319)*

The theme of relations between children and digital is highly debated and many people speak of it in terms either apocalyptic, or exalted and salvific.

In the field of education the digital is frequently entrusted with an almost magical capacity for transforming the school system, by effecting the transition from an institution of transmission and expulsion to an agency that is attentive to the learning of all, offering active forms of encounter with knowledge.

Those who work in education cannot afford to think either in enthusing or apocalyptic terms. Education's task is to offer children tools for accessing knowledge, criteria for interpreting it, abilities and knowledge for living in their own life contexts, and sociality. Schools and places of education must therefore be offered as places for experimenting with and elaborating the critical and active capacities for using the opportunities digital offers. This is coherent with the fourth objective of the 2030 UNESCO Agenda for Sustainable Development (2019): to "provide a quality, equitable and inclusive education, and opportunities and learning for all".

In order to do this we believe it is important to have a phenomenological approach that on the one hand casts light on children's intelligence and on the other scrutinises the present in which they live, capturing and interpreting the meanings of which they are bearers, and translating these into opportunities for learning in which children can have possibilities for activating all their potentials with freedom and creativity, exploring limits and potentials together with others.

These occasions should let young children, and not only, discover the logics and dynamics that regulate spaces augmented and remodelled by digital and networking technologies, as witnessed in *Adaptive gamification framework to promote computational thinking in 8-13 year olds* by Mayyadah A. Altaie, Dayang N.A. Jawawi,

and the reflections of Stefano Moriggi in *Next Stop Perpetual Beta: notes for an ethics of design in digitally augmented learning contexts*.

Schools and places of education should be attentive interpreters of life contexts, of the sense and meaning children experience, so that together with them they can construct the kinds of awareness and cultural tools necessary for us to find our place in the world in active competent ways. Educators should support the construction of digital citizenship in young people growing up in an era of radical connectivity: in *Children as Digital Citizens: insights from classroom research with digital dilemmas*, Carrie James and Emily Weinstein, Project Zero researchers at Harvard Graduate School of Education, maintain the necessity of dealing with "digital dilemmas, using pedagogies that lean in versus skirt the complexity".

Children are great constructors of image, representation, and performance; they investigate the world, curiously observing it; they discover and highlight its poetry, beauty and transformations. For this reason, what we hope for is activation of dialogue in which there is a necessity for the intelligence of human beings to meet with the intelligence of tools, both analogical and digital: a dialogue in which the two intelligences reciprocally shape each other and co-evolve.

The theme then is not only introducing digital tools into spaces and environments but above all understanding the logic and concepts underlying these digital opportunities for building experiences, opportunities for learning and discovery we can offer children, shifting our attention from the technology onto the learning processes: the role of schools is to think of new ways of building knowledge together with children and of reconfiguring analogical and digital technologies.

How can we interpret the entrance of digital technology into schools?

Taking educational experience in Reggio Emilia as their starting point in *The Hundred Languages of Digital in the Reggio Emilia Approach*, Maddalena Tedeschi, Elena Maccaferri, Annalisa Rabotti argue digital technology should first and foremost be interpreted as a connector of fields of knowledge and multi-disciplinary explorations, a system that, by interweaving with analogical languages, gives greater potential to children's ways of knowing, inaugurating new spaces of socialisation and sharing in which the *mental* of every child can find a possible representation.

Digital has the potential to transform teaching-learning contexts by amplifying and enriching the possibilities available to children for representing their theories, and proposing a cultural dimension capable of creating continuity between abstraction and artisanship. Digitally augmented environments give children of all ages the potential to be authors and constructors of their own knowledge, sharing their individual and collective imaginaries and constructing new realities together with others. In fact in these contexts children can act simultaneously on multiple levels of representation, exercising thinking styles that are hybrid, integrated and flexible, and crossing the boundaries between different languages. As Roberto Maragliano argues in *Digital Mischief*: "There are two philosophical premises (I think) we need to consider as fundamental and inalienable to digital experience: a pluralism and integration of codes that excludes any possibility of hierarchy, and an associative reticular logic excluding forms of superiority, recognized sequences, and linearity".

From this perspective we can speak of *maker* technology in which children and adults become authors, constructors and inventors of their own knowledge (see *Digital Sculptors*, Maria G. Grasselli) projected into an experience of *learning by doing* where learning itself resides in the processual quality of experience (see also *The Hundred Languages of Digital in the Reggio Emilia Approach*, Tedeschi M., Maccaferri E., Rabotti A.).

The sudden closure of schools caused by the pandemic, that took place at different times in almost every country of the world, robbed children of a social dimension and learning with others. Distance learning, and Distance Education Ties (*LEAD)*, built up through educators' commitment in often lonely and precarious conditions, cast a light on problems that are not new: differences in family conditions; children's different autonomies; reduction of experience to the mere acquisition of content; the loss of learning's relational dimension.

From the myriad experiences realised in schools around the world a myriad questions and reflections on digital learning were generated. Those who work in schools and education felt the need to define a new model of didactics.

Debate on the themes of teacher training and professional learning re-emerged forcefully and with different kinds of awareness (*Distance Educational Links: a qualitative study on the perception of kindergarten teachers*, Luisa Zecca; *Creative Learning in Stem: towards the design of an approach between theory and reflective practice*, Maria Xanthoudaki, Amos Blanton). We are faced with the necessity and urgency of updating the debate on distance learning: in *Next Stop Perpetual Beta: notes for an ethics of design in digitally augmented learning contexts* Stefano Moriggi underlines how adopting technology in ways that are indiscriminate, unconsidered and unaware risks reducing what ought to be a cultural revolution to a question of IT updating of devices and skills, and he goes on to propose a vision that emphasises the constitutive and restructuring functions of any given *medium*. For these reasons the paradigms and knowledge content of teacher education related to learning and the digital become crucial issues both for

distance and in-presence schooling. Several reflections and suggestions are offered here on modified learning environments in experiences from very different contexts: Tedeschi M., Maccaferri E., Rabotti A. also offer significant reflection on the relationship with parents, an aspect that is also examined in *Child Mediation: effective education or conflict stimulation? Adolescents' child mediation strategies in the context of sharenting and family conflict*, Gaëlle Ouvrein, Karen Verswijvel.

Education is fertile ground for the use of technological innovation as witnessed in *Online learning in the Jordanian kindergartens during Covid-19 pandemic*, Maha Y. Abu-Rabbà, Ayat M. Al-Mughrabib, Hamed M. Al-Awidi. In *Students' perception of e-Learning during the Covid Pandemic: a fresh evidence from United Arab Emirates (UAE)* G. Ahmed, A. Abudaqa, Mohd F. Hilmi, H. AlMujaini, Rashed A. Alzahmi offer their reflections in a consideration of how students perceive their e-learning environment in the United Arab Emirates, and share that there is a "deep concern about the quality of education in online learning [...] due to social isolation, lack of interactivity and participation, along with the delay in the timely response and feedback" and therefore invite the "various policy makers in the education sector" to take these aspects into consideration and "provide some strategic guidelines".

They are joined by authors Khawla H. Al-Mamari, Suhail Al-Zoubi, Bakkar S. Bakkar, Abedalbasit M. Al-Shorman who analyse various aspects of distance learning and teacher education in children with disabilities in *The impact of e-Learning during COVID-19 on teaching daily living skills for children with disabilities*.

Instead Walid Aboraya shows how using technological innovation can increase student understanding of abstract content and mathematical concepts in the context of a blended learning environment given potential by a virtual laboratory (*Assessing students' learning of abstract mathematical concepts in a blended learning environment enhanced with a web-based virtual laboratory)*; analogous reflections emerge in *Impact of online simulators on primary school children's visual memory development* by Roza Valeeva, Elvira Sabirova, Liliia Latypova. Second language learning and the maintenance of bilingualism are objectives in several countries and digital technologies can make important contributions, as explained in *Maintaining bilingualism through technologies: the case of young Russian heritage learners*, Liliia Khalitova, Gulnara Sadykova, Albina Kayumova, and in *Adoption of social robots as pedagogical aids for efficient learning of second language vocabulary to children*, Abdelouahab Belazoui, Abdelmoutia Telli, Chafik Arar.

All these papers highlight how important it is to begin deep reflection and research that goes towards producing a new definition of distance learning, the more so today as several countries discuss the digital transformation of their school systems, frequently based on "distance learning" that is ill-defined and thought through. This risks weighing in negatively both on the debate and on the choices that must be made as Roberto Maragliano argues in *Digital Mischief*. The digital is a transformation that touches, and will continue to touch, our constituted knowledge, founded on the awareness that knowledge is constructed in relations.

While observing children's digital play during the time of the pandemic in *Children's Digital Play during the COVID-19 Pandemic: insights from the Play Observatory*, Kate Cowan, John Potter, Yinka Olusoga, Catherine Bannister, Julia C. Bishop, Michelle Cannon, Valerio Signorelli further highlight how much today's world is characterised by the integration of virtual and physical dimensions, of material and immaterial, and the extent to which children are immersed in this from birth (if not before). Touch is fundamental for experiencing and knowing the world, others and oneself, and can be central to the ways we communicate. New sensory communication technologies are amplifying our possibilities for "feeling" the world around us, changing our ways of embracing and touching at a distance. Digital Touch Communication therefore also brings a need to examine the social and psychological implications for our social ties, and for communication in general. In this direction *Moving between the boundaries of physical and digital contexts: a case study about a shared project by a group of children* Eloisa Di Rocco, Jennifer Coe, Federica Selleri, Simona Cavalieri, presents a case study in which children move to and fro between the boundaries of physical and digital contexts. Instead, through illustrating the "Future Inventor" experience at Milan's Leonardo da Vinci Museum of Science and Technologies, the paper *Creative Learning in STEM: towards the design of an approach between theory and reflective practice* by Maria Xanthoudaki and Amos Blanton, contributes to our knowledge of learning experiences modelled on the dialogue between material and immaterial, between physical and virtual, when these are considered as environments *of* and *for* teaching/learning. On the same lines Stefano Moriggi in the paper cited above, proposes an ethic of design for digitally augmented learning contexts.

Our contemporary world poses social, political and educational challenges that must be interrogated and debated in order for us to elaborate and share new visions and possible trajectories of development for relations between children, adolescents and digital, as well as developing educational policy on the use of technologies with children.

Each *medium* triggers transformation in our communication styles, in structuring the forms our knowledge takes (as well as its access and use), and in learning conditions. Technologies, not only digital, "extend" our minds by offering deep and radical transformations we have yet to examine. This therefore renders necessary our interdisciplinary exchange and reflection on the various kinds of devices and software, as well as on epistemological approaches and psycho-pedagogical models that might contribute to interpreting challenges as best we can, with the purpose of achieving the objective of plural inclusive education capable of producing generalised citizenship competencies in societies of the future for our younger generations.

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# DISCUSSION TOPICS

## Digital Mischief

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1. Although we are immersed in it, or perhaps because we are too far in, we risk understanding very little of the digital and how it reflects and at the same time determines our shared primal perceptions of reality as we experience it and practice it. We worry about the fate of children, who inhabit this dimension live, "naturally", so to speak. Not that it is wrong for adults to worry about children, and for them. We are responsible for their development, so it is legitimate to try and protect them from the damage we fear will be caused by exposure to the digital: to an experience then that children live as theirs, "naturally", and which we adults control little and badly.
However the point is we should be worrying about ourselves, "good" adults experiencing digital whether we want to or not, without any serious commitment to understanding what it is, or how it transforms our inside, together with the transformations we see on the outside.
In fact, it is a sign of immaturity, ours, the immaturity of those who ought to be educating but are not capable of managing themselves, deceived by the old illusion we can choose whether to accept, or reject, certain manifestations of reality.

Deep down we are victims of a paradoxical condition.
On one hand the terms we use most often to stigmatise the dangers of the digital world derive from a family of concepts that at their centre have an idea of simplicity. Everything in everyone's reach, of crumbling of selection and understanding as legitimate defence, unlimited and unreflecting consumption; no, we tell ourselves, this is not a good thing, and when possible, we tell the children too. But deep down this ease of access is something we enjoy, even when we repent and confess, using it as a medium.
On the other hand, when we do try and come to terms with the problem we can't free our minds and vocabulary of a hard cumbersome word, and above all of a concept – technology. This show the extent to which we are victims of a cultural tradition that makes the technical and all its manifestations into something external, complicated, dangerous, something not fully under our control. What is haunting us is the ghost in the machine. But it is a ghost we forget about when engaged with writing or books, both technologies we do not experience as extraneous, and indeed often build up as protective walls "against technology".

Simplicity and complication are opposites – obviously. It should be equally obvious that these two opposites, which explode out or instead compact together depending on circumstance, denounce the limits of our archaic conception of technology,
Children are somewhere else, inside complexity.
So, we need to ask some good questions about them.

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Children are part of digital technology before they are born. Family members whose images are fixed and circulated in shared ultrasound portraits, they grow up experiencing the world largely through the medium, and in the company, of the digital, without ever realising it is technology. (Happy children!) They are attracted to external material manifestations of this part of reality, exactly the ones that most annoy right-thinking adults. This is nothing new. In pre-digital times the first objects children wanted to grasp and hold were telephones, even baby toy versions. Why is this? Because they make a sound, they have a soul. If this perturbed us in the past, it perturbs us even more today when they are an extension of the body; they keep alive a world we both want, and don't want, to be part of.

Let's move on.

Leaving aside the relational-affective framework we manifest with our adult agitation on seeing a child with a mobile phone (instilling them with our virus) here the children are, at their most mature, systematically immersed and engaged in total experiences where the digital lives, reproduces, and circulates, with sounds, images, and action, not just promoting their sensory-motor intelligence but coding it. Perhaps a book that plays when you move it, a small screen on a phone or tablet that responds to touch with movement and sound, or toys stuffed virtuously with intelligent artifice. For children this is reality, all of it, at once physical and imaginary, tangible and fantastical. They don't feel or perceive it as external technology, they feel it as a manifestation of Self, a feature of their positive self-centredness.

Coming back to adults, if we could accept the idea that until we internalise something it feels like technology, and then no longer, it would be a great step forward. Don Quixote can't see the books Sancho can, but he sees, lives, and is nourished through a bookish imagination that allows him to survive life's chance events and misfortunes. Adults today's are more Don Quixote than Sancho, and when we read (not forced as often happens in school) we don't perceive books as material objects, we experience and feel their soul.

So why can't we have this understanding of children and "their" technology? In short, I am convinced that if we make the effort to rid ourselves of a persecutory and materialistic idea of technology and tools (valid for everything but for exceptions I have mentioned) we would understand, seeing the way we behave ourselves, that children are born with this technological reality innate, and that downsizing its role isn't a pedagogical exercise we can accomplish materially, prohibiting and inhibiting (the way we would, rightly so, with an adult living only through reading and books). Denying children the need to slate their hunger for sound, image, and touch is like denying their need to experiment with their body and sexuality. So let's recognize this. There is something digital incorporated into almost every "bay" object children come into contact with, and it is the component that attracts them most, because they were born with this sensory predisposition, the technology is inside them. But careful. After this demanding step we need to prepare for another one, equally important.

To have children grow up the best way possible, giving them tools to enjoy the world and protect themselves from its dangers, but above for an understanding of the reasons for this world we live in, rather than telling them off them and teaching them precaution and containment, we need to learn from them what it is that makes digital so pervasive, so immediate, so simple, that is to say "natural". Natural for us too, whether we like it or not. In short, we need to recognise, as a pioneer in this field Seymour Papert maintained, the very close relation between the digital dimension and the dimension of childhood. We can't help children with the dangers of their own immersion unless we ask them for help to get out of our own.

To get inside the "naturally" digital logic of children, that can we can only have if we think and conceptualize digital for what it is, we need (while maintaining our adult state) to become children, accepting the challenge of a phenomenon behind which there is a language (in the broad sense), an epistemology, and an anthropology, different from those our nobler (but obsolete) pedagogical tradition has handed down to us, and on which we continue to construct our schools and education – above all, scholastically speaking, by giving adolescents a "serious" education.

Instead, there is an urgent need for us to be more aware (though academic tradition makes it difficult) that the language, epistemology, and anthropology we still consider typically "educational" (almost obsessively focused on literacy) all converge on precisely the cultural canon that sciences, tarts, philosophy, and popular culture blatantly and dramatically critiqued in its very foundations, all through the twentieth century. If we took this path it wouldn't be difficult to admit the disintegration of several classical ancient and certainties took place last century because the arts, sciences, and mass culture accepted and promoted primal, "infantile", "illiterate" needs (to quote Alberto Abruzzese's provocations).

2. There are two philosophical premises (I think) we need to consider as fundamental and inalienable to digital experience: a pluralism and integration of codes that excludes any possibility of hierarchy, and an associative reticular logic excluding forms of superiority, recognized sequences, and linearity. These are not premises born with the digital. In a reading of Walter Ong's work we can consider digital experience as a sort of *precipitate* of the "mother tongue", having a different (but not totally opposite) texture and substance

to the "father language", which instead coincides with the written word, even better if printed. It is no coincidence in this approach that we touch on something Freudian and sacred, which Ong was well aware of.
What complexities there are hidden behind things we are induced to consider reductively, as too simple or too complicated!
The digital world has a primitive quality we need to be able to grasp for ourselves, as people of the world before being educators, to avoid a passive subjection to the action of its reality, its luminous liberating component, or being equally passive victims of its dark perturbing elements. This prerogative I am talking about was not born with the digital, obviously, but the digital, especially the digital we consume, has been capable of intercepting it, finding it out there in the world and universe, and amplifying it, making it social with its typical mechanism of viral vital contacts. Like the arts and sciences before it, like mass media culture before it, digital, coming later, has made its own a human propensity for breaking things down to see how they are made and making new things with the pieces left. Which really, is the most childish thing we can imagine today. As it was before, for the whole of the twentieth century. Let's look at an example of this, and go back in time a century.
To produce "total fusion in order to reconstruct the universe making it happy, by recreating it in its entirety"; give "skeleton and flesh to the invisible, the impalpable, the imponderable, the imperceptible"; find "abstract equivalents of all forms and elements in the universe" then combine them together, "according to the whim of our inspiration, forming complexes of plasticity that we will set in motion"; ensure that art fuses with experience in everyone and everything, guaranteeing "the dynamic expression, simultaneous, plastic, and noisy, of the universal vibration".
We can read these words in the first lines of *Ricostruzione Futurista dell'Universo*, a Manifesto by Giacomo Balla and Fortunato Depero. March 11, 1915.
It comes with a suggestion (how can we not admit it?) that with today's digitisation of the real we are witnessing another re-creation, more extensive, pervasive and successful than the Futurists hoped for, but not wholly different in the similar intent it pursues, aestheticizing if you like, but liberating in comparison with many of our classical chains, letting us melt down reality and reconstruct it with different, more dynamic and "capricious" characters. With sounds, with colours, with things. The Internet of Things, making everyday objects magic (like cars equipped with satellite navigators), making them move and breathe, and allowing us (if we make peace with our fears) to live in a Disney-like world. This reference to Walt Disney, a cornerstone of twentieth-century culture, allows us to develop a suggestion from our two "futurist abstractionists" (Balla and Depero call themselves this in their Manifesto) in two directions.
The first invites us to understand, taking art and entertainment together, how overly rigid barriers between the cultures of childhood and adulthood, or between formal and informal levels of knowledge, have progressively eroded, with the consequent promotion of original forms of collaboration, dialogue, weaving, and cross-fertilisation between different elements. If we make the effort with Jay David Bolter to see in the scenario of contemporary media, marked by the presence of the web, a condition of "plenitude" that only a digital predisposition with its typical "mischievous anarchy" can navigate and use (everything mixed with everything else) then we can't help noting, again, that to deal with the world of experience as it is configured today, we must acquire the gaze of children before they are forced to acquire our own, currently limited, adult gaze.
The second direction invites us to look at pedagogical approaches to digital issues. If we take our cue, or momentum, first from the "playful", seriously "ironic" element refusing to be cancelled from our national cultural production of art, music and writing, and then secondly, from several significant events of public entertainment in twentieth century Italy, we can't help but note a "mischievous" attitude mirrored and diffused here too, gently subversive towards reality. If we acknowledge this "endowment" it would help with our aim of turning into children to fully understand the digital, and how it can contribute to shared regeneration (cultural, economic, social).

To succeed with the aim we need to take advantage of the "plenitude", having everything at hand without any kind of barrier between the elevated and the futile. To study, together or mixing and matching, Luciano Berio and Giacomo Balla, Paolo Poli and Gianni Rodari, Achille Campanile and Bruno Munari, Jacovitti and Umberto Eco, Dino Risi and Totò. This is the kind of study that would help us understand digital's positively "infantile" and liberating trait, the opportunities of future it offers everyone, here and now, even those worried about its dangers. I am convinced that if we could make an "epistemological break" like this, we would find things in the national pedagogical culture in harmony with the mischievous characteristic I have tried to highlight, things that in spite of everything offer energy and valid arguments for interrogating much of the respectable rhetoric that still prevails. I am thinking of a thread that goes from Maria Montessori to Loris Malaguzzi, and that includes testimonials from such diverse thinkers, all equally destabilizing, as Antonio Faeti, Francesco De Bartolomeis, and Egle Becchi.
If we were to make this effort I am certain it would bring oxygen to the today's currently grey and inert field of research and production on the overall themes of

education and how it is historically determined. Here events connected with mass globalisation of markets and ideas mean we feel the effect of a slow oscillation between cognitivist and positivist kinds of common sense (the latter is laying down the law today with the consensus of owners of the digital world, interested in a status quo between the apparatus of educational media and that of more worldly media). In the academy and politics there is little questioning of this condition, but the great danger is that probably our most fertile pedagogical and philosophical card for truly learning (with childlike sensitivity and aesthetics) to face the challenge of ongoing change is slipping through our fingers. The card I have in mind is that of pragmatic constructivism, not hypocritically verbose, but courageously practical.

3. So then, what to do?

On the level of comparing our viewpoints on ideas of education first we need to work in voicing this mischievous spirit open to every kind of assemblage, consider the degree to which it can be considered embedded in our cultural DNA, and continue to inform the "endless novel" Emilio Garroni refers to in *Pinocchio uno e bino*. If we accept this perspective it would at the very least introduce a measure of courage, a splash of liberating joy to the pedagogy of childhood, a conceptual area particularly marked today in Italy by mournful inhibitions, which we would be justified in thinking are caused by the demographic desertification we are going through, and the internal conflicts many adults suffer between the public exercise of virtue and private vice.

Looking at digital in a different way and taking children's "point of view" would help with our efforts of conceptual "resuscitation".

But then, connected with these different behaviours of children and adults in a reality the digital has totally recreated, there is the issue of educational (and self-educational) decisions that have to be made day after day, in the family, and at school.

Reversing our perspectives the way I have proposed (adults being children so they can help children become adults) at least in terms of mental attitude, is part of a tendency, albeit minor, in the national pedagogical culture. Until now though it has been used only marginally, and with some embarrassment, in connection with relations between children and the digital. We have to be stronger and overcome our internal barriers, and we have to do it now (we should have done it yesterday) if we want children to become protagonists and not victims of anthropological changes taking place.

Previously I said that pedagogy, both the official and spontaneous kind, is still hallmarked (almost obsessed) by principles of literacy. This makes us assume that written and textual culture, or rather, a fixed, circumscribed, articulated culture, is a "superior" alternative to culture that is mobile, open, and fluid kind: abstract versus concrete, formal versus informal, order versus disorder. From an evolutionary standpoint it is like thinking we can overcome the mobile culture by doubling down strongly on the other. Recently, when the pandemic forced much of school experience to move from the physical world of classrooms to the liquid world online, several critics highlighted what was lacking in the digital compared with previous conditions, using this as a sort of paradigm. At this point a mischievous approach would be useful for instilling some doubts, and making the view acceptable that written and printed texts are not a superior alternative to the reticular, but a fundamental and specific expression of it, something to be gradually accomplished, in the right and, so to speak, "reserved" ways of educational action, but without any of us ever losing contact with the condition of sensory concrete knowledge texts are situated in, where sound, image, and doing, earn a plus marks, not a minus.

Foscolo is scholastic, Rossini is not. Can we still afford this? And in any case, is it working?

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# DISCUSSION TOPICS

# Children as Digital Citizens: insights from classroom research with digital dilemmas

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Dear Editors,
this special issue of the journal focuses on "Children and the Digital" and, importantly, is grounded in the Reggio Emilia-based editors' image of the child as a knowledgeable, curious, and capable agent and citizen. This view is highly relevant as we consider the opportunities at youths' fingertips in a connected world and, crucially, the ways educators can support digital citizenship.

For over a decade, we have been careful observers of young people's experiences as they grow up in an age of radical connectivity. Our studies have spanned the ways digital life intersects with adolescents' mental health and well-being, close relationships, civic development, and moral and ethical decision-making, among other topics. We are based at Project Zero, a research center at the Harvard Graduate School of Education where designing powerful, student-centered learning experiences in partnership with educators is a central focus.

Our own latest round of research has focused on digital dilemmas. We study dilemmas by investigating young people's perspectives. Our multi-generational research team includes youth as co-researchers. As we do this research, we often struggle ourselves to find satisfying answers to the digital dilemmas that youth (and indeed all of us) may encounter: *If someone participates in a hateful protest, is it fair game to use social media to expose personal information that might in turn compromise their physical safety or employment? Is it okay to share violent videos online to call attention to what is happening in the world, even if the content is triggering to some viewers? When is it reasonable to expose people's past posts and private messages?*

For many adolescents, social media use is now a routine aspect of everyday life. Interspersed with social updates and casual sharing on apps, young people encounter weighty civic posts and decision points about what to share, re-post, "like", and screenshot, as well as what content to follow, unfollow, mute, and block. We believe that good citizenship in a networked world requires knowledge, skills, and dispositions to recognize and grapple with digital dilemmas.

Although digital citizenship has been on schools' agendas for some time, it often takes the form of cautionary tales and a list of "Don'ts" *Don't* cyberbully. *Don't* believe everything you read. *Don't* post anything

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that could get you in trouble, kicked out of school, or denied a job opportunity.

Supporting young people in a networked era requires approaches that meet the complexity of our times. We therefore advocate intentionally educating *with* and *for* digital dilemmas, using pedagogies that lean in versus skirt the complexity.

Dilemma scenarios have long been used as signature tools in moral psychology and in education – going back at least to Lawrence Kohlberg's model of just schools (Blatt & Kohlberg, 1975). When our team started working with educators to use digital dilemma scenarios in the classroom, we found that they immediately sparked students' engagement and interest, in no small part because they are provocative and often directly relevant to students' lives.

But we also saw how youth (and even adults) can get stuck on their initial or "gut" reactions. We wanted to design prompts that help push past first reactions to support deeper consideration of one's own views and intentional dialogue with others' views. This is all the more important because digital life can itself trap us in echo chambers where we only engage with perspectives that reinforce our existing views. Good citizenship certainly requires broader consideration, and classroom discussions are an apt context for discussing dilemmas with others and debating pros and cons of different paths forward.

Good thinking is foundational to digital citizenship and to citizenship more broadly. Pedagogies that invite reflection and intentional listening to different perspectives are recognized as best practices in civic education (Hess & McAvoy, 2014). Much of our work has converged around the aim of helping students develop dispositions that guide reflective, responsible, and ethical use of technology (James, Weinstein, & Mendoza, 2021). These essential *dispositions for digital* life include *slowing down* to recognize dilemmas as they arise; *self-reflecting* on responsibilities to self, close relations, and wider communities; *exploring perspectives* (especially those that differ from one's own); *seeking facts and evidence* to make informed decisions; and building agency through *envisioning options and impacts, and taking actions* that are both self-protective and socially responsible.

How do we get there? In classroom practice, thinking routines are an established powerful pedagogy to support dispositions (Ritchhart et al., 2011; Tishman et al., 1993), Taking direct inspiration from our Project Zero colleagues' long-standing work on thinking routines and dispositions, we created classroom routines like *Take A Stand*.

Co-developed with our collaborators at Common Sense Education, *Take A Stand* is designed for use in conjunction with dilemma scenarios. This four-step protocol gets students in the habit of considering and reconsidering their own and others' perspectives. It especially directs consideration to tensions between responsibilities to individuals and responsibilities to the wider world and civic life.

In brief, the Take A Stand protocol prompts are:
**Take a stand**: What do you think?
**Stand back:** Listen to classmates' perspectives
**Look again**: Think back to your initial response. What considerations did others raise that you hadn't considered?
**Look beyond:** How does this dilemma connect to real world situations?

When paired with a digital dilemma that feels relevant to students' lives, *Take a Stand* can be a powerful structure for reflection, listening, and learning. In a public middle school in Los Angeles, California, USA, a teacher paired *Take a Stand* with a dilemma scenario about the ethics of streaming fights online. The topic was timely: a recent public incident at nearby Disneyland had led to viral videos of a fight that erupted between two people. The videos had received widespread attention online and from the police, who used the video as evidence to arrest one of the aggressors. The fight was local news for students. This incident and concerns about a larger "record everything" culture among students sparked the teacher's interest in bringing the scenario into her classroom. The school district's recent launch of a 1:1 iPad policy, which gave students ongoing access to their own recording devices throughout the school day, was another motivator.

*Take a Stand* prompted stances across the spectrum from approval to disapproval and created space for students to give voice to different considerations on the ethics of recording and streaming violence on social media. Students discussed instances when recording violence is for entertainment or done to attract more views on one's posts versus instances when recording is carried out as an effort "to serve justice" (for instance, in cases of police brutality). Whether and when to use mobile devices for recording purposes – a thorny dilemma – became an accessible topic for rich, purposeful classroom learning. Importantly, the thinking routine provided a way to scaffold deeper awareness of one's own values and authentic listening and engagement with others' perspectives.

Digital dilemmas offer opportunities for talking with students about hard situations *before* they arise in students' own lives. When we pair them with thinking routines like *Take a Stand*, we can build students' sense

of agency by supporting dispositions to envision options and possible impacts. Such dispositions can then help them make informed decisions in their real, radically connected lives. Students share reflections like:

- "You have to be aware of the implications of your actions, not just from where it takes you but where it takes other people"
- "You need to look from multiple perspectives and make sure you know every outcome"
- "One thing I took away from today's activity was that if something big and negative is happening nearby, and [if] we have the power to try to stop it, we should, instead of posting it on social media."
- "We have to take in consideration of others and posting may ruin their reputation."
- "Once we take out our phones and start filming the problem we've automatically become part of it"

We share this vignette from classroom-based research in the U.S. in order to highlight the power and potential of leaning into digital dilemmas. As readers consider the topic of this special issue – "Children and the digital" – we advocate consideration of an approach that centers dispositions for digital life and pedagogies that may support it.

## Note

An earlier version of this comment appeared as a blog post on The Good Project Blog https://www.thegoodproject.org/good-blog/2021/8/5/taking-a-stand-on-good-citizenship
Educators interested in using the *Take a Stand* routine to bring digital civic dilemmas into their classrooms are invited to access the following free resources: Take A Stand Educator Guide and Student Handout.

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INVITED PAPER

# Children's Digital Play during the COVID-19 Pandemic: insights from the Play Observatory

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**Abstract**

The COVID-19 pandemic has had an enormous impact on many aspects of children's day-to-day lives, including their play. Measures such as lockdowns, school and playground closures, quarantine, isolation and social distancing introduced to curb transmission have resulted in major consequences for where, when, how and with whom children can play.
This article reports on interim findings from 'The Play Observatory', a 15-month project researching children's play experiences during the COVID-19 pandemic. Collecting data through an online survey and online case studies, the research offers insights into ways in which children's play has endured, adapted and responded to restrictions brought about by the pandemic.
This article focuses on children's digital play throughout this period, including examples of digital gaming, online play, social media, playful creation of digital media texts and hybrid online-offline play. Drawing on theories relating to dynamic literacies, multimodal perspectives and the Reggio Emilia concept of the 'hundred languages', this article examines the role of the digital in children's contemporary play practices and the specific affordances of digital play during times of stress, uncertainty and physical distancing.
The findings highlight ways in which digital play continued, adapted, evolved and reflected children's experiences and understandings of the pandemic. The study reveals the complexity of digital play and its place within contemporary digital childhoods, troubling simplistic notions of 'screen time' and highlighting the increasingly blurred boundaries around digital and non-digital practices, calling for educational approaches that value digital play as significant meaning-making.

**KEYWORDS**: Digital Play, COVID-19, Childhood, Digital Media, Literacies.

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## 1. Play in a Pandemic

Children draw rapidly and readily on the social and cultural context around them, often layering traditional games, local legends, news, media and popular culture in their play (Opie & Opie, 1959; Willett et al., 2013; Potter & Cowan, 2020). Since the early stages of the COVID-19 pandemic there have been reports of children's games referencing the virus. For example,

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children in the UK were observed playing "coronavirus tag", pretending to infect one another through touch, in early March 2020 shortly before the government ordered a nationwide lockdown (Smith, 2020).

Despite appearing new, with their timely renaming, games such as "coronavirus tag" build on much older themes in play. Folklorists have noted that "plague" and "fever" were widespread names for chasing games during the twentieth century, with associated rituals for in-game immunity, such as crossing fingers or covering mouths (Roud, 2011). More recently, and in digital form, contagion and survival have been central themes in a number of videogames released prior to the pandemic such as *Resident Evil*, *Halo* and *Plague Inc*. Play is therefore a complex intertwining of contemporary influences and longer histories and traditions (see also Willett et al., 2013; Potter & Cowan, 2020).

Bridging both reality and fantasy, play is understood to offer a means of exploring challenging ideas and feelings in a way that gives children a degree of distance and control (Frost, 2005). The particular power of play during periods of stress and uncertainty has been well noted. For instance, in his study of children's play in Jewish communities during the holocaust, Eisen (1990) argued that play brought an element of sanity in the midst of catastrophe. Similarly, studies of children's block play after witnessing the 9/11 attacks (Edstrom, 2003) and pretend play after natural disasters such as the New Zealand earthquakes (Bateman et al., 2013) highlight the powerful role of play in making sense of traumatic experiences and contributing to wellbeing.

As the COVID-19 pandemic began to unfold in early 2020, it seemed likely to become a point of reference in children's play and that restrictions would shape play in significant ways. However, literature on the impact of pandemics on children's play is notably absent, with a rapid review calling for "more research that evaluates children's play, particularly from children's perspectives, in social isolation during a pandemic or disease outbreak" (Graber et al., 2020, p. 144). The Play Observatory, funded by the UKRI's rapid response call for research into the impact of COVID-19, was explicitly designed to address this absence. This article seeks to shed light on children's play experiences throughout this time in history, placing a particular focus on the role of digital play.

## 2. Digital Play During the COVID-19 Pandemic

Digital technologies occupied a central place in many children's lives prior to the pandemic, but the outbreak and resulting measures to limit transmission appear to have led to an increase in children's digital activity. For instance, a UK report of children's media lives in lockdown noted that "restrictions on normal life have left a space which [children] are filling with social media, gaming and watching content" (Ofcom, 2020, p. 4).

Children's increased use of digital technology throughout the pandemic can be viewed as an intensification of a growing trend. Data from previous reports (e.g. Ofcom, 2017, 2019) have shown a steady increase in the number of children that own or have access to devices and who play games, including online games. For many children, play practices were therefore already highly digitised (Marsh & Bishop, 2014; Stephen & Plowman, 2014), including play that crossed over and blurred boundaries between online-offline and onscreen-offscreen forms (Cowan, 2018; Potter & Cowan, 2020).

In the initial months of the pandemic, digital play was actively encouraged as a measure for slowing the spread of the virus. The World Health Organization (WHO) launched the campaign "PlayApartTogether" in collaboration with games industry partners in March 2020, promoting gaming as a way to observe the WHO's physical distancing guidelines. This endorsement of online play contrasts the organization's warnings about "gaming disorder" and a narrative of gaming addiction (World Health Organisation, 2018), that prompted headlines about "the rise of a 21st century epidemic" (Bliss, 2020). When faced with a very real and urgent health crisis, the WHO appeared more open to the benefits of such play, with attitudes towards video games shifting from health concern to health intervention.

Whilst digital play has at times been endorsed throughout the pandemic, it has also been criticised, with articles in the press expressing alarm at children's increased "screen time" (Geddes & Marsh, 2021). However, simple quantification of "screen time" has been critiqued for failing to recognise the many practices that can take place on a screen, varying in content and contexts of use (Livingstone & Blum-Ross, 2020).

The endorsement of digital play on the one hand and problematisation of it on the other reflects an ongoing binary discourse surrounding children's digital practices, exacerbated by news media, tending to fall into polarised extremes. Rather than blunt measurement of "screen time" there is a need to better understand what young people have been doing on, through and around screens during this unique time. The complexity of children's digital lives therefore requires a balanced and nuanced approach to understanding digital play and approaches that includes children's own views in these discussions.

## 3. Digital Play: Multimodality, the "hundred languages" and dynamic literacies

A multimodal perspective, with roots in social semiotic theory (Kress, 2010), focuses on ways in which

meaning is made in multiple modes beyond language, such as image, moving image, music, gesture and movement. It is a perspective that has gained particular popularity among researchers interested in digital media and digitally-mediated social practices as a means of attending to the complexity of contemporary communication (e.g. Adami, 2009; Domingo, 2011; Flewitt, 2011). Multimodality places emphasis on identifying and understanding the affordances of particular modes, that is, what kinds of meaning-making each mode makes possible and what kinds they constrain. In this way, a multimodal perspective offers a more balanced approach to understanding digital play through focusing attention on the potentials and limitations of digital tools and their uses in everyday social contexts.

Multimodal perspectives help to draw connections between digital play and learning, recognising that in play children are drawing rapidly and readily on a range of resources, often both digital and non-digital, to make meaning. Each choice reflects interests and understandings of the child, offering insights into their worlds and experiences. Recognising that this happens in a multitude of forms, not only spoken and written modes, helps to expand the lens around what counts as learning (Bezemer & Kress, 2016). In this way, play with a range of materials (e.g. digital and non-digital) might be seen to expand meaning-making and expressions of learning, as "the combination of modes amplifies and/or complicates the separate strands of monomodal meanings" (Wohlwend, 2008).

There are complementarities between multimodal perspectives and the concept of "the hundred languages of children", a theory developed by the innovative Reggio Emilia schools in Northern Italy, informed particularly the work of Loris Malaguzzi (see Malaguzzi & Cagliari, 2016). The concept of the "hundred languages" recognises and gives value to the many forms of expression children use to make meaning, beyond those of speech and writing, and is supported in educational practice that provides time, resources, spaces and relations for play and creation in multiple modes (Filippini & Vecchi, 2000). Whilst the "hundred languages" have often been considered in terms of physical materials (clay, wire, paint etc.), consideration of "digital languages" has been given increasing focus in Reggio Emilia in recent years (Reggio Children, 2019). Underpinned by a strong multimodal pedagogy, the Reggio Emilia approach therefore offers an additional frame for recognising the potentials of the digital in meaning-making (Cowan, 2019).

Such meaning-making is essentially the product of interrelated "dynamic literacies", incorporating the production of multimodal texts within a sociocultural frame, responding to the changing nature of texts, artefacts and practices over time (Potter & McDougall, 2017). Children's play, with its "hundred languages" and facility for drawing on multimodal resources to hand, whether digital or non-digital, is socially constructed and highly complex, with much to tell us about their experiences of living through an historically important event such as a pandemic. Perspectives such as multimodality, dynamic literacies and 'the hundred languages' therefore offer valuable lenses for observing and recognising the significance of these moments as serious and significant meaning-making, and for valuing the many avenues of communication and expression made possible by the digital.

## 4. Methodology

This article reports interim findings from the project "A National Observatory of Children's Play Experiences During COVID-19", a 15-month study led by an interdisciplinary team of UK researchers, bringing perspectives from social science, multimodal research, media cultures, folklore studies and histories of childhood. The project examined the impact of the coronavirus pandemic on children's play, offering insights into their experiences during times of stress and uncertainty, and creating an archived collection to inform future generations' understandings of young people's lives at this time in history. The key research questions were:

- How have children been playing during the COVID-19 pandemic (both online and offline, analogue and digital) from the initial outbreak of the virus, throughout lockdown and during ongoing social distancing?
- How has the COVID-19 pandemic featured as a point of reference in play and peer culture, and what insights does this give into children's unique experiences of it?
- What continuities and discontinuities does this play and peer culture have compared to those of the past, and between different communities?
- How can interdisciplinary perspectives help us better understand the role and value of play for wellbeing during times of crisis?

The project drew on the legacy of British play researchers Iona and Peter Opie and the research team's previous case studies of playgrounds (Opie & Opie, 1959; Willett et al., 2013; Potter & Cowan, 2020), combining ethnographic, multimodal and participatory approaches to data collection, drawing on sociocultural theories of childhood (James & Prout, 1997).

However, being unable to conduct face-to-face research due to the pandemic necessitated a shift to entirely online methods. The project sought to maintain the core principles and ethos of these earlier in-person studies despite the changing context and new challenges, an approach that has been called "keeping the essence of

methods alive" in pandemic times (Barker, 2021). For instance, the research was approached by "thinking ethnographically" (Atkinson, 2017) despite being unable to carry out traditional on-the-ground ethnography, requiring new online methods of data collection.

The research was designed as an online survey and a series of online case studies. The survey, led by members of the research team at the University of Sheffield and UCL CASA, aimed to capture the spirit of Iona and Peter Opie's loosely structured play questionnaires, or "suggestionnaires" (Bishop, 2016). The survey was designed to gather examples of children's play throughout the pandemic through a mixture of open and closed questions, with the option to upload accompanying media files such as photographs, drawings, video and audio recordings in addition to written descriptions. This feature enabled a rich multimodal dataset to be collected, consisting of examples in a variety of forms accompanied by demographic information about contributors, providing valuable metadata such as country and age of children. An adapted version of the survey was created to make the survey more accessible to child contributors, inviting children to share examples in their own words or with the help of an adult, as well as pathways for adult contributors (e.g. parents, teachers). The survey invited contributions about any examples of play and peer culture relating to children and young people aged 18 and under from anywhere in the world, from the outset of the pandemic onwards. Contributors were also invited to post responses to avoid potential digital barriers to participation.

To add depth to the survey responses, case studies were carried out with a sample of families who had participated in the survey and indicated their willingness to be involved in further research. These families were sampled to represent a range of geographical locations throughout the UK, a spread of children's ages and aimed to represent a diverse range of respondents (using optional information entered in the survey relating to ethnicity, disability etc.). The case studies combined a number of methods designed to support children's participation, including semi-structured Zoom interviews, the invitation to draw a picture or make a map of their play experiences, the option for older children to create a short film highlighting their experiences, and the possibility to design and develop project outputs with the team. This range of methods gave children opportunities to represent their experiences in multiple modes beyond language, and to be active researchers of their own lives, drawing on multimodal methodologies (Jewitt, 2014) and participatory approaches to researching with children (Clark, 2017). In this way, the research aimed to include children's own voices in the research and give them multiple avenues for involvement in various forms.

The study received ethical approval from UCL Institute of Education, guided by the BERA Ethical Guidelines (British Educational Research Association, 2018) and the NCRM ethical guidelines for working with visual data (Wiles et al., 2008). Particular attention was given to ethical issues concerning research with children, including seeking voluntary informed consent from parents and providing specially designed information and consent forms for children.

This article draws on interim findings from the study, at which point there had been 137 contributors to the survey, and case study interviews had been carried out with eight children between the ages of one and thirteen. For the purposes of this article, data from both the survey and case studies were searched to identify examples related specifically to digital play. Digital play was classed as examples in which digital hardware, software or media texts were mentioned by either children or adults. From this selection, the data was analysed thematically and iteratively, identifying four overarching categories of digital play during the pandemic: "Digital Games", "Digital Play through Video Calls", "Play Referencing Digital Media" and "Playful Digital Media Creation". Although these four categories highlight distinct themes in the data, there are many connections between and across these categories that show the interconnected and holistic position the digital has in many children's lives, as discussed in the sections that follow.

## 5. Findings

### Digital Games

A key finding across both the survey and the case studies was the popularity of digital games among many children throughout the pandemic. For some children this included online gaming, and for others it included playing with digital games and apps alone. The world-building game *Minecraft* and the game creation platform *Roblox* were particularly popular, mentioned by several children as ways they spent time during the pandemic. For younger children, games such as *Toca Boca* and features such as *Google Augmented Reality* (AR) were also mentioned, as well as games marketed for education such as *Phonics Hero*, designed to support early literacy.

In some cases, digital gameplay was an intergenerational family activity. For instance, a family from Australia described playing the console game *Mario Kart* together and the mobile game *Hay Day*, with a parent from the UK talking about playing the movement-based games *Just Dance* and *Ring Fit* with their children. Several of the examples also mentioned online play with extended family they were unable to see in person. For instance, a ten-year-old from the UK explained how he built structures in *Minecraft* with his cousin and an eleven-year-old from the UK told us his

family had used the online platform *Board Game Arena* to play games with their grandparents at the beginning of lockdown.

Many of the examples also mentioned using digital games to play with friends, sometimes one or two and sometimes as part of large groups. For example, a parent from the UK told us their fourteen-year-old son played the online multiplayer game *Among Us* with groups of friends. In some cases, digital games involved meeting up with friends in virtual worlds. For example, a parent from Australia described their eleven-year-old daughter spending "a lot of time playing *Roblox* and *Minecraft* with her friends … In the past week or so, she has been building a world in *Minecraft* with one friend". A parent from the UK told us their fourteen-year-old son had been using a virtual reality (VR) headset "to allow meeting up and collaborative play", playing the virtual reality game *Beat Saber* with a friend.

Whilst digital games have been steadily growing in popularity in recent years, the data suggests their use increased throughout the pandemic. A parent from Australia commented "my children have relied a lot more on digital play – the older ones play online with their friends and the younger one likes to play with me (mum)". This seems in part to have been due to the restrictions on seeing friends in person. For example, a parent from the UK said, "As they weren't seeing friends, they linked [their tablets] online and had the chance to build together [in *Minecraft*]". Another UK parent explained that for her children "screen time definitely increased … because phones were the only way that children could stay in touch with their friends". A ten-year-old from the UK told us that he "did more online games in the second lockdown", when he had to stay home and the winter weather limited the time he spent playing outside.

Both the adults' and children's comments suggest digital games were an important way of keeping in touch with people and improved their wellbeing during a challenging time. For instance, an eight-year-old from the UK explained, "I have been doing *Roblox* with a friend in Singapore… It made me feel happy because I could connect with my friend through a game". A ten-year-old from the UK told us that he had been playing "*Minecraft* and *Roblox* with friends on the iPad" reflecting that the activities made him feel happy and more connected to his friends during lockdown. An eighteen-year-old who was waiting to go to university told us he had connected with others at his new college through social media and that they had played online games such as the drawing game *Scribbl.io*. He explained that the games "were really important: although we would often just chat for ages about all kinds of topics, having them meant that we had more fun and were able to build experiences together."

The findings therefore suggest that digital gaming was an important play experience for many children and young people throughout the pandemic. Digital games were sometimes played alone and with family members in the same household, and sometimes with extended family and friends. The findings suggest that the use of digital games increased during the pandemic and that this play was valued by children and adults alike as an important way of socialising and staying connected to people they could not see in person due to restrictions such as lockdown. Digital games therefore seem to have significant potential for maintaining social connections across distance and supporting wellbeing during periods of physical distancing.

## Digital Play through Video Calls

Although digital games were extremely popular, our findings reveal that this was not the only form of digital play children engaged in throughout the pandemic. Several examples in the data relate to Voice over Internet Protocol (VoIP) systems for video telecommunication, such as *Skype* and *Zoom*. Although primarily designed for conducting meetings, these systems saw a dramatic increase in use during the pandemic as ways of staying in touch with people who could not be met in person.

Examples in the data highlight the diverse ways in which children, young people and families used these systems playfully during the pandemic lockdowns. For instance, a seventeen-year-old from the UK described playing online quizzes via *Zoom*, explaining that a "group of school friends took turns every week to make general knowledge quizzes, usually on *PowerPoint* on laptops. We kept a record of scores every week so we could decide an overall winner at the end". One parent from the UK shared that their children hosted "a bingo session and their friends joined via video call, which was a lot of fun". A ten-year-old from the UK also described playing the dice game "Shut the Box" with his grandfather over *Zoom*. In these ways, video calls supported gameplay across distance.

Several examples revealed that video calls and other messaging systems were often used simultaneously alongside digital games. For example, an eleven-year-old from the UK said he "started playing *Among Us* this year- and over *Zoom* at the same time with friends". Similarly, a ten-year-old from the UK said using the instant messaging system *WhatsApp* to chat while playing online games with friends helped him to feel more connected to them. These examples show the interconnectedness of children's digital practices, where multiple systems and devices may be used together to facilitate social layers to digital play.

For some children, video calls were used in playful ways that blended elements of digital and non-digital play. For example, a parent from Germany explained that her four-year-old son used *Skype* to play with his grandmother who lived in Scotland: "They would set up so one or the other had their dolls house and they would instruct each other where to put the figures etc."

A UK parent described how their four-year-old child, who was shielding due to medical conditions and was classed as extremely vulnerable, played with her support working through *Zoom*: "She'll run off and get cuddly toys and make them talk to the camera and [the support worker] would talk to them". During our *Zoom* interviews with children as part of the case studies, we were sometimes invited into play scenarios ourselves. For instance, a four-year-old from the UK chatted to us from inside his "bear cave" den made out of fabric and pegs, and his one-year-old brother initiated a game of selling pretend ice cream, "passing" an ice cream through *Zoom* to one of the researchers.

These examples show ways in which traditional play could be adapted to the medium of video calls. Sometimes, the use of video calls seemed to give traditional games a new dimension and make new forms of play possible. For example, a parent from Denmark explained: "My kids (girls aged 3 and 6 at the time) were playing hide and seek with their grandparents using an iPad. I was involved to facilitate, since I had to hide grandma and grandpa (the iPad) for the kids to find them. This gave a whole new dimension to the game, as grandma and grandpa could be hiding in the kitchen drawer or under the sink – or under the bed. When the kinds couldn't find them, they asked them to make a sound as a clue."

These examples show enhanced and multiple instances of the kind of games reported in previous research on intergenerational play over *Skype* (Kelly, 2015). Our findings similarly suggest that video calls were a valuable way of sustaining play with people who could not be met in person. This included adapting existing games to the potentials and constraints of a new digital format and creating new forms of hybrid play in the process, blending online/offline and digital/non-digital elements.

## Play Referencing Digital Media

Many of the submissions revealed that children had engaged playfully with digital media of various kinds throughout the pandemic, including watching films, television, streaming services like *Netflix* and content on *YouTube*. For example, one family from the UK described watching and singing along to funny songs together on *YouTube*. Several parents mentioned *YouTube* tutorials such as "Draw with Rob" and classes such as "Cosmic Kids Yoga" and "PE with Joe", a daily home workout series launched during lockdown that was extremely popular with families in the UK. In this way, some of the media children enjoyed during the pandemic was a continuation of earlier practices but some of the content was shaped particularly by the pandemic context.

These influences from digital media were reflected in several play examples. One parent in the UK shared an example where her seven-year-old daughter had used her Barbie dolls to recreate "PE with Joe" by arranging them into press-up positions, and had made them masks to wear. A video shared by another parent in the UK showed their child pretending to give a COVID test to a toy character from the film *Frozen*. A parent from Berlin described her children playing Harry Potter-inspired games during lockdown and "conjuring spells to defeat corona" as well as making "potions" to cure the virus. The influence of digital media was therefore evident in several accounts of play that we received, inflected also with influences from the pandemic context.

Digital games also found their way off the screen and into other play of various kinds. For example, a parent from Australia described her children recreating a physical version of the online game *Among Us* with their friends when they were able to play outside together in the local neighbourhood. Figures from *Among Us* also featured in an example of children's chalk markings made in the street during lockdown in the UK. Similarly, one of the enemy characters from *Minecraft* featured in an example shared by a ten-year-old in the UK: "I did chalk drawings on the drive in front of my house… Because of COVID I didn't want people to come near the house and act like COVID doesn't exist. So I did chalk drawings of things like a ghost, a bottle of poison, a skull and crossbones and I wrote Keep Out. Later my sister came out and we drew a creeper from *Minecraft* as well".

These examples show ways in which children's play blends inspiration from familiar media texts of various kinds, including *YouTube* videos, films, books, and digital games whilst also incorporating references to the pandemic context. This reveals the interconnedtedness of children's playworlds and the permeability between onscreen-offscreen and digital non-digital play experiences. It echoes findings from our previous research in physical playgrounds and the "laminates" of experience children draw on in their play, from remixed and remediated popular forms through folklore and children's everyday lived experiences (Potter & Cowan, 2020).

## Playful Digital Media Creation

In addition to play influenced by digital media, the findings reveal that several children also created their own playful digital content in a variety of forms during the pandemic. This seemed, in part, to be supported by having more time to engage in such practices during lockdowns, and often took inspiration from the context of the pandemic as well as media texts they enjoyed and were familiar with.

Some of this digital creation took place within digital games. For instance, an eleven year old from the UK said he had spent time during the pandemic "watching *YouTube*, getting hints and tips for *Minecraft* builds". A ten year old from the UK told us he had built a replica

of his own house in *Minecraft* and the parent of a nine-year-old described a "cave house" her son had made using the programme. Sometimes the pandemic featured in this digital making, for instance two brothers from the UK built a "coronavirus clinic" in *Minecraft*, including a lever to trigger an outbreak and a cure for infection.

A number of children mentioned creating their own films and animations during the pandemic. For example, a ten-year-old from the UK described creating a stop-motion animation using loose parts and *LEGO* minifigures that he called "Bumblebee vs Sinestro", referencing characters from the *DC Comics* series: "I recorded my animation on my iPad with a tripod and I used the *LEGO* animator app… It took a lot of time but I was very happy with my film. My mum sent it to my grandma and my uncles, aunts and cousins". One parent in the UK described their daughter creating videos "with her Dad/Brother using Barbies and her *Disney* Aladdin which have made her laugh immensely", showing ways in which toys can become props for videos. A parent from Australia also described her fourteen-year-old son creating 3D models using the software *Blender*, including making things requested by his friends.

Further examples included the parent of an eleven-year-old and eight-year-old in Australia who described how her children enjoyed making movies and "edits" (a series of photos edited together in a short film). An example shared by a seventeen-year-old in the UK featured a music video he had created during lockdown for a national media competition: "My music video "Lost Without You" was created, directed, edited and filmed by me. I had to work independently due to the pandemic and lockdown restrictions". Another submission featured a short film created by a teenager in the UK as an assignment for her college course during lockdown, created using *iMovie* and stop motion software: "I decided to follow a 1920s style, that explores what lockdown could've looked like 100 years ago, where there was no technology and children and young people had to entertain themselves!" She reflected that the film-making activity helped her "put a positive spin on lockdown".

The pandemic was also a central theme in a short film created by a ten-year-old from the UK made with his father during lockdown, entitled "Covid Gone", in which photos and videoclips from their home and local neighbourhood during lockdown are given a voiceover reflecting on their experiences. A parent from Chile noted themes relating to the pandemic in her thirteen-year-old son's filmmaking: "making videos and uploading them to *YouTube*, with wooden animal figures as protagonists. One of the stories was about the animals not being able to go anywhere and being bored, when we were in the middle of lockdown". A parent in Australia shared a series of *YouTube* videos created by her daughter in a vlog style, in which she shared information about coronavirus and tips such as handwashing.

These examples highlight some of the playful ways in which children and young people have been creating digital media during lockdown and throughout the pandemic. They show digital hardware and software being used to draw on familiar popular media genres such as comics, cartoons, film, videogames and *YouTube*. The pandemic itself was a focus in several of the media submissions, highlighting children's understanding of and response to the pandemic in audiovisual forms.

## 6. Discussion and Conclusions

The Play Observatory findings reveal that digital play has been a significant part of many children's experiences of the pandemic. Both young people's own accounts and adult observations indicate that digital play increased throughout the pandemic, showing an intensification of ongoing trends identified in other recent surveys of children's digital lives (Ofcom, 2017, 2019, 2020). This may have been, in part, due to having more time at home to engage in playful activities throughout the pandemic and to take up new hobbies such as animation and film-making.

However, it is important to also recognise that children's experiences of the pandemic have varied considerably. A 2020 report by Save the Children highlights digital inequalities, noting that many families "lack reliable, affordable internet access, which makes it hard for children to play online or benefit from digital ideas and resources for play" (p. 3). This suggests that the pandemic may have exacerbated existing digital inequalities as more practices, including play, turned online. However, our study also revealed many episodes of play that did not include the digital, such as outdoor play, physical play, crafts, den-building, play with toys and imaginary play.

From the Play Observatory findings, a major affordance of digital play was the possibility to socially connect with others while being physically separated, helping children's play endure, adapt and respond to restrictions.

Firstly, it made possible the *continuation* of several existing play practices. Whilst schools and playgrounds were closed, and meeting up with others in person was restricted, digital play such as online gaming offered a way of continuing to connect with friends and extended family members.

Secondly, the data revealed many instances of *adaptation* of traditional play to new digital formats, for instance playing quizzes, bingo and board games through video calls, as well as younger children sharing toys and role-playing with others through the screen. This shows the resilience of play, and the creative

capacities of children and young people to find alternative ways of playing when subjected to restrictions.

Thirdly, the findings show the *emergence* of new forms of play through this digital adaptation. For instance, a game of hide and seek played through an iPad enabled grandparents to be hiding "in" a kitchen drawer; a physical impossibility in the traditional version of the game, but made possible digitally. Such examples show the hybrid nature of much digital play, where boundaries such as online/offline, virtual/real and onscreen/offscreen have become increasingly blurred and blended throughout the pandemic.

Finally, in several examples the pandemic itself was a point of *reference* in play, often intertwined with digital media influences. For example, a coronavirus clinic built in Minecraft showed understanding of outbreaks, infection and immunity, Barbie dolls re-enacted a home workout popular on *YouTube* during lockdown and a toy character from the film *Frozen* was tested for COVID. These instances reveal children's awareness and understanding of the pandemic, with play potentially offering a way of exploring new and unsettling ideas and exercising agency. Similarly, children's digital media created during the pandemic often playfully, and poignantly, explored themes relating to the virus in forms such as films, animations and *YouTube* vlogs, often then shared with others. These creations combined both influences from popular digital media texts and genres, whilst often inflected with themes relating to the pandemic. In this way, digital play offers rich insights into children's understandings and experiences of this unique time in history.

The enduring nature of digital play as a source of connectedness, resilience, wellbeing and creativity has been seen throughout our data, adapting and responding to the pandemic. The Play Observatory therefore highlights the complexity of children's digital play, troubling the "screen time" discourse. The blanket term is often used to cover a multitude of practices whilst positioning children as inactive, uncritical consumers of media. Instead, framed by perspectives such as multimodality, dynamic literacies and the Reggio Emilia concept of the "hundred languages", the findings from the Play Observatory highlight the many "languages" or "modes" that are combined in play, and how the digital can amplify potentials for meaning-making rather than constricting them. Crucially, it emphasises that digital play is far from passive.

This raises questions as to whether children's digital practices, often developed in play at home and outside of school, are given equal attention and recognition in formal education. Dynamic literacies, multimodality and the "hundred languages" offer both conceptual lenses and pedagogical practices that can support meaning-making in the widest sense, including the digital. Valuing the complexity of children's digital play, its specific affordances, the interconnectedness of play practices and the increasingly blurred boundaries between digital and non-digital play is necessary not only in relation to making sense of children's play experiences during the pandemic, but also for understanding and supporting digital childhoods more broadly in the post-pandemic period and beyond.

## Acknowledgements

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INVITED PAPER

# Digital Sculptors

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**Abstract**

Together with painting and music, sculpture is considered one of the Fine Arts, for its intrinsic aim of expressing beauty. It consists of the art of modelling clay, sculpting stone, wood, and other materials to create three-dimensional objects. It allows us to shape materials and research a reality that produces knowledge of the world, and of ourselves. With its rich expressivity sculpture can be considered to all effects a language, given to children's hands, and offering them a way of communicating the interior world, creatively expressing thoughts and feelings. What happens when an artistic expression strongly associated with materiality encounters the digital? We speak today of hybrid materiality, of space and time "spime" objects, of digital fabrication and indirect manipulation of artefacts. These new forms of digital sculpting enrich imaginaries and meet original artistic visions. Relations between materiality and digital are increasingly complex and interesting, so that we wanted to explore this in a school context, with a group of 23 children at the Primary School at the Loris Malaguzzi International Centre in Reggio Emilia. The intent of the project design that supported this research, was to experiment in parallel ways with different sculpting proposals (clay, 3D pen, digital manipulation, and 3D printing), asking the children for their comparative analysis.

**KEYWORDS:** Digitally Integrated Didactics, Digital Modelling, Creative Thinking, Technology, Art.

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## 1. Pebble or sculpture?

The Makapansgat Pebble is a 3 million year old jasper cobble, reddish-brown in colour, and weighing 260 grams. Human features can be made out on its surface: round eyes, a mouth hole, and grooves tracing a head-cover or haircut.

The pebble was found in 1925 in a South African dolerite cave on the banks of the Limpopo River, but was only connected with the finding of African Australopithecus bones in 1974 (Bednarik, 2011). So, is it a pebble or a sculpture? We still cannot be certain it is a sculpture today, and it has also been suggested the pebble was taken into the cave when an australopithecine recognised a stylised face in it, which would make it the oldest known example of symbolic thinking and an aesthetic sense. The fact that an australopithecine recognised a face in the pebble could indicate the first hominids were capable of symbolic

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thinking, a necessary condition for the development of art and language (Kleiner, 2011).

**Figure 1** - The Makapansgat Pebble (source: Alamy Photo Stock).

One morning, children in the third year at the Primary School at the Loris Malaguzzi International Centre were consulting accredited books and websites for the study of human evolution, when they came across the Makapansgat pebble. Is it a stone or a sculpture? The words accompanying the illustration did not clarify the uncertainty and the children's research necessarily extended to consult other sources. Debate was immediately generated in class. After magnifying an image of the pebble on their tablets some children maintained the pebble was certainly a sculpture. Other children, more sceptical, responded that the picture could be a photograph re-touched using a computer programme. Another group believed the theory that the pebble was taken into the cave because it resembled a human face. Together we decided some trials and experiments were needed in order to credit the children's different points of view and opinions. One group would try and make a similar sculpture to the pebble after studying what tools were available to australopithecines, and using these themselves. A second group would use digital technology to alter an image of a pebble and try to make it look similar to a human face. A third group chose to explore and search for other examples of zoomorphic or anthropomorphic pebbles to see if these could be found.

For two months the three groups explored and worked, trying and testing, and carefully documented the various passages of their work and investigation. Group 1 found that the mineral jasper is not found in the area they live in and after discussion chose to use porphyry cobbles as an alternative. With scientific rigour they chipped other kinds of stone to make rudimentary stone chisels with which they could work and sculpt, but after several attempts and results they were not satisfied with, they decided to suspend this line of research for the moment, and pause to reflect. The second group used two different kinds of software, Gimp and Photoshop, to retouch photographs of pebbles. They started with photographs of pebbles that either they took themselves or which they found on various websites. Then, using the digital software they altered the colours of the pebbles, and began to draw hollows, crevices, and shaded areas, until they had a collection of representations of pebbles with human features, in a similar way to their reference point, the Makapansgat pebble. The children in this group were highly satisfied with their results. However, having successfully completed their task the children wrote in their documentation that their research should be rejected, because they had discovered the Makapansgat pebble is a real stone found in the British Museum in London, and that this proof invalidated their starting hypothesis of a faked two-dimensional construction. The third group explored various environments, collecting and selecting pebbles in riverbeds, in mountain areas, and in the school garden. They put together a collection of about ten pebbles and classified them into the most interesting shapes: a fish, a lizard, a moon, an eye, and a house. However they did not find any stone resembling a human being. At the end of this journey this third group stated that they were no longer sure of their starting hypothesis, that the stone had been carried into the cave because it resembled a human face.

Is it a pebble or a sculpture? At the end of the school year we decided the question was still open for us.

## 2. The educational context

The majority of the children who are the protagonists of this story (16 out of 23), attended the Municipal Preschool at the Malaguzzi International Centre in Reggio Emilia before proceeding into the State Primary School in the same building at the Centre, and where the Preschool and Primary School shares the ideas and practices of teaching/learning, design/planning, organisation and participation, and documentation. It is one unified school whose identity is generated starting from two experiences, a municipal preschool and a state primary school with a continuity of educational project for children aged 3-11 years. The school is aware of, sensitive to, and active towards an epistemology of knowledge. At once operative and reflective, it seeks to create favourable conditions for divergent and creative processes, and solicit questions to which children can research answers through a multiplicity of sources and the many – "hundred" – languages the school supports the children to use. It is a transformative school, in the sense that it seeks to constantly redefine its identity in relation to new social contexts, life styles, and the symbolic languages that belong to the new generations (Tedeschi & Manfredi, 2016).

In this educational and formative context, the digital becomes part of a cultural ecosystem of "the hundred languages" in dialogue with the ideas of children.

## 3. Listening with our hands

Leaving questions open, without arriving at a definitive answer, allows us to return to our documentation in a recursive way over time, re-reading, and re-searching problems in the light of awareness we have gained, and new connections with other fields of research. This often happens in the work we do at school, and to favour this continuous re-elaboration of thinking, the documentation archives are always available to children, who can consult them in large folders dedicated to various themes, and digital folders they share.

The children who had investigated the Makapansgat pebble reached the fifth year of primary school, where they were exploring concepts of complexity and variety in three-dimensional forms, using different strategies such as observing with concave and convex lenses, investigation and representation from real life using various materials, and drawings and graphics on paper and using digital. During this work the children remembered the proto-sculpture Makapansgat pebble they had encountered and studied two years before. However their interest was no longer on investigating the authenticity of the pebble, but the particularity of its 3D form, and ways of exploring and investigating it. Although their point of view seems new, it is closely connected with the learning and knowledge of their past experience, with the wonder generated by ideas and that was the motor for their research as a group when they first encountered the pebble. Creativity often combines curious exploration with playful experimentation and systematic inquiry (Resnick, 2017).

There were a myriad of possible ways for the children to work on investigations from life, make interpretative representations of the pebble, and explore its 3D qualities. The children are used to researching in groups and so before beginning agreements and decisions have to be made between them, about who will work together and in what way. After conversations one group chose to work with the technique of clay, which they were investigating at the time in the atelier, with the *atelierista*, a full time part of the working group of school educators with a background in the arts. Another group chose to try and interpret the pebble using digital modelling software that was installed on a 65 inch 8 touch multi-media touch display. Together with the children we agreed that we would collect our observations and compare notes, experiences and viewpoints on the different processes of working with material clay and virtual sculpting.

The initial hypothesis of the first group, working with material clay, was that they would not encounter difficulties. However after working on explorations of the three-dimensional possibilities of this material they told us this had not been the case. In conversations about their experience the children told us: “When you sculpt the clay your hands have to shape it”; “To model a material your hands have to listen to it”; “Your hands transmit sensations and communicate data about the material”; “You can only modify clay as long as it is [soft] and damp”; “At the end you have a sculpture that is unique, defined, and finished”.

**Figure 2 -** Experimenting with sculpting clay (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia).

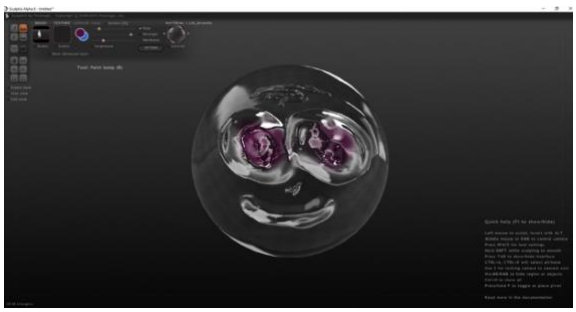

**Figure 3** - Digital sculpting (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia)

The second group chose to work with the digital software Sculptris. The functions of this software are accessible for those without a prior experience of digital art. In “sculpt” mode, users are offered a ball of virtual clay to shape, by touching the screen with their hands. The interface is intuitive for children to navigate and offers a rich variety of different modelling functions. Sculptris is a powerful 3D sculpture application offering a variety of virtual materials to sculpt, and at any point users can also send their work to a 3D printer, using STL (Standard Triangulation Language) universal format.

The children worked together on the screen, with several hands sculpting and shaping, also experimenting with different colours and shades, and with changing the dimensions of their sculptures. After a journey of work involving much exploration and experimentation the children were satisfied they had come to completion of their sculpted work. In conversations about the experience of digital sculpting the children told us: “In digital sculpture your hands don't meet with the clay, but they can shape it virtually”; “You can fashion virtual

material, but your hands can't listen to it"; "You can rotate a 3D image"; "You can change it until you get the shape you're looking for, even days afterwards, because this sculpture doesn't dry out like clay does"; "You can print your 3D model and make series, multiples and copies, but your sculptures can be lots of different sizes and colours too".

The second group, like the first, was working from "life" to reinterpret and represent the Makapansgat pebble, however in this group their sculpture was not considered definitive and the children continued to adapt it, making several variations, with happy faces, angry faces, ageing faces. They also represented a variety of hairstyles from Mohican to colourful braids, and also versions wearing hats.

One of the strong themes to emerge from the experience of digital sculpting was the possibility of creating series, or multiples, which may all be identical, but which can also express a vast range of variations, in size, rotation, point of view and colour etc.

One child said, "A digital sculpture is never finished, you can change it forever. You can look for the beauty that you like, and then still change your mind".

So is a digital sculpture an incomplete work? Can we speak of the sculptural technique of the incomplete, such as Michelangelo and Donatello experimented with in their work? And again, what kind of beauty is the beauty that I like? Where is it that I go to look for it? And when I find the beauty I was looking for, what then makes me change my mind about it?

Once again, from the words of one of the children in the group, many new questions were generated, opening new perspectives on our research, and crossing into two new and different areas and levels.

First there is an opening to research of an art history kind. We have been working with sculpture and exploring our capacity for thinking with our hands, but this gesture of shaping and giving meaning to material has a history we do not know, has been part of the history of humankind from our very beginning, and we would like to know more about it.

A second opening for research is of a philosophical nature. Beauty is a word we use often in relation to ourselves and what surrounds us, but not everyone has the same idea of beauty, it is an idea that changes, that speaks about us, and the world around us.

This idea is explored by the philosopher Herder when considering new criteria for understanding aesthetic knowledge, turning to an aesthetics considered as the history of relations between the human body and its world, and electing philosophical reflection on the arts as a place of verification (Herder, 1778).

Once again we find ourselves with an image of children as constructors, of knowledge, competencies, and autonomies, capable of identifying their own educational needs and of always comparing different points of view. Children who are at once rational and reflective, constructing bridges between their own experience and that of the world around them, feeling a desire, a need, and a necessity to explore and understand, traversed by the pleasure and wonder of knowing. It makes sense therefore to acknowledge children's natural philosophical predisposition, to speak of the philosopher child, understood as an inquirer, a potential scientist and thinker (Malaguzzi, 2012).

It is essential to cultivate our questions, conserving the pleasure of time engaged in conversation, without giving in to the temptation of given answers (Dallari & Moriggi, 2016). The activity of reflection, and asking philosophical questions are spontaneous. We need to philosophise together with children, and let them be free to explore, themselves. We need to inhabit questions, to persist and stay with the questions, rather than providing ready answers to children's "whys". We need to work in their proximal zone of development and give value to the issue of making meaning (Vygotsky, 1934).

## 4. Digital art and hybrid materiality... at school

Each day relations between the material and the digital become more complex. The two dimensions, which only a decade ago seemed so far apart, are today engaged in constants dialogue, and processes of reciprocal contamination that can only result in redefinition for both (Wilkinson & Petrich, 2013). Children experiment with and try out hybrid processes and forms without prejudice, perhaps because they are more used than adults to passing from one dimension to another without attrition, and because they do not perceive borders and boundaries as limits.

How do schools respond to the cultural exigencies of these children, so capable of going out to encounter the multiple forms of our multi-dimensional future?

In 2015, Italy's Ministry of Education introduced a National Plan for Digital Schools (law 107/2015), an operational vision of the most significant challenges to innovation in the public school system. Central to this vision are innovation in the school system and opportunities in digital education. The plan responds to a call for constructing a vision of education in the digital era, through processes in schools related to the societal challenges of interpreting and supporting life-long and life-wide learning, in all formal and informal life contexts.

Schools must be capable of interpreting and supporting innovation, through digital education capable of confronting the new and unpredictable changes in society, culture, science and technology (Lisimberti & Moriggi, 2020). This is a vital and indispensable transition. Acknowledging children as digital natives does not exclude us from our responsibility of supporting them to be aware of their own reasoning, and to develop their real competencies.

## 5. Giving shape to dreams

Our times are characterised by hyper-contemporary issues such as digital fabrication, the process in which solid three-dimensional objects are created starting from digital drawings, and indirect manipulation of artefacts, which uses new digital tools while conserving and holding the memory of thousand-year-old traditions.


**Figure 4** - Passion flower realised by class 5^ using Sculptris (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia).

**Figure 5** - Passion flower realised by class 5^ using a 3D pen (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia)

Objects, today, can communicate with each other and with us; so called "spime" (space + time), entities drawn in space and time thanks to their IT components (Sterling, 2005). Completing the scenario are the possibilities of 3D printing, which transforms the very concept of what an artefact is. Any object, from a bottle top to an entire building, can be scanned, transformed into algorithm, and re-materialised by a machine that literally sculpts it.

We are already living the future, shaping it now with our gestures, with our hands, but we need to develop new competencies in order to see ahead.

There is an important statistic we cannot ignore provided by a World Economic Forum study: 65% of children now attending school will have jobs that do not exist yet, but that we must try to imagine.

In his film *The Wind Rises* Hayao Miyazaki gives us his definition of a designer, "someone who gives shape to dreams". We believe, and are convinced, that the place where we can begin to give shape to dreams is, and must be, schools.

## Notes

- An interesting prompt to reflection on the theme of digital fabrication came in an exhibition held recently at the iMAL Centre for Digital Culture in Brussels, Belgium, on a project titled *Material Want* by Matthew Plummer Fernandez and JODI, which joins Dadaist and Surrealist suggestions with hyper-contemporary issues such as digital fabrication. In the project artists created sculptures assembled in a random way from 3D printed files generated by web users.
- In *Shaping Things* Bruce Sterling calls objects "spime" (space + time), entities that can be drawn in space and time owing to their IT component.

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INVITED PAPER

# The Hundred Languages of Digital in the Reggio Emilia Approach

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**Abstract**

Digital environments in the Reggio Emilia Approach construct relational and communicative conditions that tend towards shaping modes of ecological research, where adults and children can create "platforms of community thinking" considered as processes of elaboration, in which the intelligences of children and those of the digital become proximal.
Digital technologies create geographies of place and representation close to children's visions of possible and dream worlds, with awareness that the imaginary worlds they bring to life always border on the world they inhabit, and the emotions they generate are always and only real.
Infant-toddler centres and preschools therefore have a responsibility for generating contexts of reflexive critical reasoning, on contents, on sources, and on the modes of communicating and relating that digital environments propose and offer, and for making visible the learning processes these contexts favour digital constructs connective threads between things, between situations, between experiences, so creating mental representations, subjective and group, between the real and the possible.

**KEYWORDS:** Fluid Cultures, Everyday Digital Environments, Ecological Thinking, Mind-Body, Platforms of Community Thinking.

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## 1. Children in digital environments

Reggio Emilia's municipal infant-toddler centres and preschools have always been characterised by their desire to maintain a vitality, tension, and vibration of research that pulls towards creating proximity between children, parents, educators and contexts of play, life and learning. The hope is that of generating a dimension of proximity between the fluid and dynamic cultures of protagonists who inhabit schools and centres every day, children and adults, and their places of life.

Schools for children of all ages cannot avoid consideration of the digital today, both in terms of using its tools and instruments, and the predisposition in thinking that it activates. We need to choose how to welcome the intense and pervasive cultural contributions digital technologies are configuring. Historically, the choice in Reggio Emilia's municipal infant-toddler centres and preschools has been to progressively interpret digital's nature, in terms of innovations it offers to children's potentials and

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intelligences, and to our vision of learning as a dynamic process. Our intent has always been the tension of not betraying children or technology.
In 1984 Loris Malaguzzi had this to say in relation to the strategic choice of experimenting with computers in preschools:

> *"The meeting of children and computers is, in effect, the meeting of two 'intelligences' that need to get to know each other. The children's intelligence is fluid, intuitive, curious, and yet able to 'decentralize' itself and assimilate new interactive rules, to adjust its performance, to find and alternate communicative and constructive proposals and solutions. The intelligence of the machine is more linear, rigid, programmed, in many ways an imposition, and in other ways receptive and willing to execute commands, able to listen to children and to encourage them (without humiliating them) to rethink their actions, to indicate the way out of a problem, to suggest the means for arriving at a 'joining of forces'." (Malaguzzi 1996, p. 103).*

In the 1980s digital technology, in the form of computers, printers, and floor turtles [a small robot shaped like a turtle created in the 1960s which can move on a flat surface controlled by commands in Logo language from a keyboard], became inscribed in the daily design of our educational experience, situated in a dialogue with other "languages", taking its place in classrooms, and offering children experimentation in small groups.

For the times this choice was visionary, and determined a framework of meaning-making in which digital instruments were conceptualised as part of an interactive dynamic, always maintaining children's active relationship with them. This initial vision evolved in later years, and shifted from an idea of digital instruments to the idea of digital environment. To our mind the definition "digital environment" is more coherent with the idea of an interconnected mind and socio-constructivist dimensions of learning.

Digital environments strongly interrogate our modes of teaching, and favour learning as a process of active research. Contexts that hybridise technologies and languages overturn hierarchies between adult-teacher and children-learner. This U-turn in vision has its epistemological framework in ecological thinking, and therefore conceives of any, and every, thing as part of a larger context, inviting us to comprehend the innumerable forms of inter-relatedness between apparently separate occurrences. This conception requires us to review our inter-subjective positions from viewpoints that are dynamic, inter-dependent, and reciprocal, with a tension towards research in which both children and adults are prime researchers of phenomena, subjects, and experiences they choose as objects of study.

**Figure 1** - *Digital Landscapes* Exhibition-Atelier at the Loris Malaguzzi International Centre, Reggio Emilia (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia and Reggio Children)

In Reggio Emilia's municipal infant-toddler centres and preschools digital technology enters daily life, hybridising with other languages, and constructing environments that are not narrowly tool-based and functional. In these environments learning contexts become inventive for one and all, manifesting as situations of busy thinking and action, contexts of research demonstrating solidarity and empathy between children and adults.
Children are born tilted towards others and the world around them, with a posture of curiosity that weaves oneiric dream-like thinking with contextualised and contingent visions. They inhabit a dimension capable of making the concrete and imaginary live together, using arguments that for adults are poetic and unexpected, and giving shape to new and original mental representations. Here we follow a short conversation on the theme of dreams between three 8-year-old children at the Preschool and Primary School at the Loris Malaguzzi International Centre:

> *"Dreams... it's a world your mind creates for itself... there's another world inside our head that we don't know. When I dream it seems like I'm the person I'm dreaming about, it seems like I'm in the world around us, I think I'm in reality but I'm in a fiction. And in this place it's my avatar who feels the sensations."* Kevin
> *"It's your clone. Because one lives in the world really, and one lives in dreams."* Hansel
> *"There* [in dreams] *my character feels the sensations and I feel them too because they're created in the air. Even if another person had the same dream as me they wouldn't be able to feel those sensations. I created my avatar myself while I was dreaming... it's female, because I'd like to*

> *feel the sensation of being female. I could become one too, but that's not original, I mean in my dream I don't feel like I am the same as me."* Kevin
> *"At the most I could imagine getting older or becoming an adult, but I couldn't manage to imagine becoming female, I really can't manage that."* Samuele

Children want to give shape to dreams, identifying pluri-lingual narrative forms, and seeking forms that:

> "*inaugurate new environments of socialisation and sharing where each child's 'mental' world – which includes external stimuli and interior representations, at once cognitive and emotional – can be expressed and communicated" (Bonilauri & Tedeschi, 2019, p. 14).*

They invent theatre sets, video games, and simulations using different kinds of software and applications that they can use on smart phones and tablets. So digital environments are particularly close to children's imaginaries. The intrinsic condition of a digital environment – devices inter-connected and in dialogue – offers a vision of environment as plurality, an environment given by several contexts connected with each other: a sort of pluri-environment with powerful connections between its parts. In school we can take this concept and construct hypotheses for designing and planning with it, so that the nomadic nature of devices dialogues with environmental contexts, connoting them as dynamic places, in which objects, materials, and matter all inhabit a plurality of spaces in the school: preschool and primary classrooms, ateliers, piazzas, gardens, and kitchens, creating a multi-system of opportunity in learning groups for communication, interpretation, and knowledge.

> *"We maintain children are born with all the languages of life […] The more languages we recognize in children, the more we can help them act and identify the methodological models they need for confronting events and experiences […] Imagination and logic, as well as feelings, creativity, and aesthetics, have a hundred roots and a hundred genes*es" *(Malaguzzi, 1996, p. 30).*

This approach, open to research with digital tools, leads children to interact freely, designing original and personalised devices, and searching for functional and coherent form and meaning. Their research is always proximal to concrete situations they experience. They do not separate their own imaginaries from their juxtaposed physical world, but border-cross between them. Digital environments contribute to connoting learning contexts as interface, where aesthetics, function, and meaning-making co-habit together.

In 2013 Bressy and Gennaro were both aged 8, and with Francesca, an *atelierista*, they were imagining the possibility of designing a transparent tablet they call "Infinity". We proposed they work on a prototype with materials available to them at school:

> *"What features does Infinity have?"* Francesca (*atelierista*)
> *"Infinity is a transparent tablet. The first thing is you can fold it away so that if you have a* pochette *you can fold it up and take it away with you."* Bressy
> *"Two people can use it to play battleships or draughts."* Gennaro
> *"You can take a photo with it, and then look for information with the photo. It will give you the photo in 3D too."* Bressy

The children's creative intuition and reasoning dating from 2013 has only recently been realised: the creation of transparent, flexible, fold-away smartphones anticipated by Bressy; devices for two people to share games together by touching the same screen, as proposed by Gennaro; and apps that feed our desire to search for information on given subjects, as Bressy again proposed.

Knowledge becomes structured into process through a recursive and evolutionary dynamic, on the condition it is made of experience and reflexivity together. A necessary condition is to pause with our experience, formulate arguments and inhabit places where exchange and comparison of viewpoints is possible, so that our knowledge can be nourished. It is especially important to have experience of dynamic learning situations in which our thought structures can modify, expand, and take risks "naturally".

Children are researchers into meaning, biologically predisposed to understanding the world they live in. The newest generations of digital technology have developed touch increasingly, in forms of technology that newly interrogate the themes of body and direct contact. Frequently we see even very young children using informal objects and materials as if they were devices. The gestures they use, and the functions they ascribe to them, suggest a sort of fusion between different "bodies", those of the children and those of tools. Children are bearers of their body's knowledge, creating mental representations that include the functions and potentials of digital technology.

## 2. The body-mind in artisan technology

In these processes the body is the fulcrum, resonating with the world, without ever separating the cognitive from the emotional. Our bodies have meaning and give meaning, elaborating metaphor to communicate beyond

our perceptions. Our integrity, the sense of being present to ourselves and in the world, resides in our bodies, and is fundamental to constructing an identity both subjective and social. The body is voice, gaze, a finger pointing, building questions made of gesture, movement, rhythm, and energy. These questions speak of how children are constructing their dialogue with the world.

The body has its own memory – sensory, visual, symbolic, narrative, evocative – in a constant osmosis with the world around it. Leaving signs, re-watching themselves, annotating with their bodies, are just some strategies children use to give shape to their own identity. An investigation of faces in profile, for example, entails bringing into play spatial experience, viewpoints, two and three-dimensional relations, and tapping everyday experience where they observe and imitate each other, lend each other gestures, questions, and theories, and amplify the communicative sensibility that exists between them; a mixing of language and experience which, on condensing, sometimes become sign.

In this sense space is also always a social and relational dimension. Recent research on mirror neurons testifies to the way relations between body, space, movement, and time are decisive for social competency and construction of identity, for being synchronised with all that is in the world. Moreover, this research tells us that our brain encodes space in motor terms. How do digital technologies, and interfaces in particular, expand, problematise, and vary these processes, that are so fundamental for the construction of self? What contexts can we design to strengthen an integrated vision of the body learning, and the construction of gestures, signs, and traces in digital environments?

In the daily lives of children and human beings digital interfaces, interactive or not, alter our perceptions of space-time. It is now accepted there is no dichotomy between real and virtual in these perceptive, psychological and philosophical categories, for the emotions we feel are always real. De Kerckhove inaugurated a new paradigm for the digital, constructing the concept of connective technology, a concept that gives greater potential to two fundamental elements: connectivity and contact.

In an experience called "Encounters with your Double", with 9 to 18-month-old children (in September) at the Gianni Rodari Municipal Infant-toddler Centre, a context was designed by teachers, *atelierista*, and *pedagogista* with a projector connected to a video camera positioned to live-film children playing in the space, and project the image onto a large sheet screen on a wall. The children were immediately attentive to what was going on, and surprised to see the projection. Flavio, aged 24 months, observed the projection for some time before standing in front of his own image on the wall, saying, *"It's me... all of me"*. He went on to look for himself, behind the sheet, before again looking at his image, and exclaiming, *"It really is me"*. Then, climbing onto a small wooden platform, intentionally placed in front of the projection like a stage, he began a sort of dance, moving his whole body. After attentively studying his different movements he stated, *"Oh it's me... but am I real or pretend?... I'm alive!*" These reflections Flavio has given us, are extremely interesting, in that they suggest he is not tied down to searching for one univocal answer, that on the contrary his thoughts launch towards a new definition of self in the context. Flavio recognises he is in a connected environment where his identity has become double, in a continuum that has no real or pretend, only the vital dynamics of a context welcoming his experience. In this way contexts become more nomadic. If I see myself, as well as friends and the actual space, as double, I create a connected space, a fantastical world that evokes oneiric atmospheres of dream.

Recently, in the municipal preschools and infant-toddler centres, we worked on a deeper exploration in the area of "Resonances: listenings, productions, compositions", in which we researched which conditions allow the languages of music and dance to become part of everyday life, in an educational approach where transversal relations in and between languages are central to curriculum. As well as sharing the body as their generative matrix, dance and music are characterised by a similar performative and phenomenological nature. They share complex dimensions (emotional, symbolic, poetic, dialogical, anthropological etc.) with other languages, and have a common space-time dimension that inevitably constrains the designing of contexts and didactics.

A group of 4-year-old children at the Michelangelo Municipal Preschool was researching the archetypal figure of the bridge, and in their work bridges went from having a static posture to being dynamic, part of a choreography built up in a dialogue of gesture and movement, and with the possibility of making agreements with the body, without words.

We know technology and digital tools structure thought and perceptions, and that we create a relation with the processes of digitisation. Every day children encounter digital films, three-dimensional animations, digital sound compositions, digital advertising, digital illustrations on paper, and multi-functional phones. These are all products of the process of trans-codification into computer data, influencing the identity both of the medium and the approaches of those who use them. Children are immersed in these processes, and their interactions with them structure relations in their daily lives. They are familiar linguistic codes, whose nature the children intuit, but do not yet govern. The intent of our educational approach, with analogical and digital technology, is to try and make children more aware of the ways they formalise these languages, by entering into the cultural-symbolic systems of communicative structures, and understanding their semantics.

In music and dance it is particularly important to be able to go back and see and listen to ourselves, at different times and in different ways. One of documentation's defining features is the tension to record, so we can see again and listen again, creating echoes of the awareness being generated during learning processes, and meanings being shared, with a consideration for the times and rhythms of learning languages.

In the children's explorations of bridges we hypothesised video could be a main tool for documenting, given its capability for holding onto the temporal dimension of unfolding performance, for connecting gesture and sound. Video was a useful tool for documenting children in the act of performing, and also narrating children who participated in the performance by "listening", highlighting the whole body's tension for listening, how listening can be both movement and stillness.

Every representation is unique in itself and the language of video allowed us to keep track of both movement and sound. With these specific qualities in mind, the opportunity to use video processing software offered greater possibility for creating representations, compositions and reflections – between analogical to digital – for children and adults. Using the software, a non-linear editing system, children could enact a sort of trans-codification of their experience of movement into digital. A recording of the "Dance of Bridges" by Michelangelo Preschool children was watched by a small group of children: interesting frames were picked out, and led to discussion among the children:

> *"Watching yourself is good for seeing how much vibration there was in my body, how strong I am!"* Alex
> *"It makes you re-think the way you dance. It's good for learning new things, and dances for everyone*." Luca
> *"It's good for doing your dances better and remembering what my friend did."* Giulia
> *"It's good for imagining another dance too*." Kristel

By watching their dance in the language of video, and discussing what they had experienced, the children became more aware of what their bodies were learning, increasingly entering into a vocabulary of gesture and dance, in a sort of meta-analysis of their experience:

> *"The more we dance the more we get tired and the more we learn."* Filippo
> *"We learn energy, we learn it inside our body."* Incoronata
> *"Energy creates a force."* Martina
> *"The force creates the energy."* Incoronata

These reflections tell us how important it is to re-see ourselves after the event, of being able to dismantle experience and open new imaginary scenarios. Softwares like these are ubiquitous now, and in children's hands they give potential to connections, and therefore learning. For example, being able to extrapolate a still from a film, duplicate it and mount it, together with other images, affects the concrete experience. In this sense digital is a sort of "other" material state, converting information of every kind, so that a gesture, or a muscular contraction, can translate into an image (or sound), and change its very nature.

Re-watching their video means watching a flow of movements and thinking about how they can be varied. Movements can be analysed, we can "freeze" the idea of a movement and its dynamic, making the kinetic and compositional process visible through shifts in the frames. Being able to freeze time with a software, being able to "still" a movement in an image, or make an original sequence of images, lets us work with children on the relation between improvisation and formalisation, through processes of conventionalising codes for movement, a prelude to designing choreographies. When the children watch a gesture that has been improvised, they can then formalise and encode it, generating new possibilities of movement in space and time.

The space-time dimension offers transversal areas for reflecting on learning; a crucial point if we think how this dimension becomes modified in its relation with digital interfaces. These complex processes can be channelled through offering daily educational contexts capable of supporting and advancing children's competencies. The more we know the techniques of a language the more we discover its potential for expression, and this is what happened with the children. The newly mounted video of their dance, put together by the children, was projected onto a large screen, generating different, and new, flows of movement in space, dense with their experience of reflection and re-composing in the post-production process. Being able to move and dance, close by and in a relation with a video they had made with themselves as protagonists, meant acting out multiple interactions – with friends moving with them, and with the film of the dance they had re-composed themselves – amplifying possibilities, imaginaries, and perceptions: an inter-corporality weaving analogical and digital together.

Digital technologies, in their relations with the body, amplify the multi-modal nature of the languages of performance, such as music and dance, more than ever today, especially when we think how children are immersed in environments defined by a continuum of communicative and interactive surfaces, with exchanges of information.

Digital technology has brought new possibilities to this augmented space for the relations between body, space, gesture, movement, and material. In the Michelangelo Preschool lengths of fabric and rope elongated the time between permanent and impermanent, between real and imaginary.

**Figure 2** - Dialogue between material, space, body and movement - Michelangelo Municipal Preschool, Reggio Emilia.
From the research "Resonances: listenings, productions, compositions" (© Preschools and Infant-toddler Centres – Istituzione of the Municipality of Reggio Emilia).

Bodies become one with materials, whose identity influences the quality of movement. Rolls of cardboard suggest challenges of balance and strength, but what do large sheets of lightweight crinkled paper suggest? How do movements, thoughts, and imaginaries change?

> "*Filippo is waving the velvet material. The movements seem like the wind sweeping things away, it looks like rain...*" Carlotta
> *"The way of dancing changes with the material."* Sarah
> *"When you move the velvet you move yourself..."* Matteo

Materials are capable of evoking movement. During the research unfolding each day in the preschool, digital photography also played an important role in re-elaborating experience. It became an element of expression, vital and alive, important in these contexts for building memory, for re-interpreting and thinking about the forms materials take:

> *"I was making a storm... high, high, high, strong, strong, strong!"* Giacomo
> *"A small sound, but when you turn it, it makes a wind."* David

Photographing the forms of the body is difficult, because everything is so fast, but the challenge is an interesting one that children welcome with enthusiasm and awareness:

> *"I took lots of photos because Giacomo wasn't in some of them, he disappeared!*" Christian
> *"It looks like he's rolling!*" David
> *"Rolling, he disappeared.*" Christian
> *"The photos we take are still, they don't move, they never change, so the shape stays the way we made it."* Giacomo

Their photographs, re-observed, have evocative power. This possibility of choosing an image of a movement, making multiples of it, with image processing software, and re-interpreting it in a new movement, generates new possibilities between the ambivalence of the materials and the children's amplified senses.

The children seem to give particular attention to blurred images, where gestures seem to be lengthened, and seem to be moving. They try to create blurred images themselves, and when they look at them, the actions of their friends seem to have greater force, more energy. In this sense photographs (whether digital or not), and the possibility of modifying them, of creating multiples on the computer in post-production, amplifies the qualities of a movement, redefines aesthetic paradigms, both for the gestures and the images.

## 3. Platforms as a metaphor for the process of learning

Concerning digital platforms it is necessary to focus on a point of view that, far from the functional vision they are used for, interprets them as possible metaphors for human learning and knowledge processes. We can think of them as places where knowledge is not only deposited and found, but connects and border-crosses, creating links in new interactive codes, layering, structuring, and de-structuring: places where knowledge can take on multiple forms and has recourse to multiple codes of expression. We can interpret a platform, therefore, as being a possible knowledge interface, supporting the processes of structuring/de-structuring knowledge, and over time constructing and deconstructing knowledge maps, both in individual subjects and in groups.

We know that even very young children are highly proximal to digital interfaces that presuppose interactivity: faced with technology children expect to be able to act (and act on) in a sort of reciprocal exchange. With this awareness we believe the role of adults is to pause over questions, not to stop at already familiar actions, but inform a dimension of problematising that doesn't narrow down to function, but opens up to wealths of possibility.

Children in infant-toddler centres and preschools do not know conventionalised number and letter codes but are attracted to that world. Faced with the visual panorama they are immersed in, so rich with images, they wonder what certain symbols mean, they formulate hypotheses, exchange points of view, test things out, their thoughts chasing visual suggestions, resemblances and differences, things they already know from their experience, elaborating metaphors and new codes of communication, to share with others.

So the encounter with a communication platform first of all asks children to interpret the code it uses, its symbols,

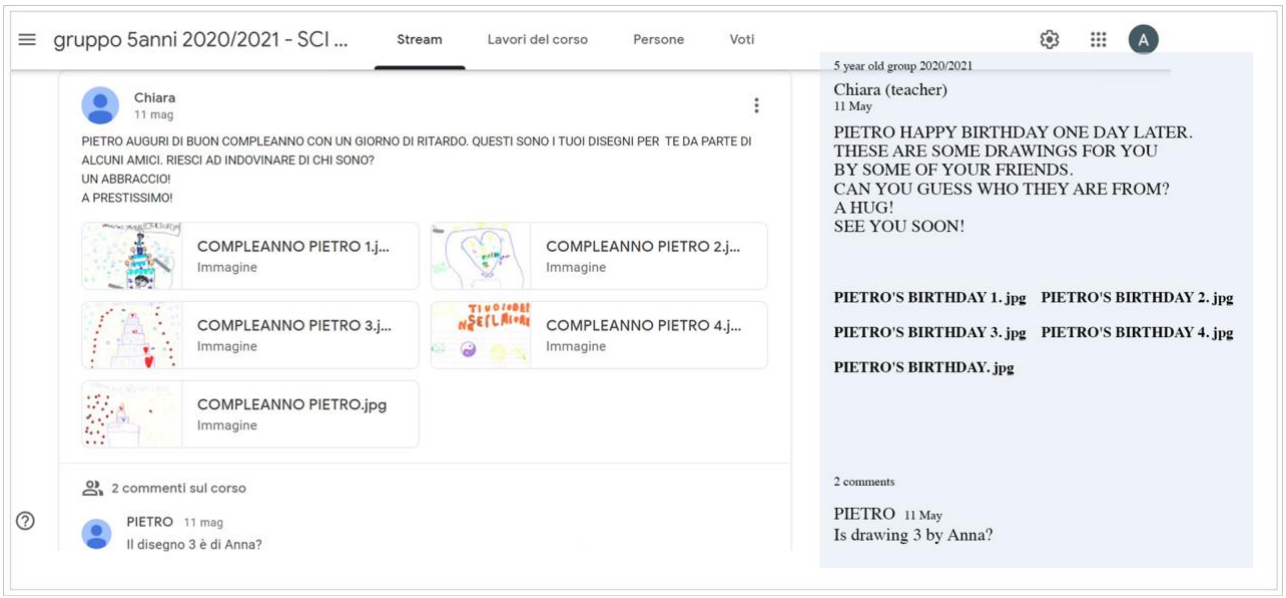


**Figure 3 -** Screenshot of Classroom 5-year-old class group
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its blank or filled in spaces. Interfaces are faces waiting to be discovered and known, receptive to children's questions, hypotheses, and first readings and significations. From birth children are immersed in the cultural symbolic systems of their times, and seek to interpret them, be part of them, correspond to them. This environmental setting is fundamental for their learning, and at the same time becomes a material that they interpret and manipulate in order to become protagonists of their relations with the world. Children today are confident with this kind of communication, are born with its uses, and look for its reasons. Living with these communicative contexts allows children to develop attitudes that are aware, reflective, and creative. The intent of conversations between children and adults in the way we design in our schools, is to go beyond contingency and research the unusual artisanal uses that these instruments offer.

Let's go into the five-year-old classroom in the Municipal Preschool at the Loris Malaguzzi International Centre, and investigate the Classroom platform. The Classroom interface, used as a tool for communicating between home and school, and in the classroom with children present, prompted children to formulate hypotheses on the meaning of its functions, and codes of communication. Further, in children's conversations we can hear vocabulary that reflects the specificity of the context, a pertinent and appropriate vocabulary, connected with digital technology. For example the headphone icon, about which Lorenzo says, "*This symbol, if you click it, is for making sounds come*". Or interpreting words they do not yet have the competence to decipher, but which they intuit to be "the names of people", because of their position, and/or because the synthetic symbol suggests a human figure:

> *"All that writing is the names of all the people."* Tommaso
> *"You can call them on the phone."* Chiara B.
> *"You can send messages and make video calls."* Tommaso

Or again, referring to the triangle pointing in the direction of an exit, the children show they know its meaning has to do with this movement, with a flow of content, drawings, writing, etc., exiting:

> *"That's a paper aeroplane*!" Zlata
> *"It's for writing, then you press the sheet of paper and send it."* Chiara M.
> *"Perhaps it's for making drawings and sending those too."* Aurora

Framed in this way we can interpret and consider communication platforms as community environments, connected and in dialogue with children's experience of learning and discovery, places that act in the diverse dimensions of space-time, and not necessarily only with the aim of filling in (presumed) gaps owing to an absence of in-person relations and encounter.

We have tried to inhabit these new environments by designing them into our everyday contexts where children and adults are present, as one of many places for encounter.

In our approach, inhabiting places means creating dialogue with events we know are important and significant for children, for example birthdays. For Pietro's birthday we chose to launch a riddle on our Classroom platform, asking Pietro to guess the authors of a series of drawings specially made for him (Figure 3): drawings as gifts, giving value to relations and

friendships between children who have been together for 3 years.

This educational approach gives value to the multiplicity of communicative, relational and expressive languages, proposing an attitude that favours encounter with a rich language system, in which "codes" can be made of words, images, sounds, or video and audio production. So we would like to interpret communication platforms as environments with a plurality of access points, with a plurality of codes, which contemporaneously favour the participation of many.

We believe it is vital to take up a position of reciprocal listening with technology born to support communication, so that we can research, prepare, and offer learning contexts capable of favouring communication processes that are part of human beings by nature. These processes are founded on several competencies: *coding and decoding, formalisation, interpretation, the attribution of shared meanings, selecting information, re-organising content, connections between contents, multi-media*. They are processes that vary from child to child, partly in relation to children's ages.

Recently we worked with small experiences of giving value to things children are familiar with, things they know and encounter in daily experience of school and home. Sounds and noises, the details of objects and materials, views of interior and outdoor spaces, voices, and more, all acquired identity as living, multi-sensory material, and in a new communication environment they created a common reference, fundamental for exchange and interaction between children. Children felt engaged, felt this might be a place to have fun. At home, Anahi recorded the sound of his cat purring and shared it on Classroom. The invitation was for his friends to try and imagine to what, or to whom, the sound corresponded: listening, imagining, evoking were processes children enacted to be part of the game (Figure 4).

But perhaps there is more: during these occasions of exploring multi-media contexts, children also enacted what researchers have called "transliteracy", the capacity to read, write, and interact through a range of platforms/channels, tools, and media. We could extend this concept metaphorically, if we think of the many ways children "read, write, and interact" their experiences, without specific literacy ability.

These short examples, small tastes of trying things out, tell of how these new environments potentially ask children and adults to think in a designerly way with a capacity for prediction, to implement knowledge processes like simulation, association, and memorisation, and to exercise a capacity for managing and organising information.

Digital has facilitated access to information, in the shape of different representational formats: images video, podcasts, and audio are now within everyone's reach, and it is increasingly easy for us to transform these formats when using them. However these possibilities also create a risk that we experience a dimension of information multiplied, an excess of communication transforming into information noise. Instead, school's way of designing needs to proceed through progressive synthesis, capable of elaborating a structure of argumentation and essence.

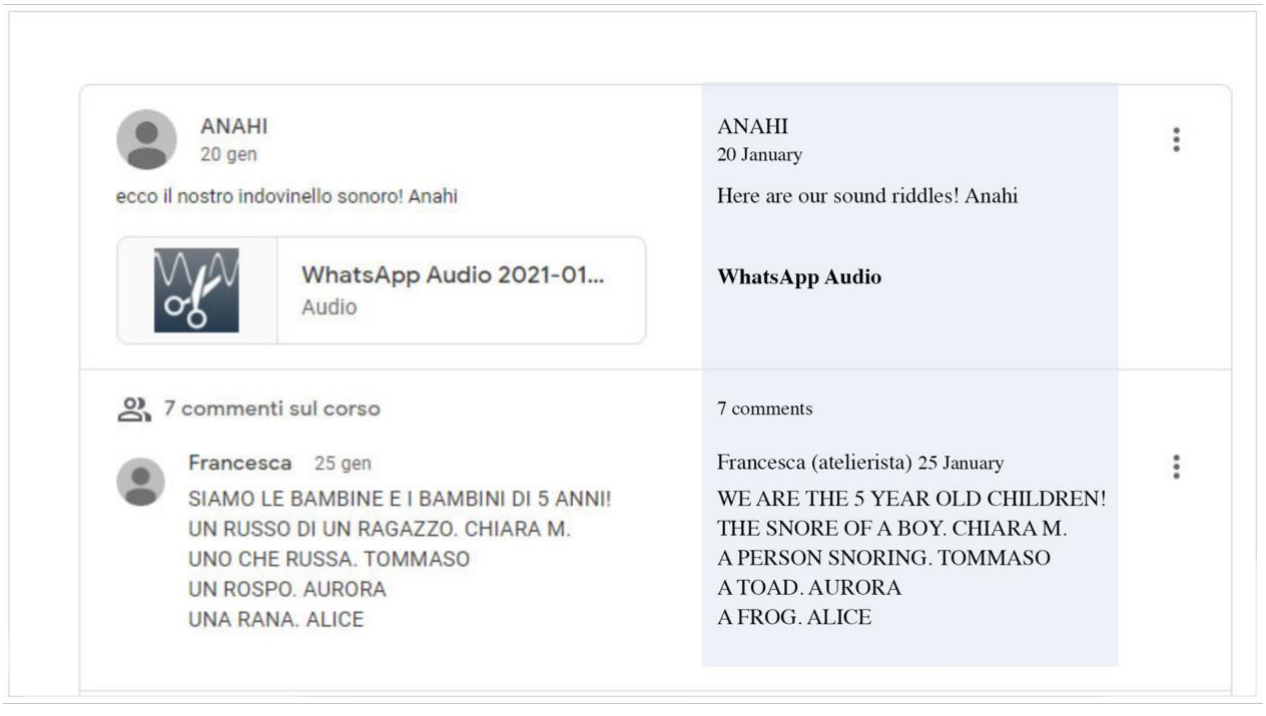


**Figure 4. -** Screenshot of Classroom 4-year-old class group
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**Figure 5 -** Screenshot of Classroom 5-year-old class group
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The conditions we study in today allow for the creation of multi-media archives that can include constructions of subjective and group meaning, archives-in-progress, and information from several sources – photographs, drawings, audio and video files etc. – facilitating the creation of open and possible narratives. Connective frameworks that maintain the connections between sources, children's work, and adult work can be of various kinds, depending on the meanings and objectives we want to arrive at. However these too should be open-ended research motors, with the condition that they help children to construct the competencies of choosing, selecting, and organising information, based on different intents.

It has been important for us to maintain a close dialogue between exploring context and reflecting on learning, avoiding the excessive abstraction that risks compromising the fertile exchange between our imagination and our perception of the real.

This humorous situation in which adults at school created an invitation to children, motivating them to return to school after the long closure of the Covid pandemic, underscores a use of digital technology that is close to children, close to their lived experience, and not imposed or distant (Figure 5).

This is a topic that leads to another deep and complex theme. We believe the simulated worlds that we have recounted here, in experiences with children, must be coherent with an ethical vision of the situation, coherent with our educational project.

The simulations and games we propose in digital environments require the same degree of responsibility and vision as our daily life environments, in the awareness that every gesture and thought produced has consequences that are real.

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INVITED PAPER

# Creative Learning in STEM: towards the design of an approach between theory and reflective practice

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**Abstract**

The paper presents and discusses the Research and Development and related reflective practice process for the design of an approach to STEM school education. It focuses on Future Inventors, an education project of the National Museum of Science and Technology Leonardo da Vinci which aims to design, develop, test, and define an approach for teaching and learning in STEM at junior high school. Through this case study, the authors argue for the need to design for learning activities in which children can learn creatively building on their own potential and, for educators, to develop and maintain a STEM teaching mind-set that recognizes a series of qualities, bodily engagement, emotions, self-expression and open-ended, creative exploration, as having a legitimate place in the science classroom This is an attempt to move beyond the de-contextualised use of technology in learning towards a learning flow that fosters engagement with digital experiences a way to develop children's thinking, their voice and identity, making them feel able to share and contribute actively.

**KEYWORDS:** STEM, Learning, Aesthetics, Approach, School, Digital.

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## 1. Introduction

School STEM Education has been the object of innumerous studies, debates and attempts for many years and internationally, most of which strongly claim the need to innovate both approach and tools for teaching and learning. This, not only for schools to be able to remain at the pace of times (i.e. integrating technology in classroom practice) but, more than that, for the need to create a context in which children can learn creatively building on their own potential (Resnick, 2017). Self-expression, creativity, agency emerge as ever more important in the learners' own experience while educators are invited to develop and maintain a STEM teaching mind-set that recognizes a broad range of experiences, skills and behaviours as having a legitimate place in the science classroom. It is an effort towards "broadening what counts", that is, towards creating a supportive and inclusive environment in which all students feel that they can contribute from their own lived experiences and that these are valid and valued (Harris et al., 2018). Enriching STEM teaching and learning at school also means redefining learning as

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such, seeing it as a process of "being, knowing, becoming" (Petrich et al., 2013, p. 53) in which "the cognitive act becomes a creative act which involves the assumption of responsibility as well as autonomy, an act of freedom" (Rinaldi, 2006, p. 141).

But how do we design an approach that contributes to this overarching goal that is authentic, inspiring and transferable? How can we know we contributed something new? The paper tries to answer these questions through the examination of the learning design process for 'Future Inventors' (FI), an education project of the National Museum of Science and Technology Leonardo da Vinci developed between 2019 and 2022 with the support of Fondazione Rocca. The project aspires to contribute a (new) teaching and learning approach for STEM education in junior high school. To meet the project goal, a team of educators built on an extended Research & Development process, which gradually evolved into reflective practice. The paper examines this experience arguing for the value of integrating pedagogical research with reflective practice as a tool for designing learning opportunities that give children a chance to be creative and self-expressive with STEM.

Reflective practice or, otherwise, "living ourselves in a permanent state of research" (Rinaldi, 2006, p. 137) is seen as a requisite for pedagogical innovation and professional development through which practitioners engage with their own experiences, learn to appreciate, to be aware and to understand experience itself (Eisner, 1985; 1998). In this sense, the process of reflecting on practice is regarded as equally important as the process of designing practice. For these reasons, the discussion of the Future Inventors approach, still in development, is done through the discussion of the reflective practice experience as it was encountered by the project team, aiming to: 1) contribute insights regarding learning spaces and experiences that build on a dialogue between material and immaterial, physical and virtual as tools for teaching and learning in STEM; 2) emphasize the importance for practitioners to be important (equal?) actors in the research activity along with scholars and researchers, contributing to broadening what counts as learning (Bevan, 2017).

## 2. Future Inventors: the project as a context for research

The project emerged from the need to contribute towards the enrichment of STEM education at school, today still characterized by transmissive approaches and rigid teaching structures (Biondi, 2020); the need to support teachers in acquainting themselves with new (digital) tools, often closer to the agendas of their own students than to their own ones; and the need to reinforce the stance that sees children as active constructors of knowledge (Papert, 1980).

To do this, the project uses the Future Inventors lab, a new learning space at the Museum dedicated to Image and Sound, chosen because they are, at the same time, STEM curriculum topics and digital expression means widely used by young people (Manjoo, 2018). The lab is the context of research and includes a range of learning activities, from immersive experiences using art installations to inquiry-based experimentations that encourage interdisciplinary, creative and active explorations of contents. The digital and the analogic, the physical and the virtual, the material and the immaterial blend into the same learning flow mixing tools and means of expression (Raffone, 2018). Digital culture is exploited to engage learners promptly in an experience which can be deep and articulated and activates new connections and understandings (Xanthoudaki, 2018). Our intention is to move beyond the de-contextualised use of technology or its use through a pedagogy that remains the same as before. Instead, we use this opportunity to extend learners' creative thinking in STEM through an approach that fosters engagement with digital experiences contributing thus to develop their thinking, their voice and identity, making them feel able to share and contribute actively (Sawyer, 2006; Escueta et al., 2017; Resnick, 2017, 2018; Papert, 1980).

The lab, resources and activities were designed by the Museum education staff in collaboration with several experts and are also the context for the pilot testing of the FI approach in collaboration with schools, in two parts: the first one involved 12 expert teachers with the aim to co-design and reflect on the characteristics of the approach and its transferability into the school practice; then, a series of collaborative professional development experiences with teachers and learning experiences for students aim to test and refine the approach. It is worth mentioning that for both co-design and pilot testing phases we asked for the participation of science, technology, and art or music teachers. This was intended to promote interdisciplinarity through the collaboration among teachers of different disciplines, something not common at junior high school level.

Our intention to involve the teachers as co-designers was in order to give them agency in both the process and the product that is Future Inventors, for several reasons: the first is that teachers have intimate knowledge of context and practice, as well as relationships with the students, that we do not. This is significant because we are designing activities that are opportunities for creative self-expression. Because each student is unique, they require enough freedom to orient their projects around their interests to meaningfully connect with their curiosity. Since we will not be in a direct relationship with the students for most of the time, we cannot maintain the relationship of curiosity, openness and respect for their ideas that is the best means of supporting their creative process. Only the teachers, by virtue of their proximity, can do that.

We can, however, try to establish a relationship with the teachers that is similar to the kind of relationship we hope they will create with their students during the project - one of acceptance, curiosity, and most of all respect. That is not possible without granting them agency, and indeed responsibility, in reinterpreting our design and intentions in their classroom. Such reinterpretations from the teachers are also one of the best ways we have of getting feedback to improve our program in both the short and long term.

The paper discusses the project from its beginning and up to the conclusion of the co-design process with the expert teachers. It draws attention to the theoretical principles that influenced our thinking, the explorations of ideas in practice, the factors that changed the course of the design and the feedback from the expert teachers regarding methodological choices and transferability to school practice.

## 3. Developing Our Approach: Blending Theory with Personal Repertoires of Practice

When the Museum team accepted the challenge of FI we knew that this was not an easy task: the education field, both formal and informal, is full of wonderful projects and innovative resources that try to change traditional schooling. The Museum itself has been the protagonist of several of those so we knew that change is slow, and that defining anything new and capable of making a difference would be the very last phase of a long process. But the challenge resonated perfectly with our mission. The Museum has been dedicated to learning since its foundation in 1953 and investing in educational research since 2009 (Xanthoudaki, 2013). This time we had to take a step further: not (merely) design resources for teachers and students, but use the project as a context for research to come up with an approach to learning that helps question fossilized attitudes and bring change; not (at all) do yet another project in coding or a series of isolated 'tech-in-education' experiences for students, but create a 'learning flow' that looks into learning as a value, "creating a synthesis of the individual and her context, in an affective relationship between those who learn and that which is being learned" (Rinaldi, 2006, p. 141). But, even more, FI presented an opportunity to look into our practice with its idiosyncratic nature, history and identity within a process of reflection that would bring an understanding of how we can contribute to the transformation of STEM learning in the long run. The work acquired thus an action research dimension in the sense of a self-reflective, research-oriented inquiry to enhance direct practice and improve the rationality and justice of our practices, our understanding of these practices and the situations in which the practices are carried out (Carr & Kemmis, 1986). It meant a rigorous examination of which pedagogical elements from our own approach we should use to reinforce STEM learning and which ones we needed to question as a way to introduce change. Action research, in the form of conversations among the team of educators, was dedicated to observing and problematizing through practice, "thinking for themselves and making their own choices, asking themselves what they should do and accepting the consequences of their own actions" (Smith, 2017). As Bevan & Xanthoudaki, 2008, p. 108) argue, we wanted to:

> *"explore the theoretical basis for alternative conceptions of knowledge and learning and discuss how they can [...] address deep-seated instructionism conceptualizations that may currently operate to limit the reach and impact of our work, namely:*
> *1. subject matter conceived as an array of discrete concepts and facts (as opposed to a set of cultural and social practices);*
> *2. learning conceived as moving knowledge from "out there in the world" to "in here in the head," (as opposed to the development of increasingly sophisticated, autonomous, and active practices);*
> *3. learners conceived as universalized beings (as opposed to subjective agents with dynamic funds of knowledge and repertoires of practice)".*

To do this, we chose to maintain some of the methodological principles that we knew worked well in our work, i.e. the combination of content, approach, materials, environment and facilitation in the design of our learning spaces (labs); the tinkerer's disposition, strong in our Tinkering activities, that state of mind of taking oneself through a process of exploring a problem rather than solving it (Petrich et al., 2013; Bevan et al., 2015); our approach to professional development based on the notion of the teacher as learner and reflective practitioner (Tickle et al., 1999; Xanthoudaki, 2007); and, of course, inquiry-based (science) learning, constructivism, constructionism and project-based learning, a well-established, solid basis to strengthen the idea of knowledge as experience through the creation of a "conversation with the material" (Schön, 1983 in Resnick & Rosenbaum, 2013, p. 165) and the construction of artefacts as a way of understanding and learning (Vossoughi & Bevan, 2014).

But the goal of coming up with a new approach for STEM learning meant that we also needed to break the ground and introduce methodological elements and concrete ideas for practice that were new and original. The direction we wanted to take was towards a "STEM learning ecology" according to which the learner constructs her personal STEM ecosystem and STEM identity through a range of educational experiences; and it is this 'identity' that gives a sense of ownership when it comes to engaging in STEM-oriented experiences. It means that we, as educators, needed to "build on what young people bring to the learning experience – their interests, skills, and personal areas of expertise – and help youth see how their interests can extend into the future" (Bevan, 2016).

In FI we acknowledged the fundamental importance of creative thinking as well as the plurality, complexity, thus the richness of learning which is continuously influenced by personal stories and interactions with stimuli from the world around us. Personal stories and interactions with the world are not only pedagogical tools to exploit, and foster, with learners but have also been a decisive factor in our learning design process. The components of the FI approach were influenced by the pedagogical debate and case studies from ours and other fields or professional practice, but were also shaped by some particularly inspirational moments that "made us see" - aha! - a solution for what we were seeking, and thus take a decisive turn in the development of ideas (Irvine, 2015). We mention two of those:

The Ars Electronica Festival 2018 – one of the pivotal events for understanding the potential of the digital for blending a range of fields into rich experiences – was the opportunity to encounter artists that "converse" with, and integrate the STEM fields into their work. Among those, Gerhard Funk and his Cooperative Aesthetics (www.youtube.com/watch?v=AxBfStEbwi0) represented a powerful inspiration for the conception of some of the fundamental components of the FI approach. Funk's research and work focus on the creation of immersive spaces in which participants can live collective audio-visual experiences and in which bodily engagement, immediate feedback, collaboration and the negotiation of behaviors become fundamental components of what takes place. Cooperative Aesthetics, now part of the FI lab, offered the opportunity to explore the notion of immersivity and embodied cognition and their role in learning, and represented the first important stimulus to the team to design experiences around the theme of (digital and analogic) Image. The paper takes Cooperative Aesthetics as a case study to discuss our process of design for learning in FI.

Following that, the visit of the team to the "CALDER-PICASSO" exhibition at the Musée Picasso (www.museepicassoparis.fr/en/calder-picasso) helped us reflect on, to later introduce, the notion of aesthetic experience. While in the exhibition, and in the following discussions, we realized once more the ever-lasting dialogue between art and STEM. The theme of the Void, or the absence of space, was explored with curiosity and intellectual challenge by Calder and Picasso; for us it represented a beautiful example of the power of art in (re)interpreting a STEM-related concept stimulating at the same time emotions, an appreciation of beauty, connections and new meanings, all of them qualities of the aesthetic experience (Knobler, 1967). How would it be, we wondered, if we tried to create a similar dialogue within a teaching/learning situation?

What was increasingly brought to the surface of our thinking were a series of qualities acknowledged for their role within an individual's experience but unfortunately still not considered equally valuable in STEM learning: bodily engagement, emotions, self-expression and open-ended, creative exploration (Girod, 2007; Claxton, 2015; Chemi et al., 2017), all of which can be also seen as constitutive elements of the aesthetic experience (Vecchi, 2010).

Aesthetic experience is an overarching notion with great pedagogical potential. In our case it encompasses all the qualities we want to introduce into FI and, defined as follows, determines the nature of the learning activities and experience designed for the project:

- a way to interpret human experience, which a) recognizes our body as the means to encounter and understand the world around us, the body perceived as the unity of senses, gestures and words; recognizing thus the importance of the physical experience as learning tool; b) is guided by curiosity and awe and inspired by beauty to create new meanings; c) inviting the creation of connections, at both cognitive and affective level, among ideas, objects and experiences (Vecchi, 2010; Girod & Wong, 2002; Dewey, 1934/1980; Girod, 2007; Claxton, 2015; Xanthoudaki, 1997).
- a pedagogical tool, compelling, transformative and unifying, through which emotion and anticipation become the flywheel for change and for the desire to pursue similar experiences; and which mixes the value of creating knowledge with the value of exploration, joy and the expression of ideas, thoughts and emotions (Dewey, 1934/1980; Girod & Wong, 2002).

## 4. Why Should Aesthetics and Subjectivity Matter in STEM Learning?

Many resources for STEM education, including ed-tech software and toys, are "closed-ended", that is, designed to help children solve problems that have one correct answer. If there is any exploration involved, it is designed to lead the learner down one or two firmly beaten paths. Such approaches to learning seem based on the assumption that school is where you learn all the things that are already known. Only after you have learned the already known you can start to do new things and explore new possibilities.

Patrick Fleming, professor of mathematics at South Dakota School of Mines and Technology, once told [Amos Blanton] that he felt he was never given the opportunity to be creative with math until just before entering graduate school (Fleming, 2008). All his years of math in primary and secondary school and most of his time as an undergraduate at university were more or less devoted to memorizing the things other creative people had figured out. It is possible that in order to be creative with mathematics, one has to first absorb past work for a few decades, as though it were an immense alphabet one is forbidden to doodle with before it can be recited perfectly. This is an idea that Papert, a mathematician himself, fervently disagreed with and worked to change

(Papert, 1993), but which arguably still dominates education today.

If we want people to learn to be creative, we need to invite them to practice creativity and to develop a creative mindset. One approach to doing this involves creating the conditions for 'bricolage.' Bricolage was first described in the literature by Levi-Strauss in his book "The Savage Mind" (1966) as a primitive kind of thinking, contrasted with formal, rational reasoning: "The basic tenets of bricolage as a methodology for intellectual activity are: Use what you've got, improvise, make do" (Papert, 1993, p.144). While Levi-Strauss made a clear distinction between the formal methods of scientists and the ad-hoc methods of the bricoleur, Bruno LaTour showed that much of the work of science, even today, involves bricolage (in Papert, 1993, p.150), and we would argue that the same is true in the fields of design and engineering.

Any creative act of synthesis involving technology – from designing a new toaster to coding an app – requires bricolage of existing components. Achieving quality requires a process of iterative reflection to explore different designs and configurations. We often think of design as a way to make a product, but it is also a process of building an understanding. This must be practiced to be learned. Pedagogies of creative learning like constructionism often invite the learner to make projects in order to engage them with the process of gathering context, proposing, iterating, reflecting, and testing. These processes, when engaged in with authentic interest and motivation, constitute most of the educational value of the experience. Because unlike a specific project or outcome, learning a mindset or design process is highly portable. It can be applied to many different contexts and conditions in the future, even in futures we cannot predict or imagine.

But if learners are to practice and develop their skills at iterative reflection and bricolage, some requirements must be met. One is that they must be given the chance to work on open-ended problems. Closed-ended problems with a single right answer - which we might call optimization problems - do not invite the same kind of inventive creativity that open-ended ones do. Giving children only closed-ended problems to solve is like giving them the freedom to do exactly what you tell them to do. It doesn't allow for the exercise of subjectivity, the bricolage of concepts and ideas that are meaningful or interesting to them. It doesn't give them the chance to learn how to make use of their own freedom and sense of aesthetics.

One challenge with open-ended problems is knowing where to begin, and how to explore a problem space. This is an area where the learner's subjectivity and aesthetics become important. An open-ended problem - like designing a building or a piece of software - can have many different successful solutions, what Mardell et al. (2021) referred to as "More than one way." The process of creating one's own solution is subjective. It involves the creation of self-imposed constraints and sub-problems within which creative solutions must be found. If you love brick and hate concrete, you have a constraint to begin to explore and propose designs for your new building. The learner's own subjectivity, interests, and sense of aesthetics constitute the foundational elements of their curiosity, motivation, and inspiration. These in turn guide and shape the choices the learner makes in the process, becoming their means of navigating, step-by-step, the near-infinite possibilities of open-ended problems to arrive at a meaningful (and actual) destination. In our view, subjectivity and aesthetics are indispensable to the creative process not only in the arts, but also in STEM.

## 5. Capture – Focus – Engage: A Possible Methodological Framework

One of the most important ideas adopted in the process of designing the FI approach was that of the 'learning flow'; instead of a series of stand-alone activities, we foster a single and gradually evolving experience which invites learners to explore, and engage with, STEM-oriented situations, differently from one passage to the next, thus scaffolding their knowledge and skills and building a deeper and more meaningful relationship with STEM.

Our initial thinking was inspired by the 'attention-value model' of Bitgood (2010) meant for museum exhibitions to examine and improve visitor attention. It suggests three levels of attention - capture, focus and engage - each distinguished by qualitative and quantitative types of attention and by the combination of psychological and physiological processes at work. The levels represent a progression from broad, unfocused attention to narrow, deep processing of exhibit information.

Although referring to a different context, what we liked in this model was the frame it offered for developing our learning flow to integrate consolidated and new methodological elements into a progressive learning experience. We imagined the learning flow as going from *capturing* attention through a response to a powerful stimulus (Bitgood, 2010, p. 5); to *focusing* on a single aspect as a way to elaborate and deepen into concepts (p. 6); to *engaging* through deep sensory-perceptual, mental and affective involvement and a personal interpretation that would lead to meaning making and a deep, emotional response (p. 10).

This frame allows us to place, beside inquiry-based science and project-based learning, what we view as potentially pedagogically powerful methodological elements: Art (as process and product), creativity, aesthetics, immersivity, bodily engagement – in the form of arts installations, activities, tools, and materials – within a learning flow and a space, our Future Inventors lab.

In the lab, Capture-Focus-Engage was transfered in the FI lab as follows.

Capture experiences build on digital art installations which explore STEM-oriented concepts. No explicit reference is made to STEM, while encounters are of immersive nature and characterized by an interaction with immediate impact at emotional and aesthetic levels. Immersion and aesthetic experience help engage the senses, cognition, emotions, the body, often in unexpected ways and offer a series of meanings and insights that stimulate reflection among the learners.

In Focus experiences, STEM contents and digital tools, which lie at the basis of the installations, become the subject of experimentation that helps learners encounter and explore the science concepts and the technologies, understand their qualities and how they might connect, and build basic knowledge to enable reuse of learned concepts in other situations.

In Engage, learners build on the knowledge, skills and experience developed in the previous phases to conceive and design their own project with a strong self-expression and storytelling dimension.

As we sketched out potential activities for each phase, we began to investigate the question of what might constitute a 'high quality' project by a student at the end of the Engage phase. We decided that a successful Engage project should be unique and reflect the learners' synthesis of the concepts and ideas they encountered in the Capture and Focus activities. This is a high bar. But it is also an opportunity for the child to exercise their capacity to do bricolage, an experience that we feel is pedagogically valuable.

It follows then that in designing experiences to prepare learners to do bricolage, we would need to think carefully about the various interfaces between the tools and concepts encountered during the Focus experiences, in order to leave them prepared to use these ideas and tools as building blocks for their final project.

Our theory became the object of a learning design process that contributed the necessary empirical experience that would, hopefully, lead to defining the approach. Capture, Focus, Engage became key terms for our own discussions, explorations and documentation, conceived in an inter-relation and as the *fil rouge* connecting everything that takes place in the lab. They became the 'containers' for continuously bringing in and evaluating ideas, tools, as well as potential collaborators to test our theory and understand the rationality and justice of our practices. Collective conversations were full of analyses of our experience and reflections on the phenomena before us, helping to develop a new understanding of the constitutive characteristics of the emerging Future Inventors approach.

A key moment of this process was when Amos Blanton joined the Museum team as an external advisor, a role which soon evolved into one of co-designer and 'discussant' of our ideas and choices. The now extended team worked together and shared important moments of reflective conversation up until the co-design phase with the expert teachers. What follows is the discussion of the process of design for learning that took place during that period, a fundamental phase for both the purposes of the project and our own professional development.

## 6. Designing a Focus Activity for Exploratory Learning: 'The Cave'

At the beginning of the design residency in January 2020 we considered how the conceptual structure of Capture-Focus-Engage could be reinterpreted as a framework for gradually removing constraints to offer greater creative freedom in an open-ended activity. Capture experiences are relatively constrained, in that they invite the child into an experience which, while playful and expressive, cannot be "hacked" or radically redesigned. Focus activities invite them to a deeper exploration of the elements and tools used to make experiences like the capture activity, and permit modifications or "hacking" of existing tools and materials. The Engage phase, the least constrained, invites them to make a project representing a new synthesis, based on their own unique interests, knowledge and the creative confidence developed in the previous phases.

Represented graphically, the progression from limited possibilities in the Capture phase to the more open-ended Engage phase resembles a funnel. Travelling upwards from the bottom or spout, the widening walls of the funnel represent the gradually opening constraints of the activities, enabling exploration of a wider and wider space of possibilities. As the learner gains more experience and confidence, their ability to make use of their freedom and the creative potential within the activity increases. In this way the structure of the activity resembles the arc of human development and individuation, but on a smaller time scale.

This funnel structure as mapped onto Capture-Focus-Engage solves several problems. On the one hand it avoids the effect of giving a creative learner too much freedom too soon, often referred to as the 'blank piece of paper' syndrome. When offering a child of 8-12 years a blank piece of paper with only the prompt to "do whatever you like," many will not know where to begin. The experienced designer of open-ended learning activities will instead offer a more constrained prompt to help get them started encountering the possibilities of the tools and technologies involved, and then broaden the realm of possibilities as the activity progresses and the children's confidence grows.

Based on this framework, we began to imagine how children might 'hack' Gerhard Funk's Cooperative Aesthetics (conceived as a Capture experience) as part of a first Focus activity. Using laptops, projectors, software and materials commonly available in schools, we built a platform for children to develop activities that roughly mirror the kind of interactive and expressive possibilities of Cooperative Aesthetics. From this came a draft description of a Focus activity we called "The Cave," which the children would be invited to explore after experiencing Cooperative Aesthetics.

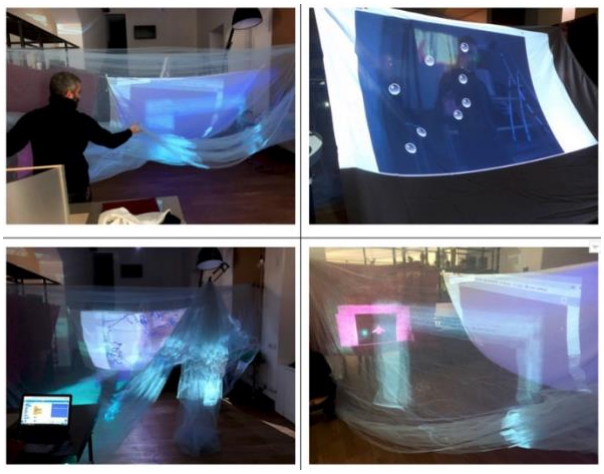

**Figure 1** - Different potential configurations for the Cave activity.

In the activity, children are invited to experiment with interactive projection using the video sensing capabilities of Scratch, free software developed at MIT and used by millions of children around the world.

Scratch makes it possible to interact with projections using physical movements recognized by the laptop's camera. [Shown in this video: https://vimeo.com/604017159]. The "Cave" activity emerged from our own exploratory and playful experiences as designers, which we hope will be a rich and fertile ground for children's ideas.

Out of this process of imagining a first Focus activity and subsequent group reflections, several important design principles emerged. First, focus activities must have a "low floor" (Resnick, 2017) – a long established constructionist design principle meaning that the tool or activity is "user friendly" and easy to get started with. Secondly, a Focus experience should have a link to the general aesthetics, behavior, and user experience patterns defined by the Capture experience. Our goal is to spark deeper aesthetic and creative exploration within those domains – in this case interactive projections triggered by physical movement. While Cooperative Aesthetics uses laser tracking to sense bodily movement and drive the interactivity, the Cave uses Scratch's video sensing capability for a similar purpose.

This iterative design process of building with what's at hand, trying it out, and then reflecting and refining ideas and products is very similar to the process described by Resnick (2017) in the creative learning spiral and by Schön (1983) in his description of reflective practice.

## 7. Co-designing with Teachers

These ideas were put to the attention of the 12 expert teachers. Our intention was to share the whole R&D process with the objective to integrate their perspective into our 'prototype.'

Proof of the potential of our ideas for school practice was received in the form of appreciation from the teachers, but what was even more inspiring was our discussions and shared reinterpretations of the key concepts. Teachers considered Capture-Focus-Engage, aesthetic experience and other qualities (interdisciplinarity, bodily engagement, digital culture, etc.) for what they can do if brought directly into school.

Their considerations, following, substantially enriched our work and what will become the object of the following testing phase:

The FI approach could foster inclusive learning in STEM as it offers the opportunity to students to use subject-knowledge across different fields together with a range of "*linguaggi*" to build situated learning experiences that engage them cognitively as well as emotionally – but this *only* if the learning flow can be addressed as a unique, evolving process [The literate translation of "linguaggi" is languages. In the education field, the term has been widely used by Reggio Children to indicate the many ways children use to express themselves in addition to the spoken language. In this paper, we use the term to mean to the expressive, cognitive and communicative languages together with the many art-oriented expressive and interpretative means. www.reggiochildren.it/assets/Uploads/Rechild-24x34-MALAGUZZI-ESEC-taglio-low.p1.pdf].

Capture was truly inspiring and positively challenging for the teachers. They saw a potential for a strong impact for students' learning in STEM, but only under the condition that its unique qualities – the poetic and 'theatrical' nature, the physical and sensory engagement, the artistic aspect and the potential of triggering questions and new explorations – can be reproduced in the school context in a similar way as they are in the Museum.

Engage was seen as the open-ended conclusion of the learning flow, totally influenced by the learners' own direction and choices, their knowledge, skills and previous experiences, both pre-acquired and those built through Capture and Focus. Although project-based learning is not new at school, Engage represents a way to interpret and express STEM-oriented ideas through a personal journey of creative exploration. In Engage, digital and analogic tools, *linguaggi*, encounters with art and all the experiences in Capture and Focus are mixed with the learners' personal context into a narrative that is meaningful to the learner. As is true for Capture, transferability of Engage at school can be of impact and benefit only if we can guarantee the possibility for open-ended explorations and authentic self-expression for the students, that can lead to realizing their own stories and ideas.

Finally, we discussed the opportunity to address the learning flow not as a linear process (one phase brings to the next) but as a circular one in which Engage, and the students' own project work can become the starting point for a new Capture, thus a new learning flow for them or for other students.

For all this to happen, though, we need a strong basis, that is:

- the commitment of the school organisation to take up the necessary changes (from learning spaces, to resources, to scheduling of the work), starting from the headteacher and down to teachers working together across disciplines.
- the possibility for teachers to be directly engaged as learners in similar situations allowing for personal experience and self-reflection before any attempt to bring this approach to their students.
- a new conception of the resources necessary; not (anymore) a collection of technologies and related protocols to implement in class and 'be done with' once and for all, but an open-ended combination of: methodological reflections, materials and tools that are not fixed but are chosen by the teachers (and students?) on the basis of the direction they want to take, examples to enrich their insight, and ways in which students can document their own learning experience.

## 8. Conclusions

Each child brings her own unique experience, knowledge and interests to any learning situation. To acknowledge this is to recognize the depth and complexity of teaching as a dialog that can be prepared for, but never scripted. But it is possible to create a structure out of activities that the learner, in collaboration with the teachers, can reshape to feed their curiosity within the immense and fascinating realm of science. Any pedagogical approach that accepts that each child is unique, and not an object but a subject in their own right, must help educators establish a dynamic balance between structure and freedom.

In the process of designing FI, we explored ways to establish such balance by creating a dialogue between STEM and artistic expression that involved aesthetics and allowed for broad expressive possibilities. We did this using the same tinkering approach that we will invite the children to learn through. In working with the teachers, we showed them the same respect and deference to their expertise and situated knowledge that we will ask them to give to the children.

A lot of questions remain to be answered in the direction we chose to take. For example, how does aesthetic experience work in these learning experiences - and why? Is it about (and does it suggest) relationships, as Bateson (1979) pointed out? Is it a kind of glue that invites bricolage-ing certain ideas? Or is it more true to say it generates a kind of reverence for things that makes possible an open mindset where curiosity is free to roam?

These questions will be explored in the coming phase working with local schools and also be the subject of a empirical research in collaboration with King's College London that will help define the FI approach and investigate the ways it can affect STEM teaching and learning at school.

There is still a lot of work to be done. This project is not like a blueprint, where success is judged by adherence to a predetermined plan. It is more like a trellis on which we hope things will grow. Success can only be proven in time, over many iterations, by the flowering of a culture of creativity and exploration in the museum and the classroom.

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INVITED PAPER

# Next Stop Perpetual Beta: notes for an ethics of design in digitally augmented learning contexts

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**Abstract**

Not even the pandemic period – which in many ways made necessary the use of networked devices – has contributed to trigger a reflection able to conceive and manage the digital beyond the opportunity/limitation represented by the remote connection. In the light of this awareness, this contribution will try to highlight some epistemological premises in order to outline a conceptual and operational context within which to make more intelligible the complexity of our interaction with digital technologies. Consequently, we will proceed to outline a design horizon within which to develop pedagogical perspectives and education approaches in which digital technology could effectively contribute to reshaping and enriching the learning scenario. More specifically, by sharing the main goals and some of the decisive phases of the project design "Briciole di Futuro" ("Crumbs of the Future") – carried out during the 2019/2020 school year in a class (fifth year) of the primary school of the IC Galilei in Reggio Emilia – we will try to highlight the opportunity to identify in digital technology a coherent extension and a creative expression of that cooperative and anti-authoritarian matrix of the scientific community. The spatio-temporal prerogatives of a digitally augmented classroom setting will be also illustrated, as well as the methodological strategies selected in order to facilitate, in the multiple types of interactions thus made possible among the children (and with the teachers), a dialectical experience and an argumentative habit in order to achieve, in this case, a shared co-design of the school of the future (year 2119).

**KEYWORDS:** Medium, Message, Hypothesis/Prediction, Cooperation, Networking, Digitally Augmented Learning.

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## 1. Digital as "message"

*"We have entered the digital age. And the digital age has entered us"* (Richtin, 2010, p. XIII). The effective incipit with which Fred Richtin, in his *After Photography*, sets out to investigate the future of images and the destiny that will await photographic art and technique in the era of the digital revolution is an essential premise for any reflection that really wants to come to terms with the impact produced by the pervasiveness of digital devices. However, because of reasons that we will try to investigate here, there is a difficulty – not to say a widespread resistance – to translate this awareness into an operational competence capable of metabolising the cultural discontinuity triggered at different levels by technological evolution.

Or, in Richtin's words:

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> *"we are struggling to reinvent the media in the form of what is essentially a marketing term, the 'digital revolution', and we dare not admit in this turbulent age that we are in fact reinventing ourselves" (Richtin, 2009, p. XV).*

This tendency has recently become evident also in the more circumscribed debate on the use of digital technologies for educational purposes. From this point of view, it does not seem too far-fetched to reinterpret the reduction of the reflection on the potential of digital technology in learning contexts in terms of the opportunities and limitations of the information technology with which, in the months of lockdown, it was possible to guarantee the continuity of distance learning.

What has hindered the triggering of one long argument (Mayr, 1994) – which could/should have started well before the pandemic – able to shed light on the need to "reinvent" school?

What has so far prevented us from initiating the appropriate gestalt switch useful to perceive, imagine, and manage, within school (but not only), the consequences of a massive use of digital technology, without reducing the cultural evolution of a context to a mere question of updating the devices and skills of the actors of that scene?

Inevitably, a plausible answer to these questions will have to address – and this is the first goal of this paper – the complexity of our relationship with technologies, freeing it from the dialectic of perspectives, more or less ideological, which variously interpret a hypothetical idea of virtuous synthesis between use and abuse.

The theoretical and research hypothesis that we intend to share here – and at the same time put to the test – moves precisely in the direction of unveiling what a (merely) instrumental approach to technologies cannot reveal. More precisely, we are referring to the constitutive and restructuring function of a given medium (Di Martino, 1998, p. 16), which we will try to put forward in its specificity by prolonging the genealogical exercise that engaged McLuhan in his effort to reconstruct the ways in which the forms of experience and mental point of view (and expression) have been modified first by the phonetic alphabet and then by the press (McLuhan, 1962, p. 22) – and then by the media that would follow.

But this kind of exercise calls for a subversion of planes in the analysis of a media phenomenon, a rethinking of priorities that allows us to focus first and foremost on the action of the media as such rather than on the contents they convey (McLuhan, 1982, p. 40). The original and constitutive function of the media should therefore be understood and pragmatically represented in its formative power, seeking to bring out the activities it inaugurates, the behaviours it makes possible, the environments and contexts to which it gives form and meaning.

While this opens up an ecological approach to the study of our interactions with technologies, it also takes the form of a design ethic that is desirable in educational settings in order to try to decipher and responsibly and creatively manage the digital "message" – or rather its form – on the learning scene.

Moreover, the historical coincidence of living, even within schools, the time of discontinuity generated by the disruptive *novitas* of digital technology could represent a prospective opportunity. If, actually, as mentioned above, the most intuitive and widespread strategy tends to trap the unprecedented in the categories of the traditional education (consequently reducing the "new media" to mere tools with which to replicate in "innovative" ways cognitive styles and relational practices produced by interactions with other media); on the other hand, this disorientation with respect to a desiderable media education could: a) represent the privileged point of view from which to return to analyse with the necessary detachment (a sort of Brechtian *verfremdung*) a cultural (and therefore also technological) inheritance metabolized to the point of no longer being perceivable as such; b) predispose, more easily, to the radical awareness from which we started by sharing Richtin's considerations.

## 2. Learning beyond communication

On the basis of what has been observed, it is now a question of indicating one of the possible strategies through which to intercept the digital "message" in order to show its potential interpretations/declinations in teaching. This will also be done through the description of some of the salient phases of an educational path actually implemented (school year 2019/2020) in the fifth grade of the primary school of IC Galilei.

About the case-study under examination, we will underline the methodological approaches and the spatial-temporal coordinates on the basis of which we have tried, in the direction of the design ethos outlined above, to operationally acknowledge the formative/transformative power of the digital medium. All this in order to reach an educational proposal able to intercept and develop – as we will see in the next paragraph – at least some of those expressive potentialities that induced Loris Malaguzzi to define the child as "unwieldy". The same child that, according to the *pedagogista* from Reggio Emilia, would have imposed a paradigm shift and would also have triggered a series of consequences of no small importance not only on the levels of psychology and pedagogy, but on the same ways of interpreting life and inter- and intrapersonal relationships as well as with knowledge and cultures (Edwards, Gandini & Forman, 2017, p. 56).

In an attempt to take up the challenge launched (and at the time won) by Malaguzzi, "Briciole di Futuro" (Crumbs of the Future) (this is the name – chosen by one of the pupils - of the instructional design) has tried to make the class experience the logic and dynamics which,

in many ways, have made digital technology possible and necessary in the various phases of its historical evolution.
In more explicit terms, the main goal of designing and conducting this educational pathway (conceived and implemented by myself in collaboration with Giuseppina Grasselli, the teacher in the class involved) was to "immerse" the children in the logic of the digital medium.
It has been a question of enabling them to (inter)act within a digitally augmented context, making them reflect at the same time on its own medial specificity, as well as on the skills necessary to "inhabit" it in a meaningful way. And this, to put it even more explicitly by paraphrasing once more McLuhan's words, corresponds to an attempt to facilitate an experience of the form of the digital, trying to avoid the linguistic and conceptual misunderstanding that considers it, still today, too often reduced – even in educational activities – to a "communication tool" [to underline this equivocal perception of the media (and not only of the digital) we refer, for example, to the frequent and paradoxical (editorial) italian tendency to translate precisely Marshall McLuhan's *Understanding Media* as "Gli strumenti del comunicare" (The tools for communication)].
Therefore, already in the fine tuning phase, we worked first of all on some articles, texts and testimonies of researchers who have been protagonists in the evolution of computer networks. The aim was to gather useful clues (first and foremost for us, the trainers) in their goals, as well as in the strategies put in place to achieve them, in order to better calibrate an educational design functional – as we said – to "stage" the digital as medium (that is, as "message").
And if somewhere else (Ferri & Moriggi, 2018, pp. 49-59), an attempt has been made to underline the irreducibility of networks in terms of instruments for communicating (and connecting) – trying at the same time to highlight the internal and constituent dynamics of the scientific community itself as it has been structured over time in the logic of the implementations those networks – on this occasion, we have rather concentrated on how the very concept of communication has been operationally understood by those "network builders" in terms of a sharing aimed at a quantitative and qualitative increase in cooperation.

We will therefore report, by way of example, some of the textual passages that have mainly shaped our educational pathway. In the next paragraph, they will be shared, but proceeding backwards with respect to the chronological order, just to further underline how and how much the attention to the development of (technological) supports aimed at optimising and enriching sharing – and therefore cooperation – has not been a recent acquisition, but a regulatory idea whose origin is rather to be found in the same constitutive characteristics of modern (and contemporary) scientific knowledge: in its own being correctable as controllable and controllable as public – that is, shared.

## 3. The historical and epistemological premises for designing (the) digital

We shall therefore begin by considering some of the strategies that guided Tim Berners-Lee in the design of the World Wide Web from the above perspective. In a book written in 2000, *a posteriori* he remembered paying close attention to the cognitive style of the physicists (the community in which Berners-Lee worked as a computer scientist at CERN in Geneva in the 1980s). In fact he explained that:

> *"one of the beautiful things about physics is its ongoing quest to find simple rules that describe the behaviour of very small, simple objects. Once found these rules can often be scaled up to describe the behaviour of monumental systems in the real world" (Berners-Lee 2000, pp. 35-36).*

He then went on to point out, by analogy, that:

> *"if the rules governing hypertext links between servers and browsers stay simple, then our web of few documents could grow to a global web" (Berners-Lee, 2000, p. 36)*.

However, the British scholar did not neglect to point out the following:

> *"what was often difficult for people [more than for physicists] to understand about the design was that there was nothing else beyond URIs, HTTP, and HTML. There was no central computer 'controlling' the web, [...] not even an organisation anywhere that 'ran' the Web" (Berners-Lee, 2000).*

And it is precisely this disorientation resulting from the awareness of being within an a-centralised system (Petitot, 1981, p. 889) that corresponds – also in an educational context – to the realisation that in such circumstances learning (as well as thinking) becomes above all a question of orientation (Kant 1996, p. 47). This context is becoming even more complex to manage from the point of view of orientation if we also take into account what Berners-Lee did not hesitate to define the fundamental principle behind the Web (Berners-Lee, 2000, p. 37). That is, the possibility for Web users to make available – in the sense of sharing in a reticular and dynamic context – texts, graphics, sounds or videos, by building new links to other already shared contents. This, as the computer scientist (graduated in physics) observed, was a substantially new practice, and not without consequences.

After all,

> *"getting people to put data on the Web often was a question of getting them to change perspective, from thinking of the user's access to it not as interaction with, say, an on-line library system, but as a navigation though a set of virtual pages in some abstract space" (Berners-Lee, 2000).*

It is just this change of perspective highlighted by Berner-Lee that finds a pedagogical correspondence in that gestalt switch that was hoped for above as a cultural strategy aimed at a plausible integration of digital in school contexts.

And it is precisely with a "link" to the theme of the library and its future that, here, we will try to further highlight – or from other perspectives – some of the issues underlying the culture of networks which have proved decisive for the development of our pathway. In this specific case, the "link" in question refers to Joseph C. R. Licklider's *Libraries of the Futures*.

In 1965 the St. Louis (Missouri) scholar wondered, among other things, about the challenges that a library would have to face in the 21st century. In this specific thematic context, he articulated his idea of the interaction between human beings and technologies and proposed the need for a new technological support that would allow a different way of sharing and (therefore) managing information.

But let us proceed step by step in the reconstruction of his reasoning as regards, in particular, the aspects that proved useful and functional in designing of "Crumbs of the Future".

First of all, Licklider in *Libraries of the Futures* was keen to point out that, from his point of view, even if we use the helpful expression "man-machine interaction", we must bear in mind that it is

> *"an abbreviation and that the corpus of knowledge is a coordinated partner of human beings and computers" (Licklider 1965, p. 90).*

This is not the place to dwell on the details of the "man-computer symbiosis" (Licklider, 1960) theorised by "Lick"; but it seems however relevant to underline at least his explicit reference to the importance of the *corpus* of knowledge and – as we shall see – of its structure in order to reach a definition capable of satisfactorily restoring the complexity with which the theme of our interaction with technologies deserves to be addressed.

His aim was in fact to restructure the *corpus* – working precisely on the possible future of the library as a system for the conservation, organisation and retrieval of knowledge – in such a way as to encourage the more creative dimension of thought. To this end, as early as 1957, he undertook to compile a register in order to analyse, quantitatively, what kind of activities he was engaged in during his working day. And thus trying to assess the actual impact of this use of his time on his research activity. The results of this survey were discouraging: only 15% of his time was devoted to thinking, the remaining 85% to preliminary or support activities (Licklider, 1960, p. 6).

It was on the basis of such considerations that he imagined a "man-machine thinking system" based on an appropriate distribution of roles. One would have to assign the human being to what he does best and the machine to what it does best (Licklider, 1957, p. 1). An apparently banal consideration, but one that in reality sheds light on the declared need to overcome the book in the design of functional support for a rational and creative management of the available information.

It was therefore a question of going beyond the book-technology in the direction of a device that would make it easy to transmit information without transporting material (Licklider 1965, p. 24).

It is in this direction that Licklider predicted the future of libraries in the realisation of procognitive systems able to promote and facilitate the acquisition, organisation and use of knowledge (Licklider, 1965, pp. 6, 21) – and not only the flow of communication.

It was in this way that he arrived at the idea of redefining (informatically) the *corpus* of knowledge in terms of a "relational network" structure: that is, a structure composed of entities, relations and properties connected by "multi-topic" relations in a "network of relevance" (Licklider, 1965, pp. 82-83). It was in this way that Licklider sought to improve his status as a researcher, and thus also that of "the very creative scientists and engineers who spend most of their time doing essentially clerical work (Licklider, 1957, p. 2).

On closer inspection, "Lick" was therefore moving in the direction of designing and implementing an environment (a dynamic and diffuse *corpus*) that would require and allow at the same time a cognitive experience capable of reproducing and enhancing the logic of sharing (and cooperation) constitutive of the scientific community itself.

This effort becomes even more evident in an article written in 1978 together with his colleague Albert Vezza and dedicated to the analysis of thirty cases of application of information networks in different contexts (among which the educational one). On that occasion, taking into account the political, social and economic consequences of such applications, the two scientists wrote the following:

> *"One of the major motivations for networking is the need to share resources. [...]. The design of a network can make it easier or more difficult to share resources and thus directly influence the amount of resource sharing that will occur" (Licklider & Vezza 1978, p. 1330).*

It is therefore on the basis of the intuitions and goals – here reproduced in brief – of two undisputed protagonists of the evolution of computer networks that we have tried to trace the "message" of digital technology, making it emerge from the pages of authors who embody and symbolise two historically and conceptually relevant junctions in the development of the technologies under examination.

Without therefore thinking to reduce the investigation of the digital as a "form" to their research work and theoretical perspectives, the reflections of Licklider and Berners-Lee were considered sufficiently representative. At least to start, with the instructional design "Crumbs of the Future", an experience of education that could find one of the plausible strategies to nurture an epistemologically correct and functional approach to the integration of digital technologies in educational contexts in the recovery of the cultural matrices of IT projects and devices - and therefore also through a careful re-reading of the founding texts of Information Technology.

## 4. The future of school in predictive "crumbs"

At this point it is a question of describing how we have tried to put into practice what has been shared so far. This will be done first of all through an illustration of the instructional design, which will correspond to the explanation of the goals set for the students by underlining the activities envisaged, as well as the classroom setting which has been able to host and at the same time make sustainable this research-action.

But firstly, the description of the group of students involved is preliminary to all this. It was – as already mentioned – a fifth grade class (Galilei primary school of Reggio Emilia) consisting of 23 children (10 girls and 13 boys). Within this group the languages spoken – in addition to Italian – were 6: Chinese, Moldavian, Arabic, Portuguese, Yoruba (Nigeria) and Asante (Ghana).

These children were asked to reflect on technologies – starting with those they used in their usual school activities. And the need to generate a proactive and cooperative learning experience that would intercept the digital "message", at least in the aspects mentioned above, took shape in the request addressed to the class group to try to design the school of the future (year 2119).

This working hypothesis was developed into the groove of a didactics of prediction (Rivoltella, 2014, p. 11) with the intention of stimulating a bold imaginative effort within the class – it would have been a question of imagining the school "in a hundred years" – but tying the formulation of hypotheses to two criteria: reliability and desirability.

In other words, the children were essentially asked to produce predictive inferences which, in their eyes, represented likely (in this sense *reliable*) anticipations of how learning environments and methodologies would evolve over the course of a century. Another condition set for the class was that, as far as possible, the various hypotheses/predictions produced by the various working groups into which the children had been organized should converge into a single idea/design for the school of 2119.

This final result would be illustrated to the parents and, more generally, to the citizens of Reggio Emilia at the public meeting that would mark the conclusion of the education path.

This last constraint added to the internal cooperative dimension of each group a further level of dialectical confrontation and collaboration aimed at committing the individual students of the various groups (and also each group of the class) to estimate – precisely in terms of reliability and desirability – the best of the available hypotheses. All this in the awareness that the final proposal could also have emerged from creative crasis between the different ideas of the groups.

From an organisational point of view, the set of instruments (digital and analogue) available to the children for their usual research and documentation activities was "re-designed" in order to build and optimise that network of relations that would have made it possible to enhance quantitatively and qualitatively the space-time of their research community.

In this direction, in fact, the Workspace for Education platform was set up for the networking of shared spaces for archiving, tracking and comparison (video calls, chats, team repositories). All of this was functional for managing and documenting phases of dialectical interaction both in the presence and at a distance, depending on the case and the moment. And here we mean interactions between students in the same group, between different groups, between the class and their teacher who coordinated the activities and monitored the processes in the everyday life of the school.

Lastly, a classroom setting conceived in this way – and, in particular, a socio-constructivist use of Classroom – made it possible to continuously exchange and share information, multimedia contents and reflections between the class and myself even on days and at times when we all were not physically presence in the classroom.

And it was precisely the children's experimentation with the cooperative potential of the digital devices in the classroom that prompted them to produce reflections similar to those selected below from a classroom discussion with their teacher.

Eva: "Classroom was for commenting on ideas". Costantino specified: "To consult each other". Alessia added: "To reconsider". Eva replied again: "To compare notes. We produced digital documents. And Costantino added: "And many times we went to revise, to get to the details". And in the end Eva even came up with a definition: "Classroom is a partner" (exactly the same word used by Licklider to define the *corpus* of knowledge).

It is therefore within the framework of a multicode learning ecosystem thus conceived (Moriggi & Pireddu, 2021, pp. 231-235) that the context design was articulated; initiated however by an activity that was in many ways preparatory to the complicated exercise of prediction.

More specifically, the children were asked to examine a series of postcards entitled *En l'An 2000*, which Jean-Marc Côté and other artists had been commissioned to produce in 1899 for the 1900 Universal Exhibition in Paris. The class was supposed to evaluate the reliability (and also the desirability) of those nineteenth century hypotheses about the future of society (including schools). The task to which they were called was actually less easy than it might seem. After all, the children in that class were not yet born in the year 2000, which is why, in addition to the awareness of having to find, at least in some cases, the historical documentation necessary to evaluate the work of those illustrators, the class group also came to the enlightening conclusion that Lorenzo (one of the pupils) formulated with the following words: "We cannot see things from the past with our eyes and we must have a little imagination even to understand historical findings".

As far as the prediction exercise is concerned their assessments of the many "errors" committed by Côté and his colleagues in the prefiguration of the year 2000 represented, however, a precious heritage from which to extrapolate methodological indications useful for managing and overcoming the initial embarrassment into which the formless spectre of the future threw them (Rivoltella 2014, pp. 64-66).

From this point of view, the following considerations, shared in a discussion with their teacher on how to proceed in the formulation of reliable (as well as desirable) hypotheses, should be read.

Daniele: "It's very difficult to imagine something that doesn't exist". Hanane: "You can imagine from things that already exist. From the certainties we have now. If you have to think about the future, you try to anchor yourself in the certainty of the present". Beatrice: "You never think of something from scratch".

The search for an "anchorage" to the present (as well as to the past of the illustrations they had to analyse) therefore had a twofold value for the children: on the one hand, it enabled them to anaesthetise, at least partially, the disorientation produced by the difficulty of thinking about non-existing things; on the other, it represented an inescapable starting point from which to imagine a plausible and desirable future for the school – experiencing each time the difficulty of choosing between two or more competing hypotheses/predictions.

Indeed, it is precisely in the proliferation of competing hypotheses about the future – fuelled in this educational path also by the cultural heterogeneity of the class group involved – that the children concretely perceived and cooperatively managed the learning experience in terms of a (qualitative) estimate of probability. That is, in terms of becoming aware of the fact that learning means, above all, learning (and eventually improving) the degree of uncertainty of our "predictive crumbs" about the world.

Therefore, it was precisely by exploiting the added value of the continuous and repeated exchange with their classmates in the spatial and temporal modalities allowed by the educational context designed *ad hoc*, that the class group produced a dynamic and operational representation of those prerogatives of the scientific community which – as mentioned above – give form (and therefore content) to the digital "message".

And this representation will be all the more faithful if it succeeds in making the computer concept of *perpetual beta* the stylistic hallmark of digitally augmented cooperation. This alludes to the principle according to which no contribution shared within a group can (and should) be considered as authoritative because there is no definitive version of it at all (Ryan, 2010, p.110).

It is precisely in this co-incidence between the "test version" and the "production version" of a piece of software that the IT world interprets and puts to work the craft and cooperative approach to knowledge typical of the technical-scientific enterprise.

It is precisely this conceptual and stylistic co-incidence that the design of this project has asymptotically aimed at in order to better grasp the (potentially) educational scope of the digital "message". And it was precisely by engaging in this kind of logic of the uncertain (de Finetti, 1989) that the children together challenged the unknown with their predictive crumbs.

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# Assessing students' learning of abstract mathematical concepts in a blended learning environment enhanced with a web-based virtual laboratory

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**Abstract**

The purpose of this study was to assess fifth-grade students' learning of abstract mathematical concepts in a blended learning environment enhanced with a web-based virtual laboratory. The "PhET" simulations site was taken as a web-based tool since it introduces a research-based mathematics interactive simulation. The study aimed to identify the extent of differences in academic progress between the experimental group taught about "Fractions" through a flexible blended learning pedagogical model, and the control group taught the same concepts through the conventional method. Thirty students were targeted and randomly selected from a private school in Muscat. To answer the research questions, both the control and experimental groups were pre-post tested on learning the targeted abstract mathematical concepts. The results showed that there is a clear positive effect on raising the level of achievement of students in abstract mathematical concepts in favor of the experimental group. Also, the experimental group were interviewed to gain more understanding about their perceptions regarding the method used in learning abstract mathematical concepts. Students were found to highly favor using the simulation website.

**KEYWORDS:** Abstract Mathematical Concepts, Achievement, Blended Learning, Virtual Laboratory, Students' Perceptions.

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## 1. Introduction

Technological innovations nowadays include the advent of many web tools, which are convenient, easy to use and common for people in society. Being easily available and dominant in everyday life practices, these tools have become widely used at different times and places. They are also economic reducing both effort and time. According to Alket (2017), vast amounts of web-applications are increasingly accessed daily. This is evidence of the increasing use of various applications and web tools to meet the needs of beneficiaries.

The educational field, of course, is a fertile soil for employing and exploiting such technological innovations. As far as the educational system in the Sultanate of Oman is concerned, it is dominated by the traditional approach in different educational settings with some successful experiences, which have been experimented in some schools – both private and governmental. Undoubtedly, employing such innovations will increase students' understanding of abstract educational content and facilitate the delivery of knowledge to students in less time and effort. As web-based applications or tools, simulation environments are considered important for supporting and reinforcing different types and modes of learning, such as direct learning and self-learning, where learners can interact with the presented instructional content (Reese, 2020). Also, they can support distance learning, and increase accessibility for students with different learning styles and needs (Aboraya & Elkot, 2020, Elkot, 2019; Heradio et al., 2016).

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Therefore, many countries, including the Sultanate of Oman, have paid attention to contemporary technological innovations, which have a profound impact on the delivery of instructional content when modern teaching methods and varied instructional strategies/techniques are used. In this regard, Muhtadi, Kartasasmita, and Prahmana (2017) indicated the need to employ technology-rich learning environment in teaching mathematics. This will help students conceptualize and develop better understanding of mathematics.

Simulation is a modern teaching strategy, method, or style where the learner goes through direct experience to reflect, and eventually develop a judgment on what he/she has learned towards the end of the learning process. It provides an appropriate environment for carrying out activities, exercises, and conducting various experiments. In this respect, the researcher sought to assess students' learning of abstract mathematical concepts within a suitable pedagogical design based on employing and using simulation websites and selected the application of the "PhET" simulations site (PhET, 2020) as an example to measure the achievement level of the learners in teaching the fractions concepts. Also, the researcher sought to investigate the students' perceptions regarding the method used in learning.

Thus, the main research problem is represented in answering the following questions:

- What is the impact of employing a blended learning environment enhanced with web-based virtual laboratory on raising fifth-grade students' achievement in mathematics?
- What are the students' perceptions regarding the method used in learning abstract mathematical concepts?

## 2. Literature review

Recently, interest in e-learning and the delivery of varied electronic content has increased with the goal of achieving more effective and meaningful learning. Math teachers are encouraged to integrate computer technology in their teaching (Findley, Whitacre, Schellinger, & Hensberry, 2019). The use of software in teaching mathematics helps to overcome many problems experienced by learners and teachers: e.g. the problems of keeping information for a longer period; simplifying the knowledge received by the learner; and the problem of finding suitable and logical solutions (Al-Hazimi, 2017). Such software allows the freedom to experiment and repeat concepts learnt without fear of error or embarrassment (Muhammadi, 2015). In addition, many studies, indicate the importance of employing educational software in teaching mathematics (Miranda-Palma, Canche-Euán, & Llanes-Castro, 2015; Zengin & Tatar, 2017).

In view of the above, the researcher believes that most studies have concluded that the use of various electronic programs, whether connected directly to the World Wide Web or as independent software, has a significant impact on raising the achievement level in mathematics. The design of such software is value-added when developed and used based on related literature, theories, and scientific foundations of educational design (Muhammadi, 2015).

The studies that dealt with the virtual laboratories (labs), or simulations laboratories, assured their significant impact on the consolidation of knowledge and retention in the learners' minds for a longer time. Virtual labs can be described as a kind of e-learning that provides what other kinds cannot (Sarhan, 2016). They are virtual learning environment that exploits the computer affordances and facilities in the digital laboratory itself. Results show that using virtual laboratories in achieving scientific concepts is significantly effective (Al-Badri, 2016).

PhET Interactive Simulations project was founded in 2002 by Carl Wieman. It is one of the most distinguished virtual labs that have been produced as it includes research-based, free, and interactive science and mathematics simulations. Its contents have been accredited by many countries (PhET, 2020).

In general, virtual labs involve several features that enhance the learning experience, such as providing external tools connected to computer monitor to receive input data based on the work done by the learner. These tools may be available in laboratories for science experiments, for example, and can be dispensable according to the type of experiment to be simulated. Personal computers must also be available and connected to the Internet or a local network. This allows the learner to conduct experiments and learn at distance anytime and anywhere. The special software of these laboratories should be to be available in both their illustrative and survey types. Also, there must be guidance and control system for the work in virtual experiments, and this comes through direct guidance from the teacher or through the program itself which gives the teacher the ability to follow up the students' progress. Also, another capability that is available in virtual labs is the automatic recording of experiments performed by the students for future use (Sarhan, 2016).

Several studies Alkhaldi, Pranata, & Athauda (2016), Sarhan (2016), Al-Bawi, Abd and Ghazi (2016), Lynch & Ghergulescu (2017, March), and Gambari, Kawu, & Falode (2018) indicate that the employment of virtual laboratories has important educational benefits. They are a very suitable alternative to traditional labs because of their capabilities to individualize learning. They also give students immediate and semi-real-life experiences, and thus protect learners from any potential risks associated with conventional laboratories. In addition, they save much time, effort, and money. The learner can conduct the experiment for an unlimited number of times at his/her own convenience (i.e. at any appropriate time and/or place). These virtual labs stimulate the learner's imagination and visualization of some abstract

concepts, theories, and laws, especially in Mathematics and Physics. They also allow the learner to experiment with clear steps with direct and immediate feedback. In addition to these advantages, these studies have agreed that virtual labs contribute to raising students' achievement level.

These laboratories develop students' self-learning and increase the accurate implementation of scientific theories and concepts, which in turn ease and facilitate better understanding of content and contributes to raising the achievement levels of learners. And this happens when incorporating a sound pedagogy, good support, detailed content, and tutor interaction (Alkhaldi et al., 2016).

In this regard, the researcher can conclude that most studies he reviewed agreed on the effectiveness of employing virtual labs in raising the achievement level among learners. The majority did not mention their disadvantages which the researcher can notice especially when interfering with teaching and learning: most notably the need for a specialized staff to work in these labs technicians, programmers, material experts and educational designers, and at the same time limited interaction compared to the real situation. One of the disadvantages of virtual labs is that they achieve few emotional – when compared with cognitive – goals, and reduce teamwork, communication, and networking skills (Baghdadi, 2014).

Besides, the researcher believes that although there are some drawbacks of these virtual laboratories that might exist, overcoming them is not so difficult since they are not major obstacles. At the same time, free laboratories and websites that provide these labs and educational content can be used for free. In a nutshell, they help to simplify and clarify some classroom situations in most school subjects. Just as virtual labs are one of the forms or strategies of implementing active learning, they are gaining ground as new and important teaching strategy and form of e-learning.

Even teachers perceive virtual labs as a technology that helped them overcome many of the classroom challenges like facilitating learning to slow learners and giving individual instant feedback as well as getting them engaged in learning and staying motivated (Lynch & Ghergulescu, 2017, July).

## 3. Methodology

### 3.1 Research design and participants

The researcher adopted a mixed methods approach design in conducting the current study. A quasi-experimental design was used while administering both the pre-and post-test to two groups: experimental and control. The experimental group was selected to learn the “fractions” unit through Virtual Laboratory, while the control group was taught the same unit, but through the traditional commonly used method. Then, students in the experimental group were interviewed to gain more understanding about their experience with the virtual lab (Creswell, Plano Clark, et al.,2003).

One of the elementary education schools (5-9 grades) was targeted in the Governorate of Muscat. Thirty (30) students were selected and equally divided into two groups: an experimental group (15 students), and a control group (15 students).

The variables of the current study were adjusted by selecting two groups of students with the same cognitive background. The researcher applied the study in one of the elementary schools in Muscat, which he was able to obtain an approval from the authorities to access and implement the study. He chose the fifth grade to control the school stage, and the same unit in mathematics was used in the interventional program to stabilize the content. Also, the researcher excluded 4 students for their absence from both pre-and post-tests. These procedures were followed to ensure validity and reliability of research results.

### 3.2 Instruments

- *Achievement test*

The Achievement test was developed by the researcher to be administered twice, as a pre-posttest to the experimental and control groups both before and after the intervention (using the virtual lab PhET with the experimental group). The researcher included clear instructions for the test and informed both groups that the test is not for real grades that would affect their real assessment at school. The test consisted of 20 items of two types, 10 multiple choice items and 10 completion items. One score was assigned for each correct answer, and a zero score for each wrong answer.

- *Interviews*

Semi-structured interviews were conducted with the participants in the experimental group (n=15) after the end of the treatment to reflect on their learning experience using the simulations website. The interview questions were developed by the researcher and were divided into two sections: ease of use and favoring the teaching method used.

- *Activities and components of virtual laboratory PhET guided by the students’ textbook and the work of Hensberry, Moore & Perkins (2015)*

- Fraction representation: Used to present the educational content to students, where student can choose the type of template that represents the fraction shape with the teacher's guidance.
- Fraction laboratory: A free space through which students can write the fractions or fractional numbers required. The teacher can ask some students to create the fraction or fractional number and ask other students to put the appropriate shape, and then perform a group discussion about these concepts.
- Building fractions: Activities and exercises, consisting of a set of ten levels. The learners can choose the level they want and move gradually from one level to another. This is where the students are assessed on how to build and write a fraction. The students can build the fractions

using either a given form, or they can draw the shape that fits the given fraction.
- Matching game: According to this game, the students match the fraction with the shape it represents, or match two forms representing the same fraction. The students select one of the shapes or fractions from the bottom squares, put it in the pan at the top, and raise the other form in the second pan, then press the word check. If the answer is correct, what was chosen above will be transmitted, with immediate feedback and reinforcement, or return to their place to try again, and thus to the end of shapes and fractions.

### 3.3 Designing the instructional settings

The researcher used the Dynamic Instructional Design (DID) model that was developed by Lever-Duffy & McDonald (2011) to set the educational design. This model is very suitable for employing technology in the educational process. The design consisted of six stages as follows: Knowing the learners and their characteristics, articulate the behavioral objectives that describe students' performance, establishing the learning environment including all the educational and physical aspects that support the learning situation, identifying the suitable teaching and learning strategies that need to be implemented to achieve the behavioral objectives, identify media, materials and technology that support each strategy, and lastly evaluate students' learning and the instructional design process itself.

The flexible blended model (Staker & Horn, 2012; Powell et al., 2015) was used to introduce the content to the experimental group. Content was presented through the PhET Laboratory and teachers supported and enriched students' learning through discussion and teacher's guidance.

### 3.3 Administering the research instruments

To achieve the objectives of the study, the researcher divided students into two groups: control and experimental, each of which consists of 15 students chosen randomly. Then he conducted, with the help of a trained teacher, the pre-test of academic achievement to measure the achievement level of students in both control and experimental groups, and to ensure the equivalence of these groups, through their convergent results on the post-test. After that, a trained teacher started teaching "fraction" unit using the virtual laboratory to experimental group students, while teaching the same unit to the control group using the traditional method. Subsequently, he administered the academic achievement post-test to both experimental and control group students to measure the level of achievement following instruction. Also, he conducted interviews with the students in the experimental group after ending the experiment. Finally, results were obtained and statistically analyzed.

## 4. Results

### 4.1 First research question

After conducting the instructional intervention, results of the pre-test and post-test for both the experimental and control groups were collected and processed using the statistical analysis software SPSS to answer the study's first question which is: "What is the impact of employing a blended learning environment enhanced with web-based virtual laboratory on raising fifth-grade students' achievement in mathematics?".

Accordingly, Wilcoxon Signed Ranks Test was applied to examine the differences between pre and post-tests of the study groups. Also, to compare between the post administration of the achievement test in the two groups, the Mann-Whitney Ranks Test was applied.

| Achievement Test | N | Mean Rank | Sum of Ranks | Z | Sig |
|---|---|---|---|---|---|
| Negative Ranks | 0 | 0 | 0 | -3.464 | 0.001 |
| Positive Ranks | 15 | 8.00 | 120.00 | | |

**Table 1** - Comparison between pre and post-test in mean ranks for Achievement in the control group, using the Wilcoxon Ranks Test.

As Z value is (-3.464) with significance level at (0.001) as shown in Table 1, the presence of significant differences between the mean ranks in achievement test for the sake of the post-test can be realized in the control group. This means that the students have shown improvement in learning the mathematical abstract concepts.

| Achievement Test | N | Mean Rank | Sum of Ranks | Z | Sig |
|---|---|---|---|---|---|
| Negative Ranks | 0 | 0 | 0 | -3.493 | 0.000 |
| Positive Ranks | 15 | 8.00 | 120.00 | | |

**Table 2** - The difference between pre and post-test in mean ranks for Achievement in the experimental group, using the Wilcoxon Ranks Test.

As Shown in Table 2, Z value is (-3.493) with significance level (0.000). This means that there are significant differences between the mean ranks in achievement test for the sake of the post-test in the experimental group. This implies that the there is an improvement in the students' performance in the mathematical abstract concepts test.

It can be noted from Table 2 that there is a clear difference between the pre-test and the post-test of the experimental group in favour of the post-test, as Z value is (-3.493) with significance level $0.000<0.05$. At that point, the researcher noticed a change in the students' acceptance of learning mathematics through using the web-based virtual laboratory, unlike the traditional normal method in which the learners did not give any abnormal interest (Aşıksoy & Islek, 2017).

| G | N | Mean Rank | Sum of Ranks | U | W | Z | Sig |
|---|---|---|---|---|---|---|---|
| CG | 15 | 8.77 | 131.50 | 11.500 | 131.500 | -4.320 | 0.000 |
| EG | 15 | 22.23 | 333.50 | | | | |

**Table 3** - The result of Mann-Whitney Ranks Test measuring the mean ranks in Achievement between the post-tests of the two groups.

Results in Table 3 shows significant differences in Achievement test between the post-tests of both groups for the sake of the experimental group, where U = 11.500, Z= -4.320, p>.05, r=0.000.

### 4.2 Second research question

To answer the study's second question which is: "What are the students' perceptions regarding the method used in learning abstract mathematical concepts?", all students in the experimental group (n=15) were interviewed to know their opinion on learning abstract mathematical concepts using the web-based virtual laboratory. After doing the transcript and coding process, results showed four main themes as shown in Figure 1.


**Figure 1** - Interview Themes.

In general, the students were found to highly favor using the simulation website within the blended learning settings. They commented on the clarity of the virtual lab, for example one participant said: "*it was easy for me to use without help*". Also, they expressed their happiness about the graphical interface describing it to be "*cheering & fun*". Moreover, they expressed their satisfaction about the teaching method used and how the teacher's guidance and group discussion supported them while working on the simulation activities. One of the participants said: "*The best thing I liked about these lessons is the group work and teacher's guidance to us*". Finally, the immediate feedback that students receive from the software during their learning was favored by many students.

Overall, the results of the interview can explain the significant points of strengths in the experiment and can interpret the significant results of the achievement test applied to the experimental group.

## 5. Discussion

The current study sought to answer the following question: "What is the impact of employing a blended learning environment enhanced with web-based virtual laboratory on raising fifth-grade students' achievement in mathematics?" and then, it sought to answer: "What is the students' opinion on learning abstract mathematical concepts using the web-based virtual laboratory?"

Referring to the above results, the research indicates that the change in the students' acceptance of learning mathematics that employs the use of virtual laboratories will transform the students' learning from the abstract state to the concrete state, that is close to reality, and here the students can significantly engage in learning experience as reported by Xu and Ke (2016).

Moreover, the pedagogy used with the experimental group can be a main explanation of increasing the students' understanding and performance. It depended on implementing the Flex blended model, where the abstract concepts of Mathematics were taught mainly using the virtual lab, then discussions and offline activities were used within the traditional classroom environment. The teacher's role was to provide help and support, and initiate discussions to enrich and deepen learning. This allows students to progress according to their individual needs (Horn, Staker & Christensen, 2014; Ardiyati, Wilujeng, & Kuswanto, 2019; Dasilva, Kuswanto, & Wilujeng, 2019).

Based on the difference in means between the two groups which was in favor of the experimental group and based on the previously reported results, the researcher can confidently report that the independent variable (i.e. using virtual laboratory within a blended learning environment) has an evident effect on the dependent variable (i.e. academic achievement).The researcher attributed this to the advantages and capabilities of virtual labs in raising learning motivation and attracting the attention of learners towards achieving all the required instructional objectives. This is confirmed by some previous studies like Sarhan (2016), Lynch & Ghergulescu, (2017, March), and Al-Hazimi (2017).

It seems that the features of the employed simulations website assisted students with improving their learning experience through allowing them to get involved in many activities and take decisions about their learning. Allowing students to choose the type of templates that represent the fraction shape and providing them with a free space where they can build new fractions for their peers, will have helped them to go beyond acquiring basic low-level knowledge and gain confidence to achieve higher-order thinking skills (Gunter & Gunter, 2015).

Students were exposed to many activities and exercises supported with immediate reinforcement and direct constructive feedback to their performance, which positively affected their learning (Siochrú, 2018). Students also were challenged to move through ten

different difficulty levels during their learning, and they started to gain confidence as they met the challenge. They felt that they were capable of achievement if they put in a good faith effort (Dicheva, Dichev, Agre, & Angelova, 2015; Li & Keller, 2018).

Apart from the virtual lab specific features, the design of learning proved effective in achieving the required aims. The study employed the Dynamic Instructional Design (DID) model that was developed by Lever-Duffy & McDonald (2011) for guiding the instructional design of the experiment. The power of that model lies in its capability to ensure creating an effective learning environment based on designing technology infused instruction. The researcher emphasizes the importance of choosing the suitable technology and teaching method in accordance with the characteristics of learners in order to help them achieve their instructional goals (Sun, Lin, & Yu, 2008; Brown & Green, 2015). The design consisted of six stages starting with analyzing learners' characteristics in order to know more about them, and hence build the right plan, passing on to identifying the suitable objectives and establishing the learning environment to act as a successful communication tool, and ending with evaluating learning using both formative and summative assessment procedures, and finally verifying the validity and quality of the whole design through validating all its stages by specialists.

Although the researcher employed the behavioral theory through activities and exercises, the social constructivism theory was the basis of the experiment, where students urged to explore and discover knowledge through the development and investigation of what needs to be solved in different activities and then be involved in group discussion with their peers to develop learned concepts.

One of the strengths of this study was represented in deployment of a flexible blended learning model (Staker & Horn, 2012; Powell et al., 2015; Bunnell, 2017) where most of the content was delivered online, but within a traditional school setting. The teacher was able to give support to students when needed and create group discussions. This practice provided great opportunities for students to learn at their own pace while benefiting from the teacher's continuous support and peer interaction. They managed to reach new levels that were difficult for them to reach without support (Smagorinsky, 2018; Ardiyati et al., 2019; Dasilva et al., 2019). This is also reported by Hensberry, Moore & Perkins (2015) who found that combining discourse-rich environment with simulation in one learning situation, leads to motivate students and support their understanding to fraction ideas.

Generally, one can say that the careful planning led the virtual laboratory to help students achieve the instructional objectives in an optimum learning environment that managed to overcome many communication barriers.

Finally, the researcher found out that the results of the current study were consistent with many previous studies including Moyer-Packenham and Suh (2012), Kablan (2016), Sarhan (2016), Al-Bawi et al. (2016), Gambari et al. (2018), and Reiten (2018), where a positive effect was reported when employing virtual laboratories in teaching mathematics compared to teaching in a traditional manner.

The results of the current study can be significantly beneficial for introducing a rigorous vision to facilitate teaching abstract mathematical concepts using simulations websites and instilling the conviction of specialists in designing curricula of the usefulness of employing different techniques in teaching such concepts in Mathematics courses in the different academic stages, and its role in increasing the learning outcomes level. Also, it contributes to divulge the usage of blended learning pedagogical model in integrating technology within the school settings in an effective way that supports students' learning.

## 5. Conclusion

Through the presentation of the results and their statistical interpretation, the researcher concludes that there is a clearly positive effect in the use of PhET simulations virtual laboratory within blended learning settings on the achievement of the fifth-grade students in mathematics in the fractions unit. This might be due to the pedagogical model used in teaching which allowed the students to work online as well as involve in group working and discussions with their peers and teacher. Also, the importance of teaching mathematical concepts with tools that raise the attention of students, and the need to move away from excessive abstraction, which affects the imagination of the students and their good understanding of math problems, and hence stimulate and attract students towards interactive electronic content.

This conclusion agreed with the studies mentioned in the theoretical framework, and through what was put forward in there. Based on the findings, the researcher recommends using virtual laboratories to reform curricula and simplify the abstract concepts of mathematics at various stages, especially in the second stage of basic education and public education. Also, it is recommended to incorporate virtual laboratories in the plans for the professional development of teachers and how to employ them in teaching instructional concepts. Finally, it is recommended to conduct similar research studies to identify the impact of simulation virtual laboratories websites on raising attitudes, motivation, and develop problem-solving skills among students in learning mathematics.

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# Online learning in the Jordanian kindergartens during Covid-19 pandemic

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**Abstract**

This study aims to investigate the level of utilization of online learning in kindergartens in Jordan during the covid-19 pandemic from the teachers' point of view. The study sample consists of 225 female teachers from both public and private schools in Jordan. To collect data, a survey was developed and implemented to the study sample after obtaining its validity and reliability. The survey intended to measure three dimensions (teaching, communication, and technological competencies). The results have shown that the mean scores of the level of utilization of online learning in kindergartens during the covid-19 pandemic from a teachers' point of view were moderate and it also showed statistical differences in the level of utilization of online learning attributed to the type of school in favor of private schools. A correlation between the number of years of expertise and both academic qualification and private education was also noticed.

**KEYWORDS:** Kindergartens, Jordanian Children, Online Learning, Covid 19 Pandemic.

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## 1. Introduction

Nowadays, the world is being exposed to the Covid-19 pandemic, which has been classified as one of the most dangerous, global pandemics that humanity faced in a hundred years, as it caused human and financial losses (Van Overmiere, 2020). The World Health Organization called on all countries to take preventive measures and procedures to try to alleviate the severity of the epidemic. Due to the total lockdown and closures, all sectors of life have been negatively affected, including the social, economic, political, and educational sectors (World Health Organization, 2020).

The education sector is one of the sectors that are mostly affected by the pandemic, because of the closure of all educational institutions. Due to the importance of the educational sector, it was necessary to maintain its continuity by employing technical and technological development, and moving from traditional, face-to-face education to online learning (Alan, 2020; Bonal & González, 2020). Online learning is a type of self-education that provides students with the opportunity to obtain various knowledge, experiences, and skills, while spatially away from school, by relying on means of communication and modern technology, as well as the creation of integrated educational platforms (Markova, Glazkova & Zaborova, 2017). The importance of online learning lies in the fact that it provides flexible learning paths and makes education accessible to everyone without exception so that it greatly enhances access to education from anywhere and at any time (Themeli & Bougia, 2016).

In Jordan, a public quarantine and a closure of all the educational institutions' decision was imposed to respond to the crisis. Education for more than 2 million students have been interrupted since schools closed (UNESCO, 2020). With the spread of COVID-19, Jordan took the quick decision to continue education through distance leatoder to minimize learning losses (Akour et al., 2020). Shifting to distance learning decision came to ensure that children could learn during the schools' closures. To facilitate distance learning through online lessons, a swift setting up of the online

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education platform took place in partnership with the Ministry of Education (MOE) and the Ministry of Digital Economy and Entrepreneurship and private sector providers Edraak, Mawdoo3, Abwaab and JoAcademy platforms to develop distance education platforms. Among these were "Darsak," an official e-learning portal which offers short video clip courses. Moreover, the national TV channels was dedicated to broadcast educational lessons. These resources cover the curriculum's core subjects for 1 through 12 grades (UNICEF, 2020).

However, Jordanian parents criticized the online learning and were dissatisfaction with distance learning modality. A study conducted by Abuhammad (2020) revealed that Jordanian Parents believe that online learning is not as effective as the traditional way of teaching and should not substitute face-to-face learning. Many barriers were encountered by parents that may affected their briefs. These barriers according to Abuhammad (2021) were related to personal, financial, technical, and logistical issues. The UNICEF (2020) reported that only about half (54%) of 1,124 vulnerable households under survey had connected to the MOE-Darsak learning platform. In addition, about 23 percent of the children did not have a regular internet connection.

The utilization of educational practices for preschool children in online learning has not been emphasized in teacher training programmes, therefore, the Covid 19 pandemic created a great challenge for kindergarten teachers, even for those who were well prepared and experienced (Darling-Hammond & Hyler, 2020). During Covid 19 pandemic a significant body of research has been carried out in Jordan and around the world to study the effect of this crisis on education. The main focus of the research has been on elementary and secondary classes and there was little focus on the effects that the pandemic has caused in kindergarten. This study will fill this gap by investigating the kindergarten teachers' utilization of online learning during the COVID-19 pandemic.

## 2. Research Questions

The study is based on investigating the level of employment of online learning in kindergartens in light of the Covid-19 pandemic from the teachers' point of view by answering the following questions:

- What is the level of employment of online learning in kindergartens in light of the Covid-19 pandemic from the point of view of female teachers?
- Are there relationships between teachers' level of online utilization and their demographic characteristics (School Type, years of experience)?

## 3. Literature Review

### 3.1 The challenges of Covid 19 in Education

The increasing spread of the Covid-19 pandemic and the inability of the countries of the world to contain and control it has been a reason to take the necessary precautionary measures that help alleviate its spread and try to reduce its negative effects on the health, economic, and educational systems. Most of the countries of the world declared a state of emergency, imposed restrictions, imposed home quarantine, closed factories, companies, schools, and universities, which negatively affected all educational systems around the world (Brinks & Ibert, 2020). The closure of schools caused a huge impact at societal and educational levels. Schools and families had to react swiftly to use online learning methods instead of traditional education to ensure the continuity of the educational process (Bonal & González, 2020). A study conducted in Greek (Foti, 2020) aimed at identifying the challenges and limitations facing the process of online learning for the Greek kindergarten stage during the Covid-19 pandemic. The study was conducted in Greece, and the descriptive analytical approach was used. The electronic questionnaire was used as a study tool, and the study sample consisted of (100) female teachers. The results of the study showed that the teachers use different methods in the process of online learning such as e-mail, platforms, and social media. The results also indicated that among the challenges and limitations of online learning was the weakness of some teachers in dealing with technology, and the difficulty of making children acquire many skills which need face-to-face learning.

Sari and Nayir (2020) conducted a study aimed at identifying the challenges of online learning during the Covid-19 pandemic. The study was conducted in Turkey, and the descriptive analytical approach was used. Open interviews were used as a tool for the study, and the study sample consisted of (65) teachers. The results showed that teachers face difficulties in accessing the internet, lack of infrastructure, in addition to classroom and human resources management. The results also indicated that students are not ready for the online learning process and that there is a lack of application in this regard related to technological, online learning, and training support. Moreover, students do not have sufficient knowledge and experience about online learning.

### 3.2 Advantages of online learning for children

Researchers believe that online learning in kindergartens is not effective and prefer to return to conventional classes (ALEZRA, 2020). Moreover, parents had negative attitudes about the value system and the benefits of online learning for children (Dong & Mertala, 2020). However, this believe was refuted by

a study carried in Cyprus (Kara & Cagiltay, 2017) which revealed that teaching online learning for kindergarten children has many advantages. According to Kara & Cagiltay (2017) teachers kindergarten teachers believe that using online learning with children can Improve their psychomotor skills, a curiosity of children, and self-confidence. Learning with technology will make learning a pleasant experience for children. The results of a study carried out by Dong (2016), revealed that children had high competencies and high interest in using digital technology in learning and experienced enjoyment and success while they work on digital activities.

There are researchers (Edwards et al. 2018; Manches and Plowman 2017) reported that the online learning experience in preschool offers great potentials to involve children in creative and thinking activities for children. The quality of online learning experiences for children can vary depending on the support provided. Family support for children while there are engaged in online learning can help children to acquire knowledge and skills and develop positive attitudes toward online learning (Kim,2020).

Online learning gives children a vast array of learning opportunities to access new concepts in unusual ways and to activate their role in the educational process as main participants in it using modern technological methods and means, which reduces individual differences between them (Ferri, Grifoni & Guzzo, 2020). The online learning process increases the effectiveness of delivering knowledge and experiences to students because it allows the use of audio and visual media (Arthur-Nyarko, Agyei & Armah, 2020). Online learning, which is spread and employment increased and expanded in the educational process during the Covid-19 pandemic, is also characterized by its ability to save time and effort exerted in the process of face-to-face education, and to provide new skills and knowledge to students without access to school, at any place and time. In addition to that, the use of modern technology, internet networks, and interactive means that contain sound and images in explaining the school curriculum contributes to overcoming the boredom resulting from explaining the lessons using traditional methods (Ferraro, Ambra, Aruta, & Iavarone, 2020).

Preschool teachers can work with parents to sustain psychological and pedagogical contact with children. Teachers can share with parents different activities like songs, short educational stories, simple games, and readings told by the teachers. (Ferri, Grifoni and Guzzo, 2020).

### 3.3 Online competencies for Kindergarten teachers

The number of children using online tools is increasing rapidly due to technologies of touch screens and internet access. Children had no experience in online learning, which is an unusual method of learning for preschool children (Yıldırım, 2021). Therefore, it was necessary to develop teachers' competencies to be able to teach in an online learning environment. In designing educational activities, the teacher is also supposed to take into account the individual differences between students in proportion to each child's abilities and interests by communicating with the family, trying to know their child's tendencies, and cooperating with them in designing an activity that meets his/her needs and develops his skills properly. Also, teachers should follow up with the child, should be keen on obtaining feedback from his/her family, and evaluate the learning process of each child continuously and daily (Bigatel et al., 2012).

Using digital technology and online learning in kindergarten is not an easy task, therefore teachers need to equip with the knowledge and skills to use technology and deliver the lessons (Gayatri, 2020). Teachers play an important role in enhancing children's participation in online learning, and their competency in the use of technology increases the effectiveness of online learning (Kim, 2020). However, A study conducted in Jordan (Alkhawaldeh, Hyassat, Al-Zboon & Ahmad, 2017) found that Kindergarten teachers did not have clear understandings of the benefits of young children's technology use. Research (Alan, 2021) reported that early childhood teachers need to acquire technological competencies. To encourage kindergarten teachers, use online learning, they must have a positive attitude toward online learning and possess effective skills in a digital environment (Kim, 2020). Childhood teachers must have access to interactive resources, be able to work with an educational platform that is intended for the children, be communicate with the parents and them with learning resources for their children (Ferri, Grifoni & Guzzo, 2020).

Among the skills needed to employ online learning for the kindergarten stage is the ability of teachers to deal with technological advances, and the use of all technological capabilities related to the teaching and learning process, such as the ability to design simple and attractive educational videos using various programs and technologies. In addition to these skills, there is employing all forms of communication through phone and computer applications in a way that provides effective communication between teachers, parents of children, and children themselves, and the teacher's ability to provide educational and entertainment activities for children in a way that is close to traditional, face-to-face education (Ferreira, Behrens, Torres & Marriott, 2018).

### 3.4 Children Use of Online learning during Covid 19

There is limited research on e-learning in the kindergarten, and in general, up to a few years, there was still a strong debate about the integration of technology in learning in the kindergarten (Campana et

al., 2019). However, after the Covid 19 outbreak, researchers realized the importance of studying online learning in preschool learning. Although disliked, but in previous research findings, research participants agreed that online learning is the only solution to maintain children learning during the Covid 19 pandemic (Mahyoob, 2020). The crisis has revealed the crucial need to improve the quality of distance learning in early childhood (Alan, 2021). Research has been conducted on children's online learning programs during the Covid 19 pandemic attempted to study the effect of the pandemic on children learning from different aspects and suggest strategies to improve these programs. A study was conducted in Indonesia (Nuraini et al, 2020) aimed at identifying online learning strategies during the Covid-19 pandemic for primary schools showed that the process of online learning has become easier due to technological development. Online learning is characterized by being more student-focused, more advanced, and more flexible in use. The results also indicated that the challenges of online learning include difficulties related to modern technology such as download and installation errors, login problems, audio, and video problems, etc. Students sometimes find online teaching boring and unattractive, and the study indicated that teachers should follow up on students to keep focusing on learning and make as many efforts as possible to humanize the distance learning process. Other studies analyzed online learning activities during the Covid-19 pandemic. Kocoglu and Tekdal (2020) found that the field of "accessibility and flexibility" got a percentage of (24%) and that the field of "infrastructure for interactive programs" got a percentage of (26%). The field of "availability of face classroom education" got a percentage of (20%), and the "resource sharing" field got a percentage of (14%). Lastly, the field of "access to virtual resources" got a percentage of (16%). The finding of a study carried out by Barnet and Jung (2020) supported the fact that the pandemic harms children learning. it revealed that only 10% of children were involved in online learning activities daily during the crisis and that online learning could not replace the learning activities that children practice in conventional classes.

## 4. Methods and Procedure

In Jordan, formal Schooling is compulsory starts at the age of 6 (First grade). Kindergarten is optional for children; Parents have the choice to attend their children younger than age 6 in kindergarten (Fayez, Ahmad & Oliemat, 2016). During Covid 19 pandemic, all kindergartens turned to online learning, this study investigates the level of kindergarten teachers' utilization of online learning.

The participants of the study included all kindergarten teachers (215) in the city of Madaba. Madaba is a small city located southwest of Amman, the capital of Jordan. All the participants were female teachers, 62% of them (135) work in public kindergartens, and 37.2% (80) work in private kindergartens. came from public and private kindergartens. With regards to the years of experience, 21.4% of the teachers (46) had less than five years, 33% (71 teachers) had from 5 to less than 10 years, and 45.6% of them (98 teachers) had more than 10 years of teaching experience.

The researchers developed a survey to assess kindergarten teachers' level of utilization of Distance learning. The survey comprises 33 items with three subscales: teaching (25 items), communication (6 items), and Teachers competencies (6). The items assess Teachers' level utilization and are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To establish face validity and content validity, the survey was reviewed by a panel of six experts who specialize in curriculum and instruction and instructional technology at the College of Education, Middle East University in Jordan (Frankfort-Nachmias, Nachmias & DeWaard, 2015). The suitable revisions and modifications were made to the survey based on the comments provided. The reliability of the questionnaire was verified by calculating the Cronbach Alpha coefficient for the sub-tool domains and the level, which ranged between (0.931-0.975). These are acceptable values to achieve the goal of the study, as Peter (2014) indicates that the values of the reliability coefficient (>0.60) are considered educationally acceptable.

The survey data were analyzed to answer the first research question, descriptive statistics (means and standard deviations) were calculated. The results of the average mean scores were categorized into three levels: 1.00 to 2.49 indicates the low level of utilization, 2.50 to 3.49 indicates the Medium level of utilization, and 3.50 – 5.00 indicates the high level of utilization. For the second research question, MANOVA was utilized to determine if there were any statistically significant differences among kindergarten teachers in their utilization of online learning in their teaching.

## 5. Results

This part deals with a presentation and an explanation of the findings of the current study after applying the study tool, data collection, and analysis. The results of the study are presented below.

*The level of utilization of online learning*

The first question of the study states that "What is the level of employment of online learning in kindergartens in light of the Covid-19 pandemic from the point of view of female teachers?" The mean scores and standard deviations of the level of online learning

utilization in kindergartens under the Covid-19 pandemic were calculated from the teachers' point of view for each field of the online learning utilization level scale used in the study.

*Teaching*

The overall scores had a mean of 3.40 (SD = 0.69), with a minimum and maximum mean score of 3.67 and 2.88, respectively. Table 1 shows that the level of employment of online learning in kindergartens in light of the Covid-19 pandemic from the teachers' point of view for the points of the teaching field were all average, as the mean scores ranged between (2.88 - 3.67), and the standard deviations between (0.82-1.08). Point (16) came in the first rank, which states: "I give children sufficient time to receive and send assignments through online learning", with a mean score of (3.67), and a standard deviation of (0.85). Point (1) came in the last rank, which states: "I can achieve the objectives of the educational subject through online learning", with a mean score of (2.88), and a standard deviation of (0.91).

The standard deviations are for all items and the overall means are relatively low indicating that there is a moderately strong agreement among the teachers when evaluating these items. The highest degree of agreement concerns the item "I apply different teaching methods with my children (dialogue, stories, problem-solving, discovery, and others)." as, in average, the teachers' scores show a deviation of 0.78 points with respect to the mean. On the other hand, the lowest degree of agreement is for item "Engage children in interactive activities through live, direct lessons (remotely)." as the standard deviation is (1.08) points with respect to the mean.

These results may be attributed to the attempt of kindergarten teachers to take into account the varying level of children's ownership of technological and material requirements; some of them cannot connect to the internet continuously to receive and send assignments, and some of them may have one computer at home while more than one child in the family study online especially if we know that the average number of children in the same family is high. A recent study (Bani Hani, et. al, 2021) showed that Jordanian household size was 5.48 on average, ranging from 1 to 12 members and some families may have 5 to 6 six children in schools. In addition to the existence of individual differences between children related to their abilities to understand and solve homework. This result may also be attributed to the difficulty of achieving the goals of some educational materials through online learning, as they require face-to-face education within the classroom and direct interaction between children and teachers. This includes providing children with values, principles, and skills that require the presence of the child among his peers away from the family. This also includes skills related to emotional and social development, language and movement development, and enhancing personal qualities such as self-confidence, responsibility, cooperation, and getting rid of introversion and shyness. What supports this point of view is what Foti (2020) indicated about the difficulty to provide children with many of the skills that need face-to-face education through means of online learning.

The mean scores and standard deviations of the level of utilization teaching strategies in kindergartens were calculated in light of the Covid-19 pandemic for each of the teaching field included points as shown in Table 1.

*Communication*

The mean score and standard deviations of the level of employment of online learning in kindergartens were calculated in light of the Covid-19 pandemic for the points of the field of communication, as shown in Table 2.

It appears from Table 2 that the total score for the field of communication came to a medium level, as the mean score was (3.26), and the standard deviation was (1.04). The field points were all of a moderate level, as the mean score ranged between (3.19-3.31), and the standard deviations between (1.05-1.13). These levels of teachers' utilization of distance learning deviate from the mean score of 3.26 because the standard deviations in all the items and the overall average are relatively large and scattered. As a result, these indicate that the instructor answers have a 'strong heterogeneity. The item that state: "I exchange experiences with other teachers in the same field" with a mean score of (3.31) and a standard deviation of (1.05). Point (30) came in the last rank, which states: "I communicate with people with experience in the field of online learning on an ongoing basis", with a mean score of (3.19), and a standard deviation of (1.04). The study attributes the average level in the field of communication with a mean score of (3.26) to the keenness of some teachers to benefit from their teaching experiences and methods of dealing with various programs and technical means during the online learning process and the way to prepare lessons and assignments in an attractive way for children, especially that the online learning process is a modern, unprecedented experience for teachers during the Covid-19 pandemic, which prompted them to exchange experiences to make the distance learning process as successful as possible.

This result can also be explained by considering the ability of kindergarten teachers to deal with online learning as a result of their knowledge of its mechanisms and as a result of the internet and YouTube clips, which contributed to enabling them to communicate remotely with children and their families smoothly and easily. This result may also be attributed to the teachers who have attended training courses and workshops for mechanisms to deal with online learning. Despite all this, it was not enough to make the level of communication between teachers, children, and

their parents high. This also may be because the teachers' interest in developing their expertise in this field did not go beyond being individual cases. Also, the training that was held remotely, may not have achieved the desired and planned results. This result is consistent with the findings of Abubakar's study (Abubakar, et al, 2020) on the average level of communication between teachers, children, and their parents.

*Teachers' competencies*

The mean score and standard deviations of the level of Teachers' competencies of online learning in kindergartens under the Covid-19 pandemic were

| Item | Mean | SD |
|---|---|---|
| I give children sufficient time to receive and send assignments through online learning. | 3.67 | 0.85 |
| I take into account the individual differences between children during online learning | 3.65 | 0.87 |
| I follow up on the homework I assign to the children. | 3.61 | 0.88 |
| I focus on the children's interaction with me in the lessons on an ongoing basis. | 3.59 | 0.84 |
| I evaluate the skills required for the stage in children in several ways. | 3.55 | 0.86 |
| I use the multimedia of audio, pictures, videos, and animation to teach children about online learning. | 3.53 | 0.88 |
| I abide by sending activities and assignments to the children at specific times, considering the parents' circumstances. | 3.51 | 0.88 |
| I encourage the studious children who participate in the lesson on an ongoing basis. | 3.5 | 0.97 |
| I motivate children to participate using various methods. | 3.48 | 0.9 |
| I apply educational activities that meet the developmental criteria of children. | 3.47 | 0.85 |
| I offer continuous feedback to children and their parents. | 3.46 | 0.93 |
| I use a variety of child-friendly evaluation methods (notes- cross lists-evaluation scales). | 3.43 | 0.82 |
| I use various evaluation methods to measure goals related to cognitive, skills, and emotional aspects. | 3.43 | 0.83 |
| I consider the allocation of time to carry out various activities. | 3.4 | 0.92 |
| I work on the interaction of the children together during the lessons. | 3.4 | 0.93 |
| I give children practical assignments aligned with the lessons. | 3.37 | 0.92 |
| I offer lessons in the form of pre-made videos (asynchronous). | 3.36 | 0.89 |
| I develop plans to implement and deliver lessons remotely | 3.34 | 0.9 |
| I send enriching activities to children on an ongoing basis. | 3.34 | 0.88 |
| I send remedial activities for children if necessary. | 3.34 | 0.91 |
| I continuously evaluate the children through online learning. | 3.25 | 0.89 |
| I present lessons in an interactive, live format with children (synchronized). | 3.23 | 0.89 |
| I apply different teaching methods with my children (dialogue, stories, problem-solving, discovery, and others). | 3.18 | 0.78 |
| Engage children in interactive activities through live, direct lessons (remotely). | 3.4 | 1.08 |
| I can achieve the objectives of the educational subject through online learning | 2.88 | 0.91 |
| *Total* | 3.40 | 0.69 |

**Table 1** - The mean score and standard deviations of participants' responses on the Teaching subscale.

| Items | Mean | SD |
|---|---|---|
| I exchange experiences with other teachers**.** | 3.31 | 1.05 |
| I communicate with parents frequently to follow up on their children. | 3.28 | 1.16 |
| I support outstanding children in a variety of ways. | 3.28 | 1.08 |
| I send to the parents the weekly plan including educational content and activities. | 3.24 | 1.13 |
| I receive constant parent feedback about children's performance. | 3.24 | 1.13 |
| I communicate with experienced people in the field of online learning on an ongoing basis. | 3.19 | 1.07 |
| *Total* | 3.26 | 1.04 |

**Table 2** - The mean score and standard deviations of participants' responses on the Teaching strategies.

| Items | Mean | SD |
|---|---|---|
| I possess the skills necessary to convert the educational content in the book into interactive electronic content. | 3.21 | 0.98 |
| I participate in the Ministry's training courses on online learning techniques. | 3.2 | 1.01 |
| Children have devices and tools that support online learning (smart devices). | 3.16 | 1 |
| I am keen to develop my technological skills to raise my efficiency in online learning. | 3.15 | 1.03 |
| The child/parent has the necessary technical skills for online learning. | 2.95 | 1.08 |
| Total level in the Teaching competencies | 3.16 | 0.89 |

**Table 3** - The mean score and standard deviations of participants' responses on the Teachers Competencies

calculated for the points of the technical field used in teaching, as shown in Table 3.

It appears from Table 3 that the total score for the field of Teachers' competencies came to a medium level, with a mean score of (3.16) and a standard deviation of (0.89). The points came between the high and medium levels, as the mean score ranged between (2.95 -3.99), and the standard deviations ranged between (0.97 - 1.08). Point (33) came in the first rank, which states: "I have constant internet connection", with a mean score of (3.99), a standard deviation of (0.97), and with a high level. The standard deviations for the overall mean are relatively low indicating that there is a moderately strong agreement among the teachers when evaluating teachers' competencies as a whole. However, for most of the items, the standard deviations large and scattered. The highest degree of agreement concerns the item "I possess the skills necessary to convert the educational content in the book into interactive electronic content." as, in average, the teachers' scores show a deviation of 0.98 points with respect to the mean. On the other hand, the lowest degree of agreement is for item "The child/parent has the necessary technical skills for online learning." as the standard deviation is (1.08) points with respect to the mean.

The lowest rank was for the item that states, "The child/parent has the necessary technical skills for online learning", with a mean score of (2.95), a standard deviation (1.08), and a medium level. The average score, with a mean score of (3.16), can be attributed to the fact that the classes times came at times that did not constitute the peak of the use of the internet, which contributed to its stability. In addition to distributing the times when assignments are sent and received, some parents do this directly after their children finish assignments, while others may have to send them at another time because they are busy at work or other things. It can also be explained why the result is medium and not high, that the internet connection is not stable without interruption in all regions, but rather suffers from some interruptions. This is consistent with what was indicated by the study of Sari and Nayir (Sari & Nayir, 2020), whose results showed that teachers face difficulties in accessing the internet as a result of poor infrastructure.

*Relationships between teachers' level of online*

The second research question is "Are there relationships between teachers' level of online utilization and their demographic characteristics (School Type, years of experience)?"

Table 4 illustrates the variation in the means and standard deviations of teachers' responses on the scale of the study. This variation is due to the type of school (Public, Private), and years of teaching experience. It was observed that private school teachers have a higher level of online learning utilization than public schools. It was also observed that the teachers with low teaching experience showed the level of utilization than other teachers who have more learning experience.

To answer this question, multiple analysis of variance (MANOVA) was used to test the significance of the differences between the mean scores of the level of utilization of online learning in kindergartens in light of the Covid-19 pandemic from the point of view of the teachers according to the study variables, and Table 5 illustrates that.

The results of Table 5 indicate the existence of statistically significant differences in the fields of the level of utilization of online learning in kindergartens in light of the Covid-19 pandemic from the point of view of teachers according to the variable of the school type in all fields of study and the level of utilization of distance learning as a whole. The level of significance in all fields was less than (0.05). Returning to the mean scores, the differences were in the private school type, meaning that the level of online learning utilization among kindergarten teachers in the private sector is higher than in the public sector. Table 5 also shows that the effect size of the school type variable (0.047), which is small effect size, means that the school type variable explains 4.7% of the total variance in the level of online learning utilization. This may be attributed to the private school type's keenness to pursue online learning and develop teachers' skills in this aspect for goals related to the economic aspect of its kindergartens, and taking care of this critical stage through designing lessons, electronic activities, homework, constantly communicating with parents, following up the children, and evaluating their performance, because that leads to the ability of these kindergartens to continue in the field of competition in education. This may also be attributed to the keenness of the private school type to remain within the performance levels as in face-to-face education and to maintain its competitive advantage in the quality of education it provides to students at all levels, including kindergarten.

There are no statistically significant differences in the fields of the level scale of online learning utilization in kindergartens in light of the Covid-19 pandemic from the teachers' point of view according to the academic qualification variable in all fields of study and the level of utilization of distance learning as a whole, as the level of significance is higher than (0.05). Table 6 also shows that the effect size of the scientific qualification variable (0.002) is a very small impact size and means that the academic qualification variable explains 0.2% of the total variance in the level of utilization of online learning. This may be attributed to the fact that kindergarten teachers, regardless of their qualifications, employ online learning for kindergarten with a similar mechanism, by preparing and explaining lessons, preparing assignments, sending, and receiving them, designing interactive and educational activities, and

following up on students' performance through various technological means.

There are statistically significant differences in the domains of the level of online learning utilization scale in kindergartens in light of the Covid-19 pandemic from the teachers' point of view depending on the variable number of years of experience in all fields of study, and in the level of distance learning utilization as a whole (except for the field of communication) as the significance in these fields is less than (0.05). To find out to whom the differences between the mean scores are attributed according to the variable of years of experience, the results of Scheffe's post-comparison test were extracted and Table 6 shows that. This may be attributed to the keenness of kindergarten teachers, in general, to communicate with the parents of kindergarten students through various means of communication, and to constantly follow up their performance with parents, because this is at the heart of the teacher's work to ensure that the required information reaches the children, in addition to the teacher's communication with each other to exchange experiences, skills, and benefit from the various methods of employing online learning and follow-up lessons.

Table 6 shows the existence of statistically significant differences in the fields of teaching and the field of technology used remotely between the category (less than five years) and the rest of the categories. The differences came in favor of the group (5-10 years), as it obtained a mean score of (3.54), (3.32) respectively. The same differences came in the level of employment of online learning as a whole. The differences were in favor of the group (5-10 years), as it had the highest mean score of (3.49). This may be attributed to the fact that teachers with average experience are more passionate about the teaching profession, and thus, more interested in and able to use and apply different

| *Variables* | *Teaching* | | *Communication* | | *Technology* | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| Type of School | | | | | | |
| Public (n = 80) | 3.21 | 0.51 | 2.60 | 0.97 | 2.75 | 0.75 |
| Private (135) | 3.52 | 0.76 | 3.64 | 0.87 | 3.41 | 0.88 |
| Years of teaching experience | | | | | | |
| Less than 5 (n = 46) | 3.03 | 0.88 | 3.13 | 0.99 | 2.95 | 1.01 |
| 5 to less than 10 (n = 71) | 3.54 | 0.56 | 3.61 | 0.77 | 3.32 | 0.76 |
| More than 10 (n = 98) | 3.48 | 0.63 | 3.06 | 1.16 | 3.15 | 0.91 |

**Table 4** - Means and standard deviations of teachers' responses on the scale of the study

| *Source* | *Dependent Variable* | *Sum of squares* | *DF* | *Mean squares* | *Value (F)* | *Sign* | *Eta²* |
|---|---|---|---|---|---|---|---|
| School type | Teaching | 2.13 | 1 | 2.12 | 5.77 | .017* | .027 |
| | Communication | 4.15 | 1 | 4.14 | 5.96 | .015* | .028 |
| | competences | 7.43 | 1 | 7.43 | 12.18 | .001* | .056 |
| | Total | 4.30 | 1 | 4.30 | 10.18 | .002* | 0.47 |
| Years of experience | Teaching | 5.12 | 2 | 2.56 | 6.94 | .001* | .063 |
| | Communication | 1.66 | 2 | .828 | 1.190 | .306* | .011 |
| | competencies | 5.73 | 2 | 2.865 | 4.695 | .010* | .044 |
| | Total | 3.78 | 2 | 1.873 | 4.434 | .013* | .041 |

**Table 5** - Summary of factorial MANOVA for teachers' level of utilization of online learning for variables of the study

| Domain | Categories | Less than 5 | From 5 to less than 10 | More than 10 |
|---|---|---|---|---|
| Years of experience | Less than 5 years | | | |
| | 5 to less than 10 years | .5115* | | |
| | More than 10 years | .4475 | .0640 | |
| Teachers' Competencies | Less than 5 years | | | |
| | 5 to less than 10 years | .3645* | | |
| | More than 10 years | .1950 | .1695 | |
| Level of employment of online learning | Less than 5 years | | | |
| | 5 to less than 10 years | .4539* | | |
| | More than 10 years | .1917 | .2622* | |

*p < .001

**Table 6** - The results of Scheffe's test for dimensional comparisons on the variables of the study

teaching methods and strategies, prepare and implement lessons and activities, prepare plans, follow up and evaluate students using different evaluation methods, focus on methods of developing students' skills, and taking into account individual differences between them. That is because they have enough experience on the one hand, and are still able to renew their methods willingly. This may be since the teachers of this category possess advanced skills and greater knowledge about dealing with technology, and thus, can employ them in teaching using smart devices, software, and various techniques.

## 6. Conclusions and Implementations

The COVID-19 pandemic has affected all aspects of life. One of these aspects is education. Upon the breakout of the pandemic, substantial changes were introduced in education all over the world, and online learning has turned out to be the main way of education. However, educational systems all over the world were not ready for this exceptional crisis and encountered many obstacles maintaining education and utilizing online learning especially with children (United Nations (UN), 2020). The current study aimed to investigate the level of kindergarten teachers' utilization of online learning during the COVID-19 pandemic.

Kindergarten teachers bust provide children with different meaningful learning experiences by creating technology-enriched learning environments and learning activities suitable for children (Keengwe & Onchwari, 2009). The results of the current study found that kindergarten teachers need to have a high level of technical skills to teach effectively using online learning. The Starting Strong Teaching and Learning International Survey (TALIS Starting Strong) has pointed to this issue, the survey concluded that kindergarten teachers feel less confident about the integration of digital technology to support students' learning (OECD, 2020).

The success of online learning depends on the teachers' technological abilities to use digital resources (Kim, 2020). It can be concluded from this study that teaches need more training to be able to teach effectively in the online learning environment. Thus, the results of this study provide a foundation for governments, and education decisions to design and implement action plans to contribute high-quality online learning for children in Kindergarten. Further studies might endorse the implementation of action plans to meet the needs of Kindergarten teachers to assess the effectiveness of the implementations. moreover, since this study used only the survey to collect, further research using different data collection methods and triangulating data to study the current issue in depth. In light of the findings of the study, it recommends the Jordanian government give more attention to kindergarten teachers. A professional development plan should be provided for kindergarten teachers to Enhance their abilities to implement online learning effectively through the use of various techniques in teaching. It is known that the Jordanian government launched educational platforms to grades from 1-12, and no platform dedicated for kindergartens, therefore it is a most to launch a platform for kindergarten that includes interactive activities, homework, and explanation of lessons through attractive videos, songs, educational games, and stories.

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# Child Mediation: effective education or conflict stimulation? Adolescents' child mediation strategies in the context of sharenting and family conflict

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**Abstract**

This study increased the insights on child mediation by investigating whether and how adolescents use child mediation strategies in the context of their parents' sharenting behavior and how this is related with family conflict. The results of a survey among adolescents confirmed their use of active, restrictive, and supervising child mediation strategies in the context of sharenting. Sharenting frequency of both mothers and fathers was associated with increased use of restrictive strategies. For mothers, it appeared that sharenting frequency directly and indirectly predicted more family conflict about sharenting via restrictive child mediation. For fathers, no significant effects were found from sharenting frequency on conflict about sharenting.

**KEYWORDS:** Adolescents, Family Conflict, Sharenting, Child Mediation.

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## 1. Introduction

Sharenting is a combination of the terms "parenting" and "sharing" and is described as the practice of parents displaying information about their children on social media (Marasli, Suhendan, Yilmazturk, & Figen, 2016). Sharenting regularly stimulates tensions and conflicts between parents and their adolescent children, because the content parents post does not affiliate with the online identity adolescents try to develop (e.g., Hiniker, Schoenebeck, & Kientz, 2016; Ouvrein & Verswijvel, 2019). Therefore, children sometimes try to start open dialogues with their parents about what they think is (un)acceptable or formulate rules and boundaries that their parents should respect (Hiniker et al., 2016; Ouvrein & Verswijvel, 2019). These strategies seem to resemble respectively active and restrictive mediation strategies, as known in the literature on parental mediation (e.g., Nikken & Jansz, 2006; Valkenburg et al., 1999), but then the other way around, a phenomenon known as child mediation (Nelissen & Van den Bulck, 2018; Scheurs & Vandenbosch, 2020).

Child mediation describes a form of socialization in which children learn something about media-use to their parents (Van den Bulck et al., 2016). Although there is ample of research on parental mediation (e.g., Mesch, 2006; Nelissen & Van den Bulck, 2018), the insights on child mediation remain limited (e.g., Scheurs & Vandenbosch, 2020; Van den Bulck et al., 2016; Van den Bulck & Van den Bergh, 2005). This is in contrast with the fact that children become increasingly important as "teachers" for digital media and related practices (e.g., sharenting) (Correa, 2014; Ito et al., 2008; Kiesler, Zdaniuk, Lundmark, & Kraut,

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2000). Such forms of socialization can stretch or even reverse traditional family relationships with adolescents becoming more dominant toward their parents (Nelissen & Van den Bulck, 2018; Mesch, 2006), which might put pressure on the family communication and stimulate conflicts (Beyens & Beullens, 2019; Kiesler et al., 2000).

This study aims to explore the use of child mediation strategies and the impact of it on family conflict within the specific context of sharenting. More specifically, we propose and test a model of the (in)direct effects of sharenting frequency on family conflict through the use of three different child mediation strategies used for sharenting (active, restrictive and supervising). Gaining more knowledge on how families negotiate the issue of sharenting and the role of child mediation in this process is necessary (Hiniker et al., 2016; Scheurs & Vandenbosch, 2020), because it can inform both parents and children on good practices in dealing with sharenting and improve their relationship.

### 1.2. Sharenting

On social media, parents often share information (e.g., pictures, videos, status updates) about their children (Brosch, 2016; Morris, 2014; Wagner & Gasche, 2018). Previous research mainly focused on prospective and new parents' sharenting behavior as it is a rapidly growing phenomenon that already starts when the child is unborn (Brosch, 2016; Duggan, Lenhart, Lampe, & Ellison, 2015). Nevertheless, adolescent children are also confronted with sharenting as today's parents are raising their adolescent children in a first digital culture (Brosch, 2016).

Although both parents participate in sharenting, it seems that mothers more often share information about their children on social media than fathers. Davis and colleagues (2015) indicated that 56% of mothers and 34% of fathers of children up to four years old share information about parenting topics on social media. Fathers and mothers differ in the topics of sharenting. A study by Ammari and colleagues (2015) shows that mothers more often post "cute" pictures and family photos, whereas fathers rather like to share about the children's achievements, often related to sports.

Parents seem to have several reasons for sharenting Firstly, sharenting might be a way to work on their self-presentation of a good parent, by getting likes and comments (e.g., Davidson-Wall, 2018; Kumar & Schoenebeck, 2015). Sharenting also offers parents the opportunity to receive affirmation, feedback and social support during parenting (Davis et al., 2015; Duggan et al., 2015) and related to that social contact with other parents (Brosch, 2016; Wagner & Gasche, 2018). Additionally, social media are a storage place for collecting pictures and videos and sharing these with friends and family (Brosch, 2016; Davis et al., 2015; Duggan et al., 2015; Kumar & Schoenebeck, 2015). Although sharenting might lead to several advantages for parents, it may also be associated with some undesired consequences for the family, such as conflicts about it.

### 1.3. Family conflict and sharenting

Family conflict refers to both children's noncompliance and resistance to parent's instructions as well as parent's resistance to children's requests (Eisenberg, 1992). Family conflicts regularly develop about new technologies/practices (Ivan & Nimrod, 2021), with oftentimes a reshape of the traditional family patterns as a result (Nelissen & Van den Bulck, 2018). Both the introduction and frequency of use of the new technology/practice seems to play a role. Applied to the context of tablets for instance, research indicated that the more adolescents used tablets, the more conflict about it was reported within the family (Beyens & Beullens, 2017). These family conflicts about technology are the result of different skills, knowledge, and expectations (Correa et al., 2013; Perry & Werner-Wilson, 2011). Adolescents and parents in general have different expectations of social media use (Scheurs & Vandenbosch, 2020) and this is also reflected in the qualitative studies on sharenting in particular. Research indicated that impression management and identity development are very important motives for social media use among adolescents (Steinberg, 2013). During adolescence, individuals discover one's true self and start to develop their identity (Steinberg, 2013). Social media provide adolescents with the opportunity to explore their identity by disclosing information and by generating feedback from others (Steinberg & Morris, 2001). Moreover, to express a certain online identity, adolescents carefully consider which information they share online so that every post they make contributes to that desired and idealized image (Krämer & Winter, 2008). For parents, the overload of positive images is not the main goal when posting on social media. They prefer to offer realistic insights in their lives and families (Scheurs & Vandenbosch, 2020). When parents share information about their children, they (unconsciously) contribute to the construction of their child's online identity (Leaver, 2020; Steinberg, 2013). Especially during adolescence, such online identity determined by parents might conflict with the way children want to profile themselves online. Consequently, adolescents are oftentimes embarrassed about the content parents share and can get frustrated about it (Davidson-Wall, 2018; Hiniker et al., 2016; Leaver, 2020; Ouvrein & Verswijvel, 2019; Scheurs & Vandenbosch, 2020). Research among adolescents found that they have very negative perceptions about sharenting, with most of them indicating that this practice is embarrassing and useless and has no added value (Verswijvel, Walrave, Hardies, & Heirman, 2019). This contradiction between motives of parents versus adolescents for sharing online has been referred to as "boundary turbulence", which

can result in difficult family conversations (Leaver, 2020). It becomes even more difficult when adolescents report that they sometimes ask their parents not to post something or delete it, but these requests are ignored. Such instances might form the basis for family conflicts about sharenting (Nelissen & Van den Bulck, 2018; Leaver, 2020; Ouvrein & Verswijvel, 2019; Vaterlaus et al., 2014).

Quantitative insights are lacking though on whether sharenting might result in actual family conflicts. Based on the positive association between general use of new technology and amount of family conflict, and the suggestions on conflicts about sharenting from the qualitative studies, it can be expected that sharenting frequency predicts the amount of family conflict. Given the differences in amount and type of sharenting behavior, this needs to be investigated separately for fathers and mothers. We therefore formulated (see Figure 1):

*H1: There is a positive association between sharenting frequency of fathers/mothers and the amount of family conflict about sharenting.*

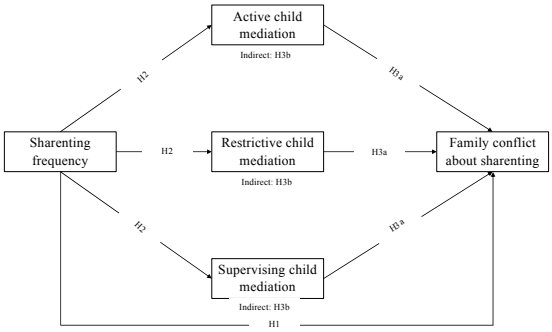


**Figure 1** - Proposed model.

## 1.4. Parental and Child Mediation

To avoid the undesired consequences of sharenting, adolescents try to steer their parents' sharenting behavior, which is known in the literature as child-effects (e.g., Van den Bulck et al., 2016; Van den Bulck & Van den Bergh, 2005), bottom-up technology transmission process (Correa, 2012; Correa et al., 2013) or child mediation (Nelissen & Van den Bulck, 2018; Scheurs & Vandenbosch, 2020). The different concepts describe the influence that children have on their parents' Internet use (Van den Bulck et al., 2016) and should be seen as the opposite socialization process of parental mediation.

Numerous studies have focused on parental mediation strategies online (e.g., Chen & Chng, 2016; Schrodt et al., 2009; Wisniewski et al., 2015). Two major forms received considerable attention: active and restrictive mediation (Chen & Shi, 2019). Active mediation refers to parents' guidance and advice, for instance in the form of discussions about Internet use and making their children aware of the risks (e.g., Chen & Shi, 2019; Kirwil, 2009). Lee (2018) associated active mediation with a warm, open, and encouraging discussion, not only with the intention of avoiding the risks of online use, but also stimulating the positive use of it. Restrictive mediation on the other hand, describes regulation strategies for children's Internet use, meant to keep it restricted. Restrictive mediation mostly consists of rules concerning how much time children can spend online or which websites they can visit (Chen & Shi, 2019; Chen & Chng, 2016; Kirwil, 2009). Several studies on children's and adolescents' online media use added a third category, which is referred to as co-use (e.g., Chen & Shi, 2019; Livingstone & Helsper, 2008; Scheurs & Vandenbosch, 2019), co-viewing (e.g., Chen & Shi, 2019) and sometimes as supervision (e.g., Sasson & Mesch, 2014). It describes a socialization process in which the parent is sitting next to the child and experiences with the technology are shared and thus also supervised, but without active discussion (Chen & Si, 2019; Livingstone & Helsper, 2008; Nathansson, 2002; Sasson & Mesch, 2014).

Across the years, some scholars went even further and increased the insights on the fact that media socialization processes between parents and children are reciprocal (Nelissen & Van den Bulck, 2018; Nelissen et al., 2019; Scheurs & Vandenbosch, 2020; Van den Bulck & Van den Bergh, 2005). Following this reasoning, some studies have switched the focus to the contribution of the children to their parents' media consumption (e.g., Correa, 2012, 2014; Ito et al., 2008; Nelissen & Van den Bulck, 2018). These processes have mostly been investigated in relation to TV-consumption (e.g., McLeod & Brown, 1976; Nelissen & Van den Bulck, 2018) and the adoption of new online media technologies (e.g., Chen & Shi, 2019; Van Rompaey, Roe & Struys, 2002).

However, due to the intergenerational gap concerning the use (and not just the adoption) of the Internet and social media in particular (Madden, Lenhart, Duggan, Cortesi & Gasser, 2013), child mediation might even be more important in steering parents' online behavior (Van den Bulck & Van den Bergh, 2005). Indeed, some studies indicated that children and adolescents in particular educate their parents on the correct online behavior (e.g., Correa, 2012; Correa et al., 2013; Ito et al., 2008; Kiesler et al., 2000; Mesch, 2006), especially on new media forms (Nelissen & Van den Bulck, 2018) and new practices, such as sharenting (Ouvrein & Verswijvel, 2019). In this way, children develop themselves as the "experts' of the Internet within their own family (Correa, 2014; Ito et al., 2008; Kiesler et al., 2000; Mesch, 2006; Schrodt et al., 2009).

Being in this role, adolescents use different methods to socialize their parents. Correa (2012) distinguishes two persuasive strategies. In the argumentative strategy, children discourse and interpret the motives and wishes

of their parents and decide together on the best online behavior. The children thus teach their parents how to behave and inform them on what is considered as appropriate or embarrassing content to share (Lee, 2018; Scheurs & Vandenbosch, 2020; Van den Bulck et al., 2016). The study of Ito and colleagues (2009) for instance, indicated that adolescents show interest in the online activities of their parents and start discussions about it. For sharenting in particular it was found that adolescents would like to talk more often about their parent's wishes to share content about them and whether and why they think this is (un)acceptable, to see if a mutual agreement on this issue can be found (Hiniker et al., 2016; Leaver, 2020; Ouvrein & Verswijvel, 2019). This strategy is comparable with the active mediation strategy from the parental mediation literature (Valkenburg et al., 1999; Van den Bulck & Van den Berg, 2005). In the non-argumentative strategy, children influence their parents' online behavior by begging and demanding (Correa, 2012). This strategy is comparable with what Van den Bulck and colleagues (2016) defined as restrictive child mediation, as these are strategies used to put limits or reduce certain behavior. In the context of sharenting it has been found that adolescents put boundaries for their parents on what they can share and how often (Hiniker et al., 2016; Ouvrein & Verswijvel, 2019). Apart from open discussion and setting rules, several studies on sharenting also reported on some form of supervising the social media profiles of parents and intervening on their accounts when parents are not listening to their wishes or are just "lost" (Correa, 2014; Ito et al., 2018; Ouvrein & Verswijvel, 2019).

To the best of our knowledge, no quantitative study has investigated the use of child mediation strategies in relation to sharenting. Moreover, it is not clear which strategies adolescents use in relation to sharenting frequency and when. This study aims to fill in this gap by investigating the association between sharenting frequency and the use of the different types of child mediation strategies. Based on the sharenting literature, we distinguish between active, restrictive, and supervising child mediation strategies:

*H2: There is an association between sharenting frequency and the use of child mediation strategies (active, restrictive, and supervising) in the context of sharenting.*

### 1.5. Family conflict about Mediation

One important difference between parental mediation and child mediation is the power balance between both. Whereas parental mediation typically meets with the traditional ideas on parents as dominant socializators, child mediation puts these structures under pressure. Many parents express fear or anger when being confronted with a switch of authority (Kiesler et al., 2000; Mesch, 2006). In the in-depth interviews of De Mol and Buysse (2008) for instance, the use of the words "influence of children" was enough for some parents to become angry because they associate it with a lack of power. Also, in the survey study of Nelissen and colleagues (2019) among parents, influence of the children was often interpreted as controlling and restricting, instead of as a transmission of knowledge and skills. Such attitudes might stimulate reciprocal frustrations and family conflicts. Accordingly, Mesch (2006), and Nelissen and Van den Bulck (2018) found higher amounts of family conflict in families in which the children are the experts on online media and try to take over the dominance on this domain. However, these studies investigated the use of child mediation in general on the frequency of family conflict. Insights are lacking on whether the use of specific child mediation strategies (i.e., active, restrictive and supervision) is associated with the frequency of family conflict about social media.

From the literature on parental mediation, it is known that the use of the specific mediation strategies has an influence on the parent-child communication and relationship (Mesch, 2006), especially during adolescence (Lenhart et al., 2010; Livingstone, 2007; Mesch, 2006). Research indicated for instance that restrictive mediation can easily backfire (Brehm & Brehm, 1981), as this strategy has been linked with more family conflict (Beyens & Beullens, 2017; Beyens & Valkenburg, 2019; Nelissen & Van den Bulck, 2018; Van den Bulck & Van den Berg, 2000). The use of active mediation on the other hand has been associated with more cohesiveness in the family (Sharaievska, & Stodolska, 2017) and less conflict (Beyens & Valkenburg, 2019; Van den Bulck & Van den Bergh, 2000). However, consistency is lacking, as other studies found no effects (e.g., Beyens & Beullens, 2017) and still others reported negative effects of active mediation on the amount of conflict and the attitudes toward the parents (e.g., Nathanson, 2002).

Applying the literature on parental mediation to child mediation, it can be expected that the use of child mediation strategies is related with the amount of family conflict. We thus formulated:

*H3a: There is an association between the use of the different child mediation strategies (active, restrictive, and supervising) and the amount of family conflict about sharenting.*

Given that, based on the literature, it can be expected that the frequency of sharenting by fathers/mothers can be associated with the use of specific child mediation strategies and that these child mediation strategies might in turn predict the amount of family conflict, the idea rises that there might also be an indirect effect at stake here, explaining the impact of frequency of

sharenting on family conflict through the use of child mediation strategies:

*H3b: The different types of child mediation strategies (active, restrictive, and supervising) mediate the relationship between sharenting frequency of fathers/mothers and family conflict about sharenting.*

## 2. Method

### 2.1 Sample

An online survey was conducted among 144 adolescents (*N*= 144; 52.1% girls) with an average age of 14.42 years (*SD*= .68). We focused on sharenting on Facebook and Instagram, as these are the most popular platforms among parents for these purposes (Marasli et al., 2016; Morris, 2014). To be included in the study, at least one of participants' parents needed to be active on at least one of the platforms. The data collection took place at two schools in The Netherlands. Prior to the study, we sought approval from the school board and parents. The study protocol was approved by the Ethics Committee for the Social Sciences and Humanities of the University of Antwerp.

### 2.2. Measures

*Sharenting frequency* was measured for mothers and fathers separately. Three items were used on a Likert scale ranging from *"rarely to never"* (1) to *"every day"* (4). The items referred to different types of information parents shared (written information, pictures, and videos). The total frequency scores for fathers and mothers were calculated by summing up the three scores ($\alpha_{mothers}$= .81, $\alpha_{fathers}$= .90).

*Child mediation strategies* (Table 1) were also measured separately for mothers and fathers by using seven items, inspired by the "parental mediation strategies scale" of Wisniewski et al. (2015). The items were adapted to the context of sharenting. A Likert scale was used ranging from *"never"* (1) to *"often"* (5). Factor analyses pointed toward three factors (Table 1), reflecting three types of child mediation. Active child mediation consisted of three items ($\alpha_{mothers}$= .69, $\alpha_{fathers}$= .73). Restrictive child mediation also consisted of three items ($\alpha_{mothers}$= .68, $\alpha_{fathers}$= .69). The total active and restrictive child mediation scores for fathers and mothers were calculated by summing up the scores for the different items. Lastly, supervising child mediation contained one item.

*Family conflict* about sharenting was captured using two items ("How often in the past six months have you been mad at your parents/one of your parents for sharing a post/photo/video of you?" and "How often in the past six months did you have a conflict with your parents/one of your parents about a post/photo/video they shared online about you?"). These were based on the study of Beyens and Beullens (2017) and adapted to the context of sharenting. These items were answered on a Likert scale ranging from *"never*" (1) to *"very often"* (5). The total family conflict score was calculated by summing up the scores.

## 3. Results

### 3.1. Descriptive results

An overview of descriptive statistics can be found in Table 2. The total scores for sharenting frequency for mothers and fathers were low to moderate, and not significantly different ($t(80)$= 1.46; $p$= .148). Results further indicate that more than 50% of the adolescents in our study explained something about sharenting in the past six months (cfr. Active mediation). Concerning the restrictive child mediation strategies, the most used strategy was telling the parents that they were not allowed to share certain things. For supervision, it appeared that almost 40% of the adolescents checked the profiles of their fathers and mothers at least once in the past six months.

Family conflict about sharenting was low. More than 80% of the participants never had a conflict. However, nearly 20% had been mad about something their parents shared at least once in the past months.

### 3.2. Model testing

To test our hypotheses, a mediation model (Model 4) was constructed and tested using the PROCESS Macro of Hayes in SPSS. Sharenting frequency was included as independent variable, family conflict as dependent variable, the three types of mediation as mediators and gender as a covariate. Separate models were created for the sharenting of fathers and mothers (Overview and details see Figures 2 and 3). Bootstrapping (5,000 resamples) was used to test the mediation models. For fathers, the indirect model did not generate a good fit, so we decided to continue with a model with only direct effects for fathers.

Looking at the direct associations between sharenting frequency and family conflict about sharenting (H1), it appeared that sharenting frequency of mothers was positively related with increased family conflict ($\beta$= .13; $p$= .003).

H2 focused on the direct effects of sharenting frequency on the use of child mediation. The results indicated a significant association between sharenting frequency and the use of restrictive and supervising child mediation for both fathers and mothers. More specifically, a higher score on sharenting frequency resulted in an increased use of restrictive ($\beta_{father}$= .08; $p$= .03; $\beta_{mother}$= .10; $p$= .001) and supervising strategies ($\beta_{father}$= .18; $p$= .001; $\beta_{mother}$= .22; $p$= .001). Sharenting frequency was not related with active child mediation.

For the association between the different child mediation strategies and family conflict (H3a), it was found that the use of restrictive strategies with both mothers and fathers resulted in more family conflict ($\beta_{mother}$= .59; $p$=.001; $\beta_{father}$= .48; $p$=.001). Moreover, an indirect effect was found from sharenting frequency of

| Components | Mothers | | | Fathers | | |
|---|---|---|---|---|---|---|
| | F1: Active mediation | F2:Restrictive mediation | F3:Supervising mediation | F1: Active mediation | F2:Restrictive mediation | F3:supervising mediation |
| In the past six months, | | | | | | |
| how often have you explained something about sharing certain things (written information/pictures/videos) of you on social media to your mother/father? | .66 | | | .74 | | |
| how often have you told your mother/father which things (written information/pictures/videos) you like that they share about you like on social media? | .83 | | | .83 | | |
| how often have you told your mother/father which things (written information/pictures/videos) you find bad when they share them about you on social media? | .83 | | | .83 | | |
| how often have you told your mother/father that she/he is not allowed to share certain things (written information/pictures/videos) about you on social media? | | .64 | | | .72 | |
| how often have you forbidden your mother/father from sharing certain things (written information/pictures/videos) about you on social media? | | .86 | | | .88 | |
| how often did you asked your mother/father to remove certain things (written information/pictures/videos) that they shared about you on social media? | | .85 | | | .77 | |
| how often have you checked the social media accounts of your father/mother to see what they share about you? | | | .98 | | | .82 |

Note: For mothers, the KMO-test verified the sampling adequacy (.68) and the Bartlett's test of sphericity was significant ($\chi^2$ = 197.43, df = 21, $p$ = .000). For fathers, the KMO-test also verified the sampling adequacy (.71) and the Bartlett's test of sphericity was also significant ($\chi^2$ = 244.55, df = 23, $p$ = .000).

**Table 1**- Factor loadings active, restrictive, and supervising child mediation mother and father.

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | | | | | | | | | | |
| 2. Sharenting father | -.125 | | | | | | | | | |
| 3. Sharenting mother | -.081 | .416*** | | | | | | | | |
| 4. Active mediation father | .025 | .196 | .222* | | | | | | | |
| 5. Active mediation mother | .043 | .125 | .175 | .812*** | | | | | | |
| 6. Restrictive mediation father | .152 | .264* | .153 | .361*** | .221* | | | | | |
| 7. Restrictive mediation mother | .127 | .124 | .363*** | .199* | .295*** | .686*** | | | | |
| 8. Supervising mediation father | .091 | .031 | .307** | .150 | .090 | .438*** | .464*** | | | |
| 9. Supervising mediation mother | .047 | .386*** | .198 | .308*** | .133 | .363*** | .145 | .051 | | |
| 10. Family conflict about sharenting | .084 | .306** | .434*** | .272** | .229* | .234** | .301*** | .097 | .663*** | |
| *M* | | 4.94 | 5.28 | 1.91 | 2.04 | 1.44 | 1.51 | 1.73 | 1.68 | 2.32 |
| *SD* | | 2.78 | 2.25 | .87 | .85 | .66 | .67 | .97 | .95 | 1.01 |
| Range | | 3-15 | 3-15 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 1-5 | 2-8 |

Note: ∗∗∗$p$ < .001; ∗∗$p$ < .01; ∗$p$ < .05

**Table 2** - Descriptive statistics and correlations.

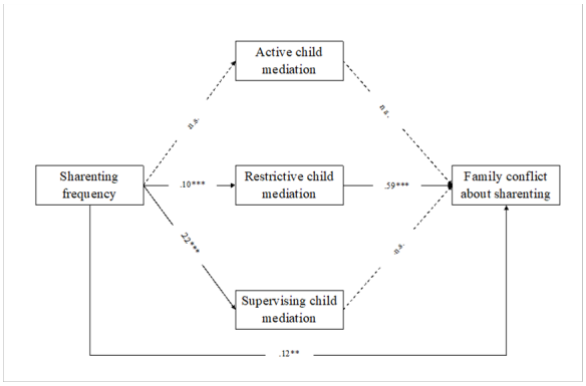


**Figure 2** - Meditation model mothers.
*Note.* ∗∗∗$p$ < .001; ∗∗$p$ < .01; ∗$p$ < .05; Model Fit mediation model: $F$(4, 84)= 6.56 ; $p$ = .001); $R^2$= .24

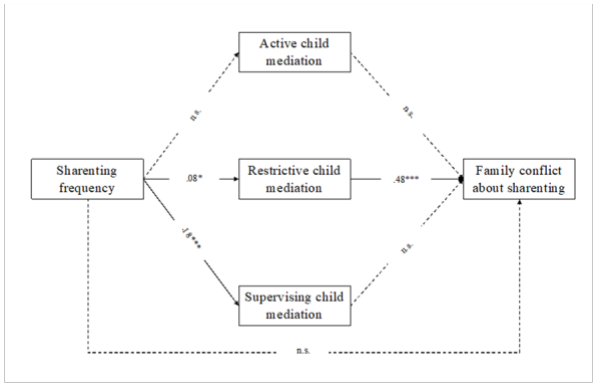


**Figure 3** - Mediation model fathers.
*Note.* ∗∗∗$p$ < .001; ∗∗$p$ < .01; ∗$p$ < .05; Model Fit model with only direct relations: $F$(1,71)= 3.27; $p$ = .075); $R^2$= .04

mothers on family conflict through the use of restrictive child mediation strategies for mothers ($\beta$= .06, C.I. 95% .007 till .138), which partially confirms H3b. Active mediation was not related with family conflict.

## 4. Discussion

The current study increased the knowledge on both sharenting and child mediation by investigating adolescents' child mediation strategies and their predictors and outcomes in the context of sharenting behavior of their parents.

The results indicated that adolescents' perceptions of their parents' sharenting behavior were moderate to low, with no differences between their fathers and mothers. This is in contrast with the study of Ammari et al. (2015) among parents, who found that mothers share more often compared to fathers. This seems to confirm the differences between adolescents' and parents' perceptions on parenting. However, differences were found on the association between frequency of sharenting and the amount of family conflict (H1), as it was only for mothers that a significant positive association was reported here. This can be explained by previous research indicating that mothers more often share "cute" things who might be easily considered as embarrassing or frustrating (Leaver, 2020); whereas fathers post more often about accomplishments (Ammari et al., 2015).

Concerning the use of child mediation strategies in the context of sharenting, significant differences were found between the different strategies. Our participants indicated to adopt more often the active mediation strategy for both their mothers and fathers. This corresponds with the fact that they also believe that this is the best strategy (Vaterlaus et al., 2014). These strategies were related with sharenting frequency. For both mothers and fathers, it appeared that increased sharenting resulted in increased use of restrictive and supervising strategies, thus partially confirming H2. This follows previous research indicating that increased use of certain technologies or new practices is related with more parental mediation (e.g., Beyens & Beullens, 2019). It thus seems that parents and adolescent children react in the same way when they notice an increase in certain media use from the other party. However, by specifying the different types of child mediation, our study can add that especially restrictive and supervising strategies are related with increased use. This might suggest that active child mediation is mostly used when sharenting is still low. Increased use of restrictive and supervising strategies can then be the next step, when active mediation is not helping or not sufficient. Further research is necessary to test and explain this finding.

The last part of the study (H3a) posed the question of whether the use of these strategies was also related with family conflict about sharenting. This was only confirmed for restrictive child mediation. In accordance with the findings on restrictive parental mediation (e.g., Beyens & Beullens, 2017; Beyens & Valkenburg, 2019; Nelissen & Van den Bulck, 2018; Van den Bulck & Van den Berg, 2000), restrictive child mediation was related with more family conflict about sharenting for mothers and fathers. It is thus not only children who can react rebellious toward rules and restrictions, parents seem to react in a similar way when their children control their sharenting (i.e., Reactance theory; Brehm & Brehm, 1981). Apart from the direct effect, also an indirect effect was found in which restrictive mediation functions as a mediator between sharenting frequency and family conflict in the model of mothers, thus also partially confirming H3b. Active and supervising child mediation were not related with family conflict.

This study has some limitations. As this study relied on cross-sectional data, we are unable to draw firm conclusions on the causality. Following the literature on parental mediation and sharenting, we concentrated on how sharenting frequency can steer child mediation and family conflict. However, it seems plausible that these processes also contain a feedback loop (Scheurs & Vandenbosch, 2020), in a sense that the used strategies and amount of conflict again have an influence on the sharenting frequency. To further investigate such transactional models, future research might benefit from a longitudinal approach. This study also relied on adolescents' self-reported data, which might differ from parents' perceptions. Future research can overcome this by including both data from children and their parents. Moreover, future research should include measures on the general family relationships and communication patterns and on conflict with father and mother separately. How well adolescents can communicate about their feelings depends on the general climate and involvement in the family (Schrodt et al., 2009).

Our results have implications for scholars in socialization research as well as for parents. Firstly, scholars must recognize the existence of child mediation practices and further explore this phenomenon. Socialization develops as an interaction between the meaning of the sender and the interpretation of the receiver. It is not because children make a different interpretation, that their perspective is wrong or is the result of less cognitive capacities, it means that they interpret the situation differently (Van den Bulck & Van den Bergh, 2005). Similarly, parents should have an open attitude toward the feelings of their children when they share things and should stimulate conversations. They should try to understand why children do not like the sharing of certain content and use this knowledge as a basis to develop guidelines together. In that way, the use of restrictive child mediation strategies that might further complicate the adolescents-parent relationship can be avoided.

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# Impact of online simulators on primary school children's visual memory development

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**Abstract**

Modern society needs thoroughly developed individuals ready to enrich material and spiritual culture of community. Therefore, the creation of favorable conditions for maximal revealing and development of learner's abilities, growth of one's individuality and prospects for self-realization is increasingly becoming of great importance. It is memory that plays the leading role in this process. Memory is a very complex process that includes getting, keeping and repetitive using of information. Memory lies at the heart of human abilities and it preconditions learning, acquiring of knowledge, formation of skills and abilities. Development of visual memory is one of the most actual problems considering the fact that the students at school are given a great amount of new information and not much attention is paid to the development of ability to memorize information. Organizing purposeful work on memory development is a crucial task. The basic task of memory development is the development of school children's visual memory. It considerably helps to increase education quality to fulfill the main tasks of education. In this regard there is a need to look for effective means for visual memory development. The purpose of this study is to reveal effectiveness of online simulators in the process of primary school children's visual memory development. In the course of the study the following methods were used: theoretical analysis of pedagogical and methodological literature; methods of checking and diagnostics (tests, observation); pedagogical experiment that helped to show effectiveness of online simulators in the development of primary school children's visual memory.

**KEYWORDS:** Online Simulators, Development, Visual Memory, Primary School Children.

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## 1. Introduction

### 1.1 The Importance of the Issue

Memory is one of the basic human abilities and it conditions learning, acquiring of knowledge, formation of skills and abilities. Memory is the most important function in life as long as it takes part in every action that a human performs every day (Bulgakov, 2014). Exploring human memory was the subject matter of science and philosophy during thousands of years and became one of the main issues of interest for modern pedagogics and psychology (Bjorklund & Sellers, 2014; Schneider & Ornstein, 2015).

The German philosopher H. Ebbinghaus (Ebbinghaus, 1913) devoted many years of his life to studying memory and made interesting conclusions. He started experimental studying of memory and summarized his findings in the work "About memory" going beyond the limits of sensory processes. Ebbinghaus discovered the forgetting curve meaning that during several days of learning some information, people memorize only a little part of the things learnt. In particular, during the first 24 hours people remember about 50% of the information learnt; after 48 hours there can be recollected 30%, and after a week only 3% of all information learnt several days ago.

Human mind can keep the amount of information equivalent to ten billion encyclopedia pages. But memory is not the ideal system of storage. Although human memory is often compared with the volume of computer memory, the difference lies in the way of retrieving of the saved information or files. Computer restores a file without any changes, no matter when it

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was saved; whereas reminiscences recalled from human memory can be changed by many factors. This ability to change memories can go so far that subconsciously would generate false recollections. Such ability is more often the characteristic of children than grown up people. Though memory doesn't have exact copies of events as computers do, still it is a reliable system that helps to remember (Papert, 1989).

Memory is a very complex process that includes getting, keeping and repetitive using of information (Talysina, 1997). As for the place of memory, there is no definite physical location where it can be situated, it exists in various parts of brain.

According to definition of J. Piaget, memory is a set of information that is acquired by brain and that influences human behavior (Piaget & Inhelder, 1973). A.V. Petrovsky (1997) considers that memory is keeping and further reproducing the individual's own experience.

V.G. Krysko (2001) defines memory as a process of imprinting, saving and reproducing of what was reflected, done and experienced.

Smirnov (2002) proved the dependence of memorizing productivity on character of activity in which it is done. As a result of his research there were thoroughly explained characteristics and age differences in relation to intentional and unintentional memorizing.

According to L.S. Vygotsky's concept of memory, the higher forms of human memory meaning the process of active memorizing with the help of signs as the other forms of behavior appear in socialization of people (Vygotsky, 2005). Historical development of a human led to using the word as a sign that helps marking in mind the memorized things.

Development of memory is one of the actual problems of primary education (Kail, 1990; Bruck & Ceci, 1999; Schneider & Ornstein, 2015). Primary school students are given a great amount of new information, but sufficient attention is not paid to the development of ability to memorize information. Memory development goes independently according to definite order. It begins first with recognition process formation, then reproduction and in the end the selectiveness of memory is formed (Lapp, 1972). It is proved that memory gets better in the process of fulfilling certain exercises (Tihomirova, 1998).

The basic task of memory development is the development of school children's visual memory. It helps increase the quality of education. Visual memory consists of human's brain ability to keep and show the result of the earlier visual perception. Information that can be visually imagined by children is as a rule easily memorized and recollected back. According to researches, up to 80 % of perceived information goes through the eyes, which means visual memory is the most important aspect of education in primary school (Buss et al., 2018).

The need in special researches in this field is justified by numerous attempts of various authors to accentuate their vision in solving this problem (Zinchenko, 2002; Repkina, 2009; Semenova & Sidorina, 2016).

The ability to create new memories, to keep them during some time and recollect them when they are needed helps us learn and interact with surrounding world. In modern pedagogy and psychology, the issue of visual memory formation in children is very critical. Deficiency of visual memory practically stays unrevealed until a child comes into learning activity (Simmering, 2012). Academic problems that are sometimes considered as laziness or low IQ can be caused by problems with visual memory.

It is known that children easily memorize everything that is bright, colorful, unusual, all things that evoke strong emotional reaction. More often those are games. But they are intended for complex development and represent difficulty in observation process for qualitative visual memory development during long period.

It is supposed that visual memory development of primary school children will be more effective if at this process online simulators are used.

### 1.2 Aims of the Study

1. to reveal possibilities of online simulators for developing primary school children's visual memory;
2. to describe the development of primary school children's visual memory in the process of using online simulators.

## 2. Materials and Methods

### 2.1 Research methods

The following methods were used: theoretical analysis of pedagogical and methodological literature; methods of checking and diagnostics (tests, observations); pedagogical experiment that helped show the effectiveness of online simulators in developing primary school children's visual memory. We made a review of online simulators that are aimed at primary school children's visual memory development (B-Trainika, Wikium, BrainApps, Boostbrain).

### 2.2 Research Base of the experiment

The research was conducted in Kazan (the Republic of Tatarstan, Russian Federation). The sample group of the study included 32 children aged 8-9. Children were divided equally between 2 groups: 16 of them were in Group 1 and 16 in Group 2 accordingly. Group 1 worked with online simulators, group 2 did not work with simulators.

Test tasks were intended to reveal visual memory development level in accordance with criteria: volume of visual memory (amount of memorized material that is measured in operational memory units), rate of memorizing (fastness), exactness of reproduction (characterized by difference between accepted information and information "at reproduction point").

## 2.3. Stages of the Research

The study was carried out in three stages: at the stating stage children from 1st and 2nd groups were offered test tasks to reveal visual memory development level by means of methods "10 pictures" and "Complex figures". Diagnostics was carried out individually with every child. The forming stage was intended to develop visual memory with the help of online simulators (group 1). At this stage we made a review of online simulators. At the control stage we held the recurrent test tasks to reveal visual memory development dynamics (groups 1 and 2).

## 2.4. Methods to reveal the level of the visual memory development

To reveal the level of visual memory development in primary school children we used the following methods: "10 pictures" and "Complex figures".

The purpose of the "10 pictures" method by L.M. Shipitsina is to define the level of visual memory development.

Below is the implementation of the method.

A child was offered to have a look at a page with 10 pictures within 10 seconds' time. After removing the page from visual field a child had to name those pictures from memory. The more pictures were remembered and named by the learner, the higher is one's visual memory level.

Processing and analysis of the results.

The results were processed on the number of pictures named by the child:

High level - 8 and more.

Middle level - 5-7.

Low level - 4 and less.

Diagnostics was carried out individually with every child. Instructions were adequately accepted and understood by them. Almost all children approached the task in a responsible way, doing their best to memorize pictures.

For more reliable results of the experiment, we used "Complex figures" by D.Vexler - the additional method to estimate children's visual memory level.

The purpose of this method is to define visual memory development level.

Equipment: stimulus material, sheet of paper, a pencil.

Below is the implementation of the method.

Four pictures were offered to a child who had to look at every picture during 10 seconds. Then a child had to reproduce those pictures on the sheet of paper.

Processing and analysis of the results:

1. Two crossed lines and two flags -1 point;

correctly placed flags -1 point;

correct angle in crossed lines - 1 point.

Maximum evaluation for this task: 3 points.

2. Big square divided into 4 parts by 2 lines -1 point;

four small squares in a big one -1 point;

two intersecting lines and 4small squares -1 point;

four dots in squares -1 point;

accuracy in proportions -1 point.

Maximum evaluation for this task: 5 points.

3. A big rectangle with a little one inside -1 point;

all tops of internal little rectangle are connected with tops of big external rectangle -1 point;

little rectangle is exactly placed in big one -1 point.

Maximum evaluation: 3 points.

4. An open rectangle with the correct angle at every side -1 point;

the center, left and right sides are reproduced correctly -1 point;

the figure is correct with the exception of one incorrectly reproduced angle -1 point.

Maximum evaluation: 3 points.

Maximum result: 14 points.

High level - 10 or more points.

Middle level - 9-6 points.

Low level - 5-0 points.

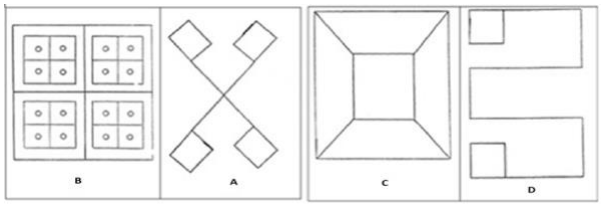


**Figure 1** - Stimulus material.

## 2.5 Review of online simulators aimed at visual memory development of primary school children

1) Memory matrixes.
Game field represents a matrix with a net of squares. Some squares are painted. It is needed to memorize positions of painted squares and after closing the pattern, it should be recreated by pressing on the right squares. With every right answer the matrix grows; the same happens to the painted squares – their number

increases. With the wrong answer matrix becomes smaller.

2) "Find a pair" game.

Game rules are simple: it is needed to open at once 2 cells of the table, trying to find similar pictures. As soon as all the pictures are opened, game is over. This game is a memory test: the program notes the time spent on the game.

3) N-backwards.

In this task children work with sequence of numbers, letters or pictures that are shown one by one at every interval of time. In the simulator attention should be paid on the condition of passing the level that is indicated at the beginning: "It is needed to remember steps …" and the number of steps is shown. At the start it is 1 step (1- n) – the user is expected to make a positive reply when the current element matches with the previous one. At the complexity "2-n" there is expected a reply when the current element matches with the one that was two intervals ago.

4) Finding changings.

On the monitor there is shown a set of colorful elements that are needed to remember. After given time for memorizing, the initial set is replaced by a copy with one wrong object. The task is to find it. The order of pictures' position can change.

5) Camera Mind.

Simulators represent a game field where circles appear. First, there appear 1 circle, its position should be remembered and clicked. Further there goes transition to the next level and on the field there would be 2 circles, it is needed to click on the circle that was not on the previous level and remember the position of 2 circles. And so on. It is needed to remember as much as possible. (Low level of visual memory -10 circles, middle – 20 circles, high - 40 circles).

Recommendation or clue: it is easier to remember the position of circles if in your mind you draw figures that are associated with them, for example, numbers, geometrical figures, animals, trees and so on.

These simulators are represented in two variants: the first – white circles on the black background, the second – multicolored circles on the black background. Game with colored circles is more interesting for primary school children and it is easier to remember when comparing with white circles.

6) Find differences.

The user is offered to compare 2 similar pictures or things with some slight differences (on one picture there is some object and on another one it is absent, colors of elements are different, their size are different and so on). It is needed to find and point out all differences.

7) Game with numbers.

On the monitor there appear cells, by their side there is a picture (a cat, a candle, a plane, etc.). When pressing the "start" button, all cells are filled with various numbers. It is needed to remember number at every picture (20 pictures in total), and then press the button "further". On the monitor there appear cells with pictures in chaotic order. It is needed to click input box near the pictures and type the remembered numbers.

In a very short time of 1 second it is needed to remember several numbers, and then randomly show those positions where they were previously located. Numbers should be shown in ascending order, for example, 1,3,7,9. The final result will be shown when 10 guesses are made (the bigger number appears on the screen, the more mistakes were done). Therefore, learners have to strive to get the minimal number.

Visual memory develops in close connection with other kinds of memory, thinking, perception, attention, etc. There are many sites with online simulators intended for memory development, its kinds and other functions. We considered the most popular and convenient sites. These sites demand registration, after which on the user's account or profile all information will appear. Firstly, users are offered to pass a test to define visual memory development level and then according to test results there will be given a program of further lessons. Next one can have a daily program that takes no more than 15 minutes (3-5 simulators), also there can be chosen a definite skill that is needed to be developed using simulators.

Most simulators do not give statistics for long period that would have shown changes in memory development. The sites with simulators that are described further do not have such deficiency. They offer a systemic approach that develops human brain in general and improves memory in particular.

1. B-Trainika.

All simulators of this site represent online games that are aimed not only at improvement of various psychological functions of brain but also in their turn they are very entertaining There is a chance to choose certain skills and abilities for self-development. Here are three simulators for visual memory. "Path of Ninja", "Numismatist", "Astrologer".

Simulator "Path of Ninja".

On the game field divided into the definite number of squares some cells open for a short time. It is needed to remember them and show in random sequence. The higher the level, the bigger and the more complex is the picture.

Rules of the game are the following:

- remember the position of light tiles;
- when tiles turn upside down point out each of them;
- no mistakes are permitted.

Recommendation or clue:

Try to remember not the position of all squares, but a form of figures that they construct. So, it will be easier to repeat their forms.

The game is called like this because of the legend about training future ninja. On the stone there were placed several objects, those objects were covered with a cloth, then the cloth was removed for a short time so that the students could remember the objects

seen. The task was to name all objects. Years of training gave the ability to recite the text to a word after just one reading.

Simulator "Numismatist".

During the game it is necessary to compare in a short time various coins of different countries.

Rules of the game are as follow:

- remember the denomination of a shown coin and press the button "Further";
- point out matching of a new coin denomination with previously shown coin denomination;
- choose the needed number of right answers during the given time;
- on more complex levels there will be needed to remember 2 or more previous steps.

In this simulator, there should be paid attention on conditions, needed to pass the level, which are indicated at the start. One of the conditions: "It is necessary to remember … steps" – and the number of steps is indicated. At the beginning it is 1 step, it means that there should be compared the denomination of current coin with the denomination of the previous coin shown 1 step ago. If it is needed to compare 2 steps ago, then there should not be compared with the previous coin but the coin that was before the previous one.

Simulator "Astrologer".

For a short time a certain number of stars are opened before a child. It is necessary to manage counting them and correctly indicate their number. With every achieved level the number of stars will grow, so it will be needed to unite them into groups. Besides, with every new level there is a chance to make a new discovery, exploring nebulosity, planets and star clusters.

2. Wikium.

At the heart of Wikium simulators there are methods of renowned neuropsychologists who proved their effectiveness during many experiments and scientific papers. The user does introductive testing to check the current level of memory, attention and thinking. Further there will be formed the personal program of development. Daily program development includes warming up and training.

Simulators of visual memory: "Matrixes of memory", "Signal lamps", "Secret room" and so on. They all follow one principle: it is needed to remember the order of actions and repeat it.

3. BrainApps.

BrainApps in automatic mode offers training program with optimal workload. It is a set of unique and effective simulators with psychologically proved results. At the core of this service are simulators that are advanced versions of known exercises and puzzles used in 19-20 centuries.

Games aimed at visual memory development:

*"Diamonds"* – on the game field the cells light up in the definite order. It is needed to remember their order and repeat it.

"*N2 backwards"* – there is given the sequence of numbers, it is needed to remember all the sequence and compare number on the last card with the number on the previous one; the answer is given by buttons "yes"/"no".

"Fast comparison" represents a set of pictures, it is needed to remember the previous picture and compare it with the current one, responding if it is repeated or not.

4. Boostbrain.

This site also has simulators that include at their core such principles as matrixes of memory, step back, games with numbers. We considered the ones that were not used on other sites:

"Lost symbol" game.

Purpose of the game is to remember the position of symbols and then to point out the missing one. On the square with 4 cells there are 4 symbols that disappear in 2 seconds' time, then there appear only 3 of them, and one cell is empty. On the lower part of the game field there appear 4 symbols, it is needed to find among them the one that disappeared in the square. On the more advanced levels the amount of cells increases up to 6 and further up to 9.

"Random" game.

The game runs for a short time, only 60 seconds - when time is over, the game stops. For this period it is needed to try to get as many points as possible. One has to remember the position of numbers and then to point them out in order. Numbers disappear after pressing the number "1", but this number stays. The game starts with three numbers and according to complication there is added one more number, and so on up to 9 (therefore the score increases after passing the level), if there is mistake in sequence of numbers, then the game comes one stage back decreasing the amount of numbers necessary to remember. When a learner achieves the level with 9 numbers, the amount of numbers stops to change and every time it is needed to remember the position of numbers from 1 to 9.

## 3. Results

### 3.1 The stating stage of the experiment

During the study it was noted that some children whispered the kinds of pictures, compensating in this way the lack of visual memory by auditory memory as another skill. Taking this into account it becomes obvious that there is no visual memory sufficiently formed in this age category, despite the fact that their level of memorizing was not bad.

| Groups | 10 pictures Levels | | | Complex figures Levels | | |
|---|---|---|---|---|---|---|
| № | Low % | Middle % | High % | Low % | Middle % | High % |
| 1 | 44 | 56 | 0 | 44 | 56 | 0 |
| 2 | 31 | 63 | 6 | 25 | 56 | 19 |

**Table 1** - Stating stage.

Interpretation of results revealed that visual memory in more than a half of the children does not correspond to this age memory volume norm in average consisting of 7-8 illustrations. These results allow to conclude that visual memory of learners is lower than average and it should be developed.

Also, considering the results of diagnostics there can be seen such peculiarity in primary school children as remembering bright and colorful other than uninteresting material. Almost all learners recollected colorful pictures of ball, house and duck. And only several learners could recollect pictures of spectacles and hammer that do not attract attention because of their unnoticeable color tones.

Interpretation of results showed that the most part of learners remembered really well and reproduced picture "C" – the picture consisting of simple figures and little amount of elements was the easiest one for children.

There are those learners who did not remember picture "D". During conversation it was found out that this picture seemed too complex for some learners and that was why the learner did not try to memorize it, and another learner couldn't remember the picture when tried to reproduce it on paper.

For the picture "B" more marks are given - 5. None of the learners could reproduce it with maximum accuracy. Some learners could not manage with proportions, the others forgot to draw small elements, some of them, on the contrary, missed a big square.

Comparing the results of remembering the "A" picture, it was clear that this task was not simple. Most mistakes were made by incorrectly placed flags and wrong angles in the intersection of lines.

### 3.2 Development of visual memory

Before the start of work with computers there was a meeting with the school doctor who analyzed medical documents concerning the health of children and in particular their eyesight. All the participants of the 1st group did not have ophthalmic diseases.

Further there was an introductory lesson where learners came with their parents. At this lesson the work structure, its purpose and expected results were explained in detail. Together with parents and teacher there was made a schedule convenient for everyone. Then, everyone was introduced to such modern means of developing learner skills as online simulators, told about possibilities of these game simulators, about their advantages in comparison with traditional didactic games. Also children were instructed about safety measures and rules of work with personal computers. After this every learner got the manual "Rules of work with computers", which included exercises on gymnastics for eyes.

For the lessons there were chosen two most interesting and popular simulators: "Matrixes of memory" and "Camera mind" (the version with colored circles), that develop visual memory in basic criteria of its estimation: volume, rate of memorizing and accuracy of reproduction.

These simulators do not limit learner in time and they stop only if the mistake is made. Choice of games without count of time is based on psychological peculiarities of children. Limitation in time causes emotional stress and increased feeling of responsibility, which lowers brain activity of a learner. At every lesson learners played during 15 minutes on the first simulator, and then for 15 minutes on the other one. Between the first and the second simulator learners did gymnastics for eyes. Such structure of lessons was organized because at junior age it is very difficult to keep attention of children on one subject, therefore a change in activity is needed. Thanks to such structure children have increased interest and ability to learn.

Online simulator "Matrixes of memory".

Purpose: development of accuracy and volume of visual memory.

This game simulator demands to remember positions of painted cells and after, it is needed to recollect them from memory. Game field represents a blue background where a block consisting of definite amount of cells appears (the amount of cells depends on the passing game level and it becomes more complicated – the 1st level is represented as a block of 9 squares, 3 of them are for remembering; the last level has 54 cells, and 12 of them are for remembering), for a few seconds (1-2) the squares that are needed to keep in mind are turned upside down, after that they get closed. Further in voluntary order it is needed to press the needed cells. If the cell is chosen correctly, it opens, and if all the cells are guessed correctly, there goes the transition to the next level.

And if the cell is chosen incorrectly, the game stops and it starts again.

The whole game can be conditionally divided into 3 stages:

1st stage – initial (easy);

1st-2nd level - 3 of 9 cells;

3rd-4th level - 4 of 12 cells;

5th-6th level - 5 of 16 cells;

2nd stage-middle;

7th-8th level - 6 of 20 cells;

9th-10th level - 7 of 25 cells;

11th-12th level - 8 of 30 cells;

13th-14th level - 9 of 35 cells;

3rd stage – levels of higher complexity;

15th-16th level - 10 of 42 cells;

17th-18th level - 11 of 48 cells;

19th-20th level - 12 of 54 cells.

Lesson observations were written into table intended for controlling the process of simulator usage. There were noted lessons and level of the game that was approached but still not passed by learners by the end of lesson.

So, the best game result showed one learner having passed 16 levels and having found 10 painted cells out of 42. Since the first lesson all learners many times passed the same levels because it was difficult for them to remember the amount of more than 4 cells. This helped them to memorize results and every time the actions of learners became more automatic.

Learners were in a very optimistic mood, despite of frequent mistakes they did not get upset and immediately started playing again. There were learners whose main mistake in many cases was haste. They wanted to see and to know so much what would be at the more complicated levels that even knowing the positions of needed cells they accidentally pressed the wrong cell. There were those who had difficulty with concentration and they constantly got distracted - that's why they could not remember the painted cells and for a long time could not pass even easy levels. But by the 3rd lesson there appeared competitiveness in children in relation to classmates and they started to show good results.

In general all children achieved good results. The game increased their motivation to succeed. Children were interested in how to remember more cells for such a short time. They were glad to see their achievements and they shared their impressions with each other.

Simulator "Camera Mind".

Purpose: development of visual memory.

Simulator represents black background where colored circles, which have to be kept in memory, appear. At the beginning there appears one circle, its position has to be remembered and it should be clicked. Further there goes transition to the next level and there will be two circles, it is needed to click the circle which has not been on the previous level and it is needed to remember position of these two circles. And so on. It is needed to remember as much as possible. Simulator does not limit the learner in time.

Instead of classical simulator with white circles, there was chosen the version with colored ones taking into account perception peculiarities of primary school children. For children a bright game field is more interesting than space with unremarkable color tone, and children easily remember circles of various colors.

The best result was shown by one learner who managed to remember 21 circles. Children liked this game very much. They played it with great interest and watched their own results. At the first lesson they remembered 6-7 circles on average, and further learners had difficulties in finding a new circle that appeared on the monitor last.

Passing further, learners comparatively longer looked for the needed circles; they used their own memory to the full and analyzed positions of all elements. In memorizing larger amounts of circles the recommendations helped that it was easier to remember if one imagines the positions of circles as a kind of some object: circles clustered in the shape of stars, of a house and so on.

It should be noted that in a process of game on this simulator, visual memory development was not traced at every lesson. There were lessons when results of some learners achieved higher levels, though at the next lesson this result was not improved but on the contrary it became lower. Children explained it by the fact that considering too many circles they lost their self-confidence and thinking that they would not get better results made them give up. But when they saw their classmates achieving records they started the game with new enthusiasm.

The work with the first group, in general, consisted of 30 lessons, each lesson lasted 30 minutes. At the initial stage children had difficulties in remembering a large amount of elements and they advanced very slowly. By the end of the forming stage all of them fulfilled their tasks actively and with great success.

### 3.3 Controlling stage of the experiment

To define the effectiveness of work done on the forming stage of the experiment the controlling experiment was carried out. At this stage, there were applied the same diagnostic methods as the ones applied at the stating stage, but there was used another set of pictures. The controlling diagnostics was carried out with children of the 1st and 2nd groups.

In diagnostic process there was revealed data about the level of visual memory development given in Table 2.

| Groups | 10 pictures Levels | | | Complex figures Levels | | |
|---|---|---|---|---|---|---|
| № | Low % | Middle % | High % | Low % | Middle % | High % |
| 1 | 0 | 50 | 50 | 0 | 56 | 25 |
| 2 | 19 | 56 | 25 | 6 | 69 | 25 |

**Table 2** - Controlling stage.

There is no doubt that the level of visual memory development in the 1st group is considerably higher than in the 2nd one.

Learners of the 1st group showed sufficient volume of visual memory, its accuracy and good rate of memorizing.

It is obvious that the level of visual memory in the 1st group became higher in comparison with data revealed at the beginning of the experiment. There were no children with the lowest indexes of visual memory; the indexes of both methods were high.

## 5. Discussion and Conclusions

Psychologists proved that memory advances in the process of certain exercises. As a result of work with similar intellectual operations corresponding neural communication develops and brain starts fulfilling the demanded task more effectively.

Visual memory plays crucial role in children's general development. It helps acquire skills necessary for success at primary school. Children with insufficient visual memory can have problems with learning.

Development of visual memory with the help of online simulators is one of the available and effective ways. You only need a smartphone with internet connection, and today it is not a problem.

Online simulator is an interesting and convenient way to develop not only visual memory but all kinds of memory, and also perception, reasoning and attention.

Through possibility to watch the dynamics of one's own success, displayed statistics and competitive spirit, the uninteresting and boring lessons intended to develop visual memory will become a captivating daily game. As a result there will be noticeable positive changes.

Online simulators help children not to do boring and tiresome exercises but have school lessons only 15-20 minutes long in a form of interesting online games. Tasks in online simulators basically are aimed to fulfill the following actions: memorizing squares in the matrix of memory; looking for pair of pictures; remembering previous "step" or a "step" that was several intervals ago; looking for differences between two pictures; finding a new element on the screen, etc.

We organized a pedagogical experiment with the aim to reveal online simulators usage effectiveness in the process of primary school children's visual memory development.

The following criteria indexing primary school children's visual memory development level are taken: volume of visual memory (amount of memorized material measured in operational units of memory); rate of memorizing (fastness); accuracy of recollection (characterized by difference degree between accepted information and information "at reproduction point").

Review of online simulators' influence on visual memory development of primary school children showed that there are many sites with online simulators for developing any kinds of memory and other functions. We examined the most popular and easiest of them (B-Trainika, Wikium, BrainApps, Boostbrain).

We chose two most interesting and simple online simulators: "Matrixes of memory" and "Camera Mind" for the children of the 1st group. The number of lessons and their length were defined in accordance with the recommendations of ophthalmology doctors - 2 lessons a week, each 30 minutes long. The learners used these simulators during 15 weeks.

As a result of the controlling stage in two groups, it was found out that the level of visual memory development in the 1st group children became higher than in the second group. Learners of the 1st group showed high and middle level, there were no children with low level. In the 2nd group the students have considerable changes.

Thus, the use of online simulators helped develop visual memory of students, children became able to keep in memory great amounts of visual images, reproduce images more exactly and remember material in a short time. These results prove that the primary school children's visual memory development will be effective if online simulators are used.

## Recommendations

Materials and results of the study can be used by teachers of primary school, parents of primary school children and school administration to organize learning activity of children.

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# Adaptive gamification framework to promote computational thinking in 8-13 year olds

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**Abstract**

Computational thinking (CT) skills are necessary to prepare students for the demands and challenges of the modern era. Students require an incentive to acquire any new skill. This can be accomplished by employing gamification, which has been widely used in educational environments and instructional practices to improve student engagement and motivation by including game elements. However, delivering CT to students through gamification is challenging. There is a lack of studies on integrating gamification into CT, especially when it comes to considering student preferences such as learning styles. Besides, according to the reviews, the existing adaptive frameworks do not directly incorporate gamification and CT into education. Therefore, the author proposed an adaptive gamified framework that supports adaptive features based on students' dimensions (verbal, visual) using the Felder-Silverman Learning Style Model (FSLSM) to foster CT skills and enhance students' motivation and performance using a modified version of the Moodle platform that supports adaptive learning features. The proposed framework integrates an "adaptive gamification framework" with the "student-centered framework" by adopting the available gamification elements in the "student-centered framework". Additionally, it matches the results with the proposed conceptual model that investigates the relationship between gamification and CT in the field of education to provide adaptive gamification and learning features. Furthermore, the results of the work indicated that the use of gamification had a positive impact on students in terms of motivation and performance, as the game elements contributed to increasing children's desire to retake the tests and thus improved the performance of students.

**KEYWORDS:** Adaptive, Computational Thinking, E-Learning, Gamification, Game Elements, Learning Style, Moodle, Motivation.

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## 1. Introduction

The rapid advancement of technology has necessitated the acquisition of new skills, which will help the next generation in meeting the requirements of the modern era, as reflected by the future of work and national advancements. Over the past years, many researchers have sought ways to help young people foster creativity and understand the consequences of technological advancements. One way to do this is by fostering computational thinking skills in schoolchildren. Many advanced countries have found that computational thinking education, as a consequence of the growth in international education policies in different countries, is very important to the future work and competition of their people and their national development. As a result, advanced countries acknowledge the importance of developing the computational thinking skills of children in early childhood (Buitrago Flórez et al., 2017). Computational thinking (CT) is considered to be a major skill for the 21st century that must be developed by future generations. It has been built as a significant 21st-century skill focused on data representation, algorithmic design, and pattern recognition. It is also considered to be a cognitive skill to apply computer science thinking processes in STEM disciplines and to apply them more to different daily problems and events (Hooshyar et al., 2020).

However, fostering CT in school students presented some difficulties. Educators, in particular K-12

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teachers and scholars, have not clearly identified how to educate students (Hsu et al., 2018). Over the past years, experts have been focusing on finding details on how to include appropriate and best materials and tools, either for all users or based on user-specific characteristics such as knowledge level, education, or learning style. Besides that, researchers have highlighted the importance of using programming to enhance CT skills. Children can use their creativity to control computers to solve problems via programming (Ching et al., 2018). However, programming languages are professional in nature (such as C, C++, and Java), which makes it very difficult for beginners, especially schoolchildren, to learn because of poor teaching methods, low levels of interaction with students, and a lack of interest (Kazimoglu et al., 2012).

In order to systematically encourage the CT skills of learners, several educational tools have been created to help students understand the logical reasoning of processing and to further support students' intuitive understanding of CT. There have been several ways that teaching aids have been used to improve the interest of schoolchildren in learning computational thinking from a young age (Kazimoglu et al., 2012). Among these tools gamification has been used to improve the learning process and encourage creativity. Gamification can be defined as the implementation of game elements in non-game contexts in order to involve people in a wide range of tasks (De Sousa Borges et al., 2014).

Over the past few years, the usage of Gamification strategies in educational contexts has increased because of the fact it has been shown to enhance the motivation and engagement of the learner. However, because the effectiveness of gamification in these contexts depends on appropriate design to prevent unwanted outcomes, many input variables must be taken into account by gamification researchers. Examples of these variables include student characteristics (such as demographic, psychological, and cognitive data) and game components that will be used to gamify the mission (Nurul and Mohamad, 2018; Toda et al., 2019). In addition, the application of Gamification does not necessarily reach the desired outcomes in educational contexts. This can happen because of many factors, such as a lack of interest in gaming or generic strategies that do not take user profiles into consideration. So, in order to implement Gamification efficiently, it must be adaptable to each user. This can be done by understanding the needs of the target audience and defining learning objectives, building strategies, and identifying available resources (Lopes et al., 2019).

Therefore, this paper investigates the effect of applying adaptive gamification to stimulate computational thinking while children aged 8-13 learn programming in the Scratch language on a modified version of the Moodle e-learning platform.

The rest of the paper is organized as follows: Section 2 discusses related work. while Section 3 offers the methodology. Section 4 shows the discussion. Finally, section 5 shows conclusion.

## 2. Related work

The fundamental concept of the study is provided in this part, which includes concepts related to the development of computational thinking abilities, gamification, and the use of gamification in eLearning systems and adaptive gamification are presented.

### 2.1 Computational Thinking (CT)

Computational thinking (CT) is an ability for the 21st century that must be developed by future generations. CT's primary goal is to develop the ability to use computers and algorithms to improve creative, critical thinking, and other skills and it facilitates the process of learning and development by decomposition (breaking problems or issues into pieces), pattern recognition (pattern observation, trends, and regularity), abstraction (identifying general rules), and design of algorithms (evolving step-by-step problem-solving instructions) (Vlahu-Gjorgievska et al., 2019).

In order to describe CT, many attempts have been documented. However, most of the definitions are ambiguous as there are no standard concepts. For instance (Swaid and Suid, 2019; Wing, 2006) described CT as "the thought processes involved in the formulation of problems and their solutions such that the solutions are represented in a manner that an information processing agent can effectively perform". Likewise, (Barr and Stephenson, 2011) described CT as "an approach that can be applied with a computer to solve problems". They proposed the term "operational definition" of CT to describe the problem solution strategy which incorporates a variety of aspects. These aspects are as follows: i) Formulate an issue in such a way that it can be solved using a computer or other instrument. (ii) Arranging and logically evaluating results. iii) The abstracting of data in the context of models and simulations. iv) Automation of the solution by algorithmic steps. (v) Defining, evaluating, and applying a potential approach to accomplish the most productive set of steps and resources. vi) Generalization and application of solving problems measures to solve a variety of issues in different fields of activity (Agbo et al., 2019).

CT concepts have also been offered by other people and research groups. Yadav et al.(2016) identified the function of CT as follows: "the essence of computational thinking is to break down complicated problems into more familiar-managed sub-problems (problem decomposition), to use a sequence of steps (algorithms) to solve problems, to analyze how the solution is transferred to related problems (abstraction),

and finally to decide if a computer can help us solve such problems more effectively (automation) ". In general, CT can be concluded as a method that uses the ability to identify problems and solve them as a solution by implementing technologies or methods.

Recently, a growing interest in CT education in K-12 schools and its role in boosting children's thinking and digital abilities has emerged. In response to this need, CT and programming have become an essential element of the school curriculum in many nations in recent years (Angeli and Giannakos, 2020). However, for K-12 educators and educational scholars, computational thinking is relatively new. Teachers and scholars have just started efforts to enhance and integrate CT in students, and few research studies have concentrated on computational thinking in kindergarten and elementary school (Ching et al., 2018). Additionally, considering the level of knowledge and education, some CT concepts can be applied to kindergarten level, and others are often considered too advanced for children because of their age and critical thinking abilities.

Over the past years, there have been a few examples of the curriculum framework recommended for the promotion of CT in education. For example, Computer Science Principles (CSP) represent a framework of standards on which computer science courses in high school can be designed. Other CT practices defined by (CSTA, 2017) concentrate on a few main concepts which may also include applications such as coding, debugging, and modelling. Angeli et al. (2016) also presented a framework to introduce computational thinking concepts to children between the ages of six and twelve. The framework defined a set of skills to promote CT: (1) abstraction, (2) generalization, (3) decomposition, (4) algorithmic thinking, and (5) debugging. Furthermore (Grover and Pea, 2013; Duncan et al., 2017; Kuo and Hsu, 2019) proposed frameworks that concentrate on CT core concepts.

According to the above review, it is clear that CT should be developed at early ages. In addition, by analyzing the existing frameworks, it has been observed that the top five skills that were highlighted by researchers were abstraction, algorithmic thinking, problem-solving, pattern recognition, and decomposition, and it became clear that the concept of CT is often based on thinking types such as algorithmic thinking, and design based. Also, the study showed that there are concepts that are suitable to be taught for higher education level only but not for kindergarten level and there are also concepts that can be learned by all levels due to the effect of age factor and the logical thinking skill level.

## 2.2 Gamification

Many studies have shown that the combination of educational games into the K-12 curriculum contributes to increasing students' concentration, motivation to learn, and good behaviour. They further indicated that gamified learning activities intended to promote computational thinking skills have a positive effect on student accomplishment (Tatar, 2019).

Several frameworks for Gamification have been designed that discuss various elements and components of the process of Gamification design. For example, (Wongso et al., 2015) proposed an educational framework focused on linking Gamification and Web 2.0 social characteristics with five steps: study, design, development, implementation, and evaluation into e-learning systems. However, no empirical validation was presented by the researchers. Another example, (Kotini and Tzelepi, 2015) developed a student-centred gamification framework focusing on computational thinking, and the game elements used were related to the topic and ideas that the students needed to learn. Yet, there is still a lack of empirical validation, and the components were strongly connected to computational thinking concepts, which may have hindered other areas from embracing them.

Klock et al. (2015) proposed a conceptual model that can be used for gamifying eLearning platforms to improve student engagement in their research researchers used 14 game elements. However, the researchers did not investigate whether the model succeeded in improving student engagement. Toda et al. (2018) proposed a teacher and instructors' framework on how to use gamification. However, they did not provide verification of the game's elements. Klock et al. (2019) provided a framework for user-centred Gamification in the educational setting, incorporating personal, functional, psychological, temporal, playful, implementable, and evaluative aspects. However, the game elements were not validated.

In conclusion, it can be seen that none of the frameworks mentioned provide any sort of validation or knowledge on how these elements could be incorporated within the context of the game elements that were used in the framework. In addition, there is a lack of frameworks that integrate computational thinking with gamification as there is only one framework related to computational thinking introduced by (Kotini and Tzelepi, 2015).

## 2.3 Adaptive Gamification

Adaptive Gamification can be defined as a strategy that seeks to maximize the expected goals of individuals by prioritizing their needs and preferences in a gamified world. Adapting gamified systems to each individual enables engagement, allows problem-solving on specific topics, and allows users to accomplish their objectives more effectively (Lopes et al., 2019). One of the strengths of adaptive models is that instructional activities are provided for each student that concentrate

on student needs and knowledge. Using adapted game characteristics with motivation and involvement in the education process will improve the learning benefits.

Among researchers, the development of adaptive Gamification has created immense interest (Rozi et al., 2019). Gamification appears to be more effective with a consistent framework design. Therefore, an integrated Gamification framework design was presented by some researchers. For instance, (Hassan et al., 2019) introduced a framework that describes students' learning types on the basis of their interactions with the system and provided an adaptive approach that helps motivate learners (internally and intrinsically) to accomplish their learning objectives according to their identified learning dimensions. Their findings showed that adaptive game elements and activities matched to learners' learning dimensions might considerably boost aspects such as motivation, course completion, engagement, and interaction in an E-learning course. Their research, on the other hand, did not give any feedback to participants. Also, students were not motivated by the system to make up for the tasks that they missed. Another example (Filipcik and Bielikova, 2014) presented an approach to student engagement using dynamic score calculation in a web-based education system. However, their framework focused only on student activity and ignored student knowledge and personality. In addition, it did not provide any support to learn or teach CT and focus on extrinsic motivation only. Böckle et al. (2018) suggested a developed framework that may be used to guide the systematic development of adaptive Gamification applications.

Based on the available studies, it can be noted that there is a lack of gamification frameworks that focus on educational contexts. Furthermore, there is a lack of studies that incorporate computational concepts with adaptive gamification systems. Moreover, the author believes that incorporating adaptive gamification can help in the development and cultivation of computational thinking ability in early age by increasing students' motivation and engagement, which in turn increases student performance.

## 3. Methodology

To accomplish the objectives of the research, a research framework was conducted as presented in Figure 1. The framework presents the working procedure of the research and starts with gathering all the information that can be used to formulate domain problems that involve CT skills and gamification. Then the information was examined and analyzed. Both subjects were then mapped into each other by developing a conceptual model in order to investigate the relationship between them and their unique criteria. Next, the framework of (Hassan et al., 2019) and the student-centered framework were selected and integrated together by mapping the common elements between the frameworks. At the creation stage (2nd integration stage), the resulting conceptual model with the integration of the selected frameworks was used to create an adaptive gamified eLearning platform that can provide students with different learning activities and materials based on their preferences. At the implementation stage, the proposed framework from the previous stage was implemented using a modified version of the Moodle eLearning platform proposed by (Ishak, 2016). The modified version enhanced the Learning Management System (LMS) features to automatically generate adaptive courses based on the adaptation features. At the final stage, an evaluation of the effectiveness of the created platform was conducted through workshops and experiments.

### 3.1 The Proposed Conceptual Model (1st integration stage)

The main objective of this stage is to develop a unique conceptual model that integrates the computational thinking domain with gamification to investigate the relationship between them in the education section. The development process went through three stages. In the first stage key elements of CT were defined through examining and reviewing existing research related to computational thinking. Information about computational thinking was gathered and organized and analyzed from the literature review and based on it the author has divided the CT into four main dimensions (core concept, field of development, educational level, and educational tools/activities), with each containing its own elements.

In the second stages, key elements of gamification were constructed based on existing studies that analyze gamification in education and depending on the recent taxonomy presented by (Toda et al., 2019). The taxonomy used consists of 21 elements of Gamification for the field of education. In their work, the game components commonly used by Gamification frameworks focusing on educational contexts were defined and analyzed. They then analyzed the game features explored by a behavioral Games-centered framework and took them as a baseline. The taxonomy was validated by 19 experts through an online survey in the field of Gamification and education (most of the experts were also lecturers and professors), achieving the overall acceptance of its elements, principles, and meanings. Based on the available taxonomy provided by (Toda et al., 2019) and with help of two existing studies complementing their own research (Toda, Klock et al., 2019; Toda, Armando M., 2019) that analyzed Gamification in education, in addition to the study assistance provided by (Kusuma et al., 2018) which analyzed gamification models in education that have been applied in four field applications: general, STEM, history, and language, the author constructed

key elements for Gamification in order to identify its criteria and characteristics.

In the third stage, key elements were mapped together to create the conceptual model by matching the common components of both domains as both subjects can be implemented in different fields and can be applied to different ages and different knowledge levels. Additionally, the two domains are related to learning activity where in the CT domain, CT skills can be delivered using different learning activities. In the gamification domain, learning activities can be gamified to provide an interesting learning process; this can help to increase student engagement and motivation, which may lead to improved student performance. Figure 2 depicted the proposed conceptual model.

## 3.2 The Proposed Adaptive Gamification Framework (2nd integration stage)

The main objective of this research is to develop an adaptive gamification framework to promote CT skills among students aged 8–13 in Iraq. To guide CT

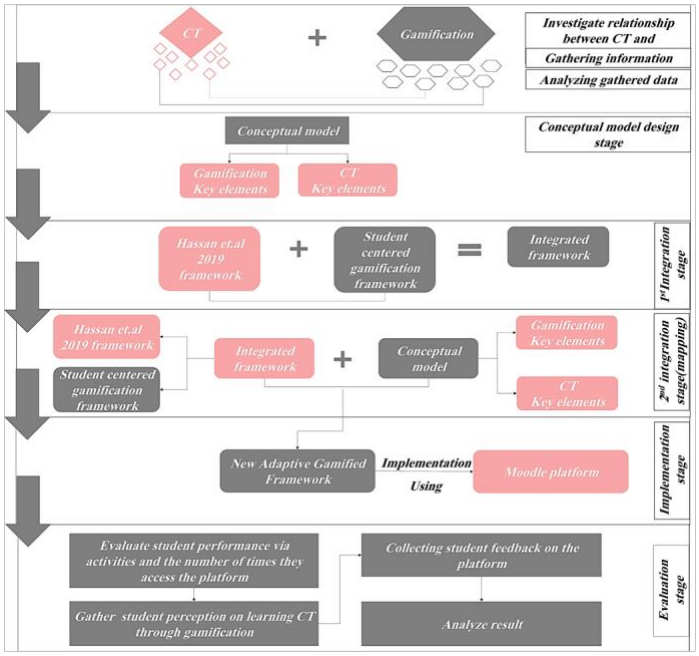


Figure 1 - Research Framework Design.

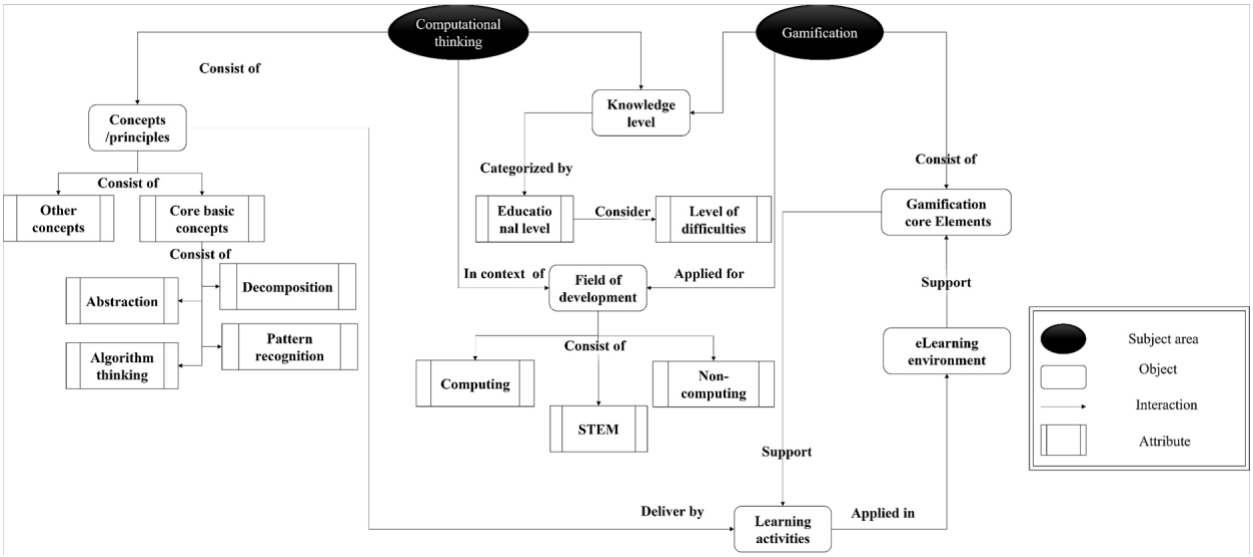


**Figure 2** - The Proposed Conceptual Model.

learning and to enhance motivation, a new type of CT framework was needed, one that could fulfill students' needs by providing them with appropriate materials based on their learning style and improve motivation towards learning. To visualize the new integrated framework, the author adopted the framework presented by (Hassan et al., 2019), which allows us to provide adaptive features to students and adaptive gamification environments to increase motivation. In addition, the author adopted the elements available in the "student-centered" framework and integrated them with the (Hassan et al., 2019) framework to support computational thinking skills. The main reason for this is that the gamification features presented in the (Hassan et al., 2019) framework was not adapted to support computational thinking; hence, there was a need to find gamification elements capable of supporting CT that can be achieved by using the "student-centered" framework that provides gamification elements that are compatible with CT and is based on constructivist learning theory, which is compatible with the Moodle platform that uses the same theory. Furthermore, the author has matched the new integrated framework with the proposed conceptual model to match key research concepts to provide an adaptive gamified learning framework that leads to the development of computational thinking skills. The mapping process is depicted in Figure 3. The result of the mapping process will create an adaptive framework to enhance computational thinking skills.

## 3.3 The Implementation of the Proposed Framework (Implementation Stage)

The proposed framework was implemented using a modified version of Moodle which enhanced the LMS

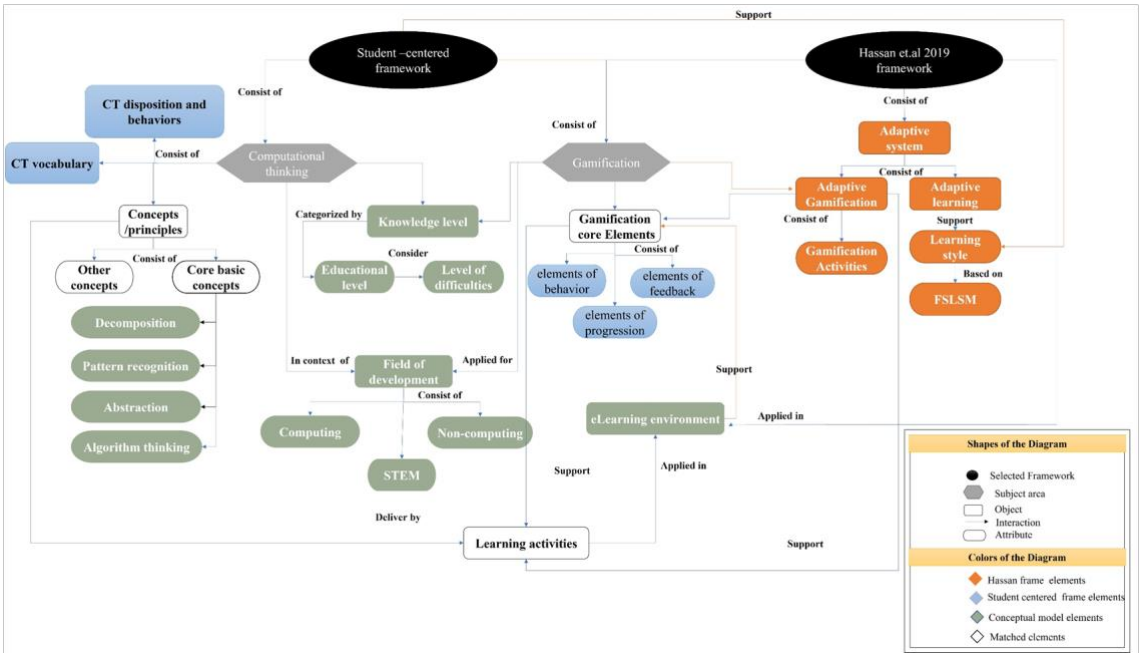


**Figure 3** - The proposed adaptive framework.

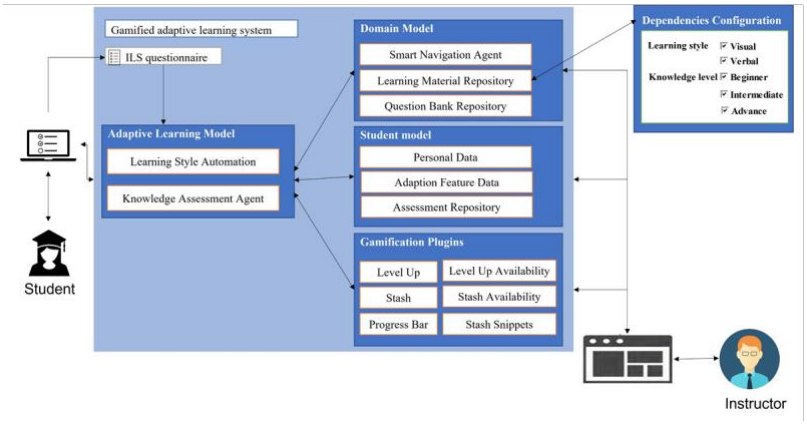


**Figure 4** - The Proposed System Framework using Moodle.

features to automatically generate adaptive courses based on the students learning style for visual and verbal learners using Felder-Silverman Learning Style Model (FSLSM) and was customized to provide adaptive gamification features to support student engagement and motivation. Figure 4 illustrates the system architecture of the proposed framework implemented through Moodle platform.

The modified version of Moodle consists of three primary modules which interact together to provide adaptive features. First, the adaptive model which includes rules and techniques that continuously interact with the domain model and the student model for adaptive performance. The model contains two main components; the learning style automation which includes rules for calculating ILS questionnaire answers that are given by students to determine whether a student is a visual or verbal learner using the range [-11, +11] to define learning style, and knowledge assessment agent which are responsible for defining students' knowledge level.

Second: The student model which serves as a repository of student information. Third: The domain model which acts as a repository for storing curriculum and domain information in order to facilitate course delivery. It consists of three parts: the smart navigation agent, the learning materials repository, and the question bank repository. The Smart Navigation Agent added to the Moodle platform for adaptive functionality. Meanwhile, the Learning Material Repository and Question Bank Repository serve as databases for storing course materials and assessments.

In addition, the platform was customized in order to provide an adaptive gamification feature by adding a set of plug-ins that support gamification which consists of Level up! Level up! Availability, Stash, Stash availability, Stash snippets and progress bar to provide a gamified learning environment. The gamification elements were chosen to suit the requirements for learning CT skills and to correspond with the experts' theory which includes (levels, points, progression (leader border), teamwork, feedback, challenge, and goals).

Furthermore, the proposed framework provides learning activities that are appropriate for the student's knowledge level and focus on the CT core concepts (decomposition, pattern recognition, abstract, algorithm thinking) using a scratch programming language. The system provides a computational thinking and programming course, which was designed as a game where each concept of computational thinking skills was considered as a level and the students were asked to go through all the levels and learn the concepts of computational thinking through scratch. Additionally, they could only get to the next level if they finished all the contents of the level they were in and collected all the hidden items in that level.

Figure 5 depicts the implementation steps of the system using Moodle.


**Figure 5** - Moodle Setup Stages.

### 3.4 Experimental Result (The Evaluation Stage)

Two case studies were conducted throughout this research to evaluate the performance of the proposed system in terms of students' motivation and performance. The participants of both experiments were students aged between 8-13 from Iraq. A total of 18 students of both genders were asked to join a five-day workshop to introduce them to the fundamentals of computational thinking and programming and they were randomly distributed among two groups (Adaptive Gamification Group and Non-Adaptive Gamification Group). Both groups were given the same learning materials, however the visual learners were provided with more graphic materials while the verbal learners were provided with more textual materials. Pre- and post-questionnaires were used as the instruments for gathering the demographic of the students and measuring the student's understanding and satisfaction before and after the training. Quizzes were used to evaluate student performance. Data for this study was collected using the automated scanning provided in Moodle and was analyzed using descriptive analysis methods.

Students learned CT Skills such as decomposition through scratch by constructing a new sprite and applying a set of different instructions to the same character. They also learned how to add motion and sound to the sprite. Moreover, pattern recognition was developed by understanding repeating actions. In addition, customizing sprite attributes resulted in the development of abstraction. Finally, with the design of games such as the catching game and the virtual pet game, algorithm thinking has evolved. Figure 6 illustrates the syllabus for the course provided in the workshop.

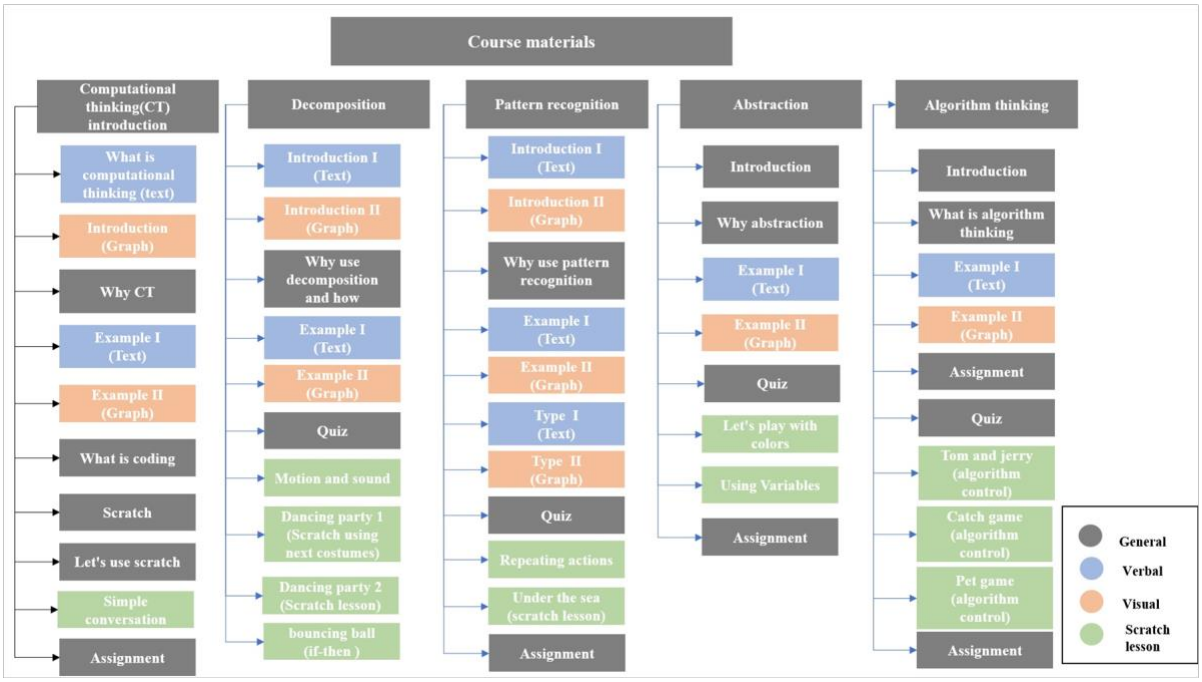


**Figure 6** - Course Syllabus.

In Experiment (I), eight (8) students from group-A (Non-Adaptive Gamification) were enrolled in an E-learning course on computational thinking and programming. The author offered a system with an adaptive feature experience, but the system was not equipped with an adaptive gamification experience. Students will first login into the system; after that they are required to answer the ILs questionnaire. Then the Learning Style Automation will identify the student's learning style dimensions (verbal, visual) and the Knowledge Assessment Agent will identify the student's knowledge level (beginner, intermediate, advanced). Then, through the Smart Navigation Agent, the system will provide students with suitable learning materials based on adaptation feature data.

In Experiment (II), ten (10) students from group B (Adaptive Gamification) were asked to enroll in a gamified E-learning course in computational thinking and programming. This course was offered using the proposed adaptive gamification framework, which provides gamification elements based on the learning dimensions of each student. This course was designed as a game where each concept of computational thinking skills was considered as a level. The course consists of four levels and at each level, a student is required to find elements and get points to reach the next level by completing the level materials. Visual students were provided with gamification elements such as progress bars, levels, badges, points, and goals, teamwork, and feedback. In addition, the content was presented using flowcharts, graphs, diagrams, mind maps, and videos. Meanwhile, verbal students were provided with points, and challenges, teamwork, feedback, and the content were presented using the textual form.

The result of students' motivation for both groups can be seen in Table 1. For the analysis, the author calculated the descriptive statistics of the questionnaire and used a 5-point Likert scale and forced-choice items. The results indicate that both groups were motivated to learn more about the topic. In addition, all participants in group B preferred to learn through gamified courses rather than traditional courses. Also, all participants in group B believed that the elements of the games matched their learning personalities.

Furthermore, the result of the students' performance can be seen in Table 2, and it indicates that the students have a better performance using the proposed system as it can be seen that there is a clear difference between the mean scores of both groups (34.13 for group A) and (67.72 for group B). In addition, Figure 7 shows that group B's quiz results are better than group A's results, which in turn means group B performs better than group A. In addition, the majority of students who did take the quiz in group B (more than 50%) had the motivation to retake the quiz to increase their scores while the rest of them had Internet connection problems. The main reason for this is the gamification features, in which all materials were restricted, and students were required to answer some of the questions in order to obtain the game elements that would help them advance to the next level.

| Question | Answers | Group A statistics | | | | Group B statistics | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mode | Median | Mean | Std. Deviation | Mode | Median | Mean | Std. Deviation |
| This e-learning helps me achieve my learning objectives. | Rating: 5 4 3 2 1 | 4 | 4.00 | 4.14 | 0.690 | 4 | 4.00 | 3.89 | 0.92 |
| I found it easy to understand the subject structure. | Rating: 5 4 3 2 1 | 4 | 4.00 | 4.00 | 0.577 | 4 | 4.00 | 4.22 | 0.66 |
| I feel confident to complete this subject based on the knowledge or skill presented. | Rating: 5 4 3 2 1 | 4 | 4.00 | 4.43 | 0.535 | 4 | 4.00 | 3.89 | 0.92 |
| Do you prefer traditional or gamified courses? | • Traditional<br>• Gamified | - | - | - | - | 2 | 2.00 | 2.00 | 0.0 |
| How would you evaluate the impact of the insertion of game elements in educational contexts? | • Positive<br>• Negative | - | - | - | - | 2 | 1.00 | 1.00 | 0.0 |
| The gamification elements mostly matched my learning personality | Rating: 5 4 3 2 1 | - | - | - | - | 2 | 2.00 | 2.00 | 0.0 |

**Table 1** – Students' motivation results.

| Group Statistics | | | | |
|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error Mean |
| Group A | 8 | 34.1375 | 37.44020 | 13.23711 |
| Group B | 10 | 67.7200 | 37.45047 | 11.84288 |

**Table 2** - Students' Performance Results.

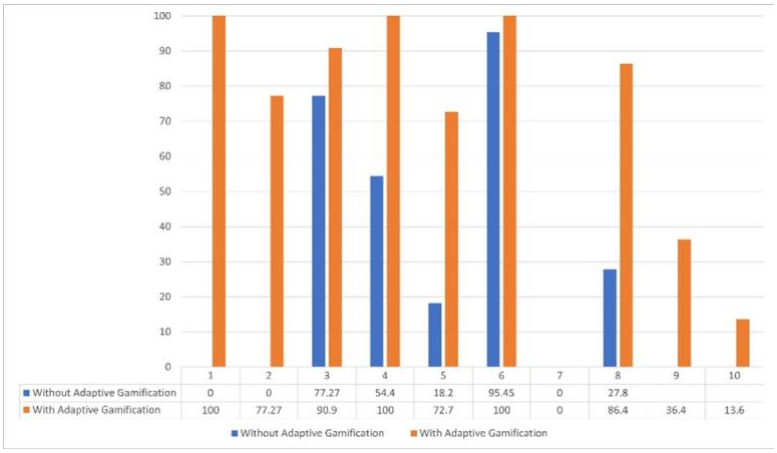


**Figure 7** - Students' Performance Results.

## 4. Discussion

In this work the search went through two phases: in the first phase the author has proposed a conceptual model which identifies the relationship between the domain of gamification and the domain of computational thinking. The conceptual model can help to understand how to use gamification in the education section to support the learning process of computational thinking. In the second phase the author has proposed an adaptive gamification framework to foster CT skills among school children aged between 8-13. The proposed framework provided an adaptive feature (learning materials and gamification elements) based on student learning style (verbal learners and visual learners) using Felder Silverman Learning Style Model (FSLSM).

The main reason for selecting verbal and visual learners only is that many studies have indicated that students recall knowledge better when it is given visually and verbally. These methods assist students of all ages in

better managing their learning objectives and achieving academic success. Moreover, visual forms account for 75 percent of the information processed by the brain. Furthermore, visual information is more effective at establishing itself in the minds of students (Raiyn, 2016). In addition, scholars have found that individual preferences for multimedia materials based on visual and verbal cognitive patterns may influence learners' emotions and performance (Chen and Sun, 2012). Therefore, the visual / verbal dimension was chosen to measure students' preferred input position in the current study.

The proposed framework was implemented using a modified version of Moodle platform proposed by (Ishak, 2016) which provides adaptive learning materials and was customized to provide adaptive gamification features automatically to the enrolled students. Visual learners were provided with 7 game elements such as (progress bars, levels, badges, points, and goals, teamwork, and feedback),while verbal learners were provided with (points, and challenges, teamwork, feedback). Levels can increase students' intrinsic motivation while points, progress bar and badges can measure students' performance and show students' progress and identify their achievements. Teamwork can contribute to the development of positive learning results. Challenges and goals make the learning procedure more exciting and entertaining for the student ,while feedback helps students when they meet difficulties or fail to accomplish a particular activity.

Two study cases were conducted to evaluate the proposed system and the findings indicate that using gamification in learning CT can play a positive role as it contributes to increasing student motivation and engagements which are the basics for learning any new skills and in turn increase students' performance.

## 5. Conclusion

The proposed framework was primarily designed to encourage kids between the ages of 8 and 13 to learn and develop computational thinking skills through scratch programming language. These abilities can enable students to keep up with the demands and challenges of the new era. However, the process of learning any new skills is based mainly on student engagement and motivation. For this reason, the author proposed an adaptive gamification framework that provides students with appropriate learning materials based on their learning style and improves students' motivation towards learning using adaptive gamification through Moodle platform. The results demonstrated that selecting learning materials and game elements based on student preference can play a positive role in increasing students' motivation and performance. The results indicate that students were motivated to continue learning the subject. In addition, they were motivated to retake the quizzes which in turn can increase students' performance. In future, the system can be extended by taking more adaptive features into consideration.

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# Maintaining bilingualism through technologies: the case of young Russian heritage learners

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**Abstract**

The multicultural realities of modern society require an effective system to support the development and preservation of the heritage language of children growing and developing outside of their heritage culture. Digital technologies may come at hand to parents and educators who strive to create such a system for their bi- or multilingual children.

This paper reports on the mixed methods research study that documented and analyzed attitude to and the usage of digital technologies by Russian-speaking parents raising bi-/multilingual children outside of Russia. Thirty-four participants from 12 countries completed an online questionnaire. Three native Russian mothers raising young Russian heritage language learners were also engaged into a case study.

The study revealed that parenting efforts could include speech development learning activities with traditional and digital learning tools. Participants expressed their favorable view on the educational value of digital (computer, mobile, online) technologies. In practice, however, parents' usage of these tools was very limited as most of them preferred a printed book and live communication for maintaining Russian. It was obvious that many parents are not well informed about the availability of high-quality digital resources for the development of Russian speech in preschoolers and/or do not see their advantages. The results of the research confirmed studies that indicated the importance of creating the "child-digital resource-teacher" interaction and the need for mediation by an adult in a situation where a child interacts with a computer or tablet. These results are of practical significance for formal and informal bilingual educators, teacher training institutions and parents of bi-/multilingual children.

**KEYWORDS:** Educational Technology, Digital Learning Objects, Bi/Multilingual Education.

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## 1. Introduction

The multicultural realities of modern society require an effective system to support the development and preservation of heritage language of children growing and developing outside of their ethnic culture. Given the globalization of the labor market and the migration processes of recent decades, many countries experience the growth of population for which the language spoken in the family circle differs from the dominant (state) language of the nation.

At the same time, the number of mixed marriages is growing. According to the UN, in 2017, 258 million people lived outside the country where they were born (Pison, 2019), with the largest number of immigrants living in such countries (in descending order) as the United States of America, Russia, Saudi Arabia, Germany and the United Kingdom. It is also important to note that the leading sending countries (in descending order) are India, Mexico, Russia, China and Bangladesh. Currently, 10.4 million people born in Russia live outside its borders (Pison, 2019). According to other sources, in the first decade of the 21st century,

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30 million Russians and their descendants lived outside of Russia (Russian diaspora, 2020).

These migration and globalization trends require the development of a multilingual member of society (Brinton et al., 2008). At the same time, existing education systems, especially on the pre-school level, do not always support bi-and multilingualism. Often, it is only the family that provides space for preserving heritage language. Studies show that parents often play a key role in the development of bi-or multilingualism of their young children (Cho, 2008; Kheirkhah & Cekaite, 2015; King et al., 2006), while their disbelief in bi-/multilingualism leads to the loss of the family language, its complete displacement by the language of the country's dominant culture (Mbakop & Ndada, 2019).

Family members who have decided to transfer their mother tongue to a child choose a range of teaching methods and technologies that allow them to create language learning environment. Digital tools, among others, may take an important place in this environment (Morgan & Peter, 2014). Learning technologies, where digital tools link the child and the parent, allow us to create the conditions for the child's speech development, contributing to his/her high engagement with the content and involvement in the learning process (Debski, 2019). Computer and mobile language games, active use of electronic resources in the target language, synchronous and asynchronous online communication can also contribute to the development and preservation of the child's heritage language (Cho, 2008; Morgan & Peter, 2014).

With the gradual introduction of digital technologies into lives of young children, researchers start documenting cases of the use of computer, mobile and other digital tools in the development of (native, non-native) speech of preschool children. Despite the presence of skeptics who emphasize the negative impact of modern IT technologies on children, a significant number of practitioners and researchers acknowledge and confirm that multimodality (that is, the use of several channels (modes) of information transfer) and interactivity (that is, the possibility of active two- or multilateral interaction) of digital technologies offer great opportunities for studying language and literacy in general (Bus, et al., 2015; Cummins, 2008; Kayumova & Sadykova, 2019; Meskill & Mossop, 2000; Plass & Jones, 2005; Sadykova et al., 2018; Smeets & Bus, 2014). Digital tools such as games, wikis, talking avatars, and interactive stories can have a positive effect on developing language skills, increasing learning motivation, creating an engaging learning situation of play (Edwards, 2016; Li & Ni, 2013; Terrell, 2011; Verdugo & Belmonte, 2007). Studies indicate the effectiveness of the use of digital resources for the development of phonological skills of children (Segers & Verhoeven, 2003). Moreover, IT technologies can become a transmitter of culture, an instrument for developing sociocultural skills, which is especially important for children brought up outside their ethnic homeland (Sadykova et al., 2018).

This study aims to partially compensate for the lack of research on the use of digital (computer, mobile, online) technologies for preserving and maintaining the heritage (mother, family) language of children. The research team set the task to study the application of digital technologies by Russian-speaking parents raising bilingual (multilingual) children outside the Russian educational environment.

## 2. Materials and Methods

### 2.1 Research questions

This exploratory mixed-methods study was guided by the following research questions:

1. What role may digital technologies play in the development and maintenance of young Russian heritage learners?
2. How do native Russia parents of heritage learners make use of digital resources for speech development of their bi- / multilingual children?

### 2.2 Theoretical foundation

This study is based on the sociocultural theoretical framework developed by the Russian psychologist Lev Vygotsky (1978) and further expanded by his followers as well as on the construct of *producerly pleasures* described in Meskill (2007).

Vygotskian sociocultural paradigm underscores the importance of social interaction in the learning process and emphasizes the significant role of a *more knowledgeable other* and *mediating tools* for creating learning environment conducive to successful internization of knowledge. In Vygotskian sociocultural paradigm, learning tools play the role of *mediators of knowledge* (Vygotsky, 1978). Digital learning objects may also be described as knowledge mediators as they are able to build learning environment that enables the child to interact with the content and acquire the new knowledge and skills. Moreover, studies show that digital technology may create the situation of play, thus presenting and practicing the content in the form most appropriate for young learners (Roskos & Christie, 2001).

Children's experiences with digital screens could also be characterized by *producerly pleasures* inherent in digital activity (Meskill, 2007). Digital technologies enable the child to seek for information, identify and relate to it, feel satisfied and rewarded when being able to locate, interact and experience the feeling of relatability. Interactions with digital technology are also described as having *screen magic* effect, when the user is captivated by what is happening on the screen and experiences the fear of missing out – FOMO (Turkle, 2016).

These four digital screens characteristics – *seeking, identification /relatability, rewards and screen magic* – were shown to affect the *child-technology-teacher* interaction. The study conducted in state and private bilingual kindergartens and preschools in the Russian Federation, (Meskill et. al, 2020) demonstrated how these four dimensions were enacted further illustrating this by mediating strategies that participating teachers employed when integrating multimodal digital resources in Russian language activities with bilingual children.

### 2.3 Data collection and analysis

This study aimed to get a broad understanding of the subject matter and involve Russian parents raising children in different countries. The data collection started with the online survey administered through Google Forms. The survey included 24 questions, both multiple-choice and open-ended (see Appendix), focused on demographic data of participants and the degree of penetration of digital (computer, mobile, online) resources into lives of young bilingual (multilingual) children.

To recruit participants, the invitation to participate in the study was distributed via social networks (groups for Russian-speaking emigrants), as well as by sending emails to public addresses of Russian preschool institutions abroad and to the personal addresses of Russian-speaking repatriates who responded to personal proposals of the members of the research team. The questionnaire was completed by 34 respondents. The responses of 9 participants were excluded from the analysis because the age of their children did not match the target group (children up to 8 years old). The rest of the survey participants were parents and educators of 3-4-year-olds (40%, 10 respondents), 5-6-year-olds (48%, 12 respondents) and 7-8-year-olds (12%, 3 respondents); 60% of the children were boys and 40% were girls. Among the respondents were representatives of Turkey (five respondents), Italy, Great Britain and the USA (three respondents each), Switzerland, Germany and Morocco (two respondents each), Australia, Canada, Lithuania, India, France (one respondent each). Results of 25 questionnaires were analysed qualitatively and quantitatively. Answers to open-ended questions underwent content analysis for recurrent themes by two researchers, while data from close-ended questions enabled the research team to analyze percentiles, create graphs and see the trends.

In the second stage, the research focused on individual cases. Three mothers of young bilingual children agreed to video record their home Russian learning activities that involved a child's interaction with a digital resource. A parent could select her own digital material, however researchers also recommended resources if a parent asked for such help. On completion of a set of lessons, parents were interviewed by means of instant messaging services and email, which enabled the researchers to get better understanding of parents' attitude to the use of technology by their children in general and for speech development in particular. The collected videos of lessons and interviews were analyzed qualitatively for recurrent themes that were then compared and contrasted with survey data and between cases.

For the purposes of this study the case participants were families in which Russian mothers were bringing up children of 8 years old or younger while living outside of the Russian Federation. All children involved into the case study were born and raised outside of Russia.

Case #1 is a family of a 4-year-old boy Erik (*here and later names of all study participants are changed to protect their identity), a 7-year-old boy Denny, their Russian-speaking mother Alia and Turkish-speaking father Marat. Both boys speak Turkish with their father, Russian with their mother and attend Turkish kindergarten and school in Istanbul, Turkey. The mother states that the level of Russian language proficiency of her children is lower than the average level of a child of the same age and gender living in Russia. Oral communication of children is mainly carried out in the language of the environment (i.e. Turkish). The percentage of Russian-language information that children receive from outside (i.e. from people, books, media, etc.) is low and comprises approximately 21-40% of the total amount of information received. In this regard, the mother makes efforts to preserve the Russian language in the family. A Russian language teacher gives lessons to the children once a week. The mother does Russian language exercises with her children in activity-books; she reads books in Russian to them, and makes sure that children regularly watch cartoons in Russian. Other ways to learn the language include communicating with Russian-speaking neighbours and friends, traveling to relatives in Russia, viewing or listening to Russian media.

Case #2 is a family where both parents are native Russians but who moved to the United States after the father took the position in the IT field. They live in Boston area. Mother Alina, who has a degree in language education, takes care of three boys: 3-year-old Faris, 5-year-old Amir and 11-year-old Ilgyz. Russian is the only medium of communication at home, though two older children attend English-speaking schools. Boys also visit their grandparents in Russia each summer (for up to 3 months) and sometimes for winter holidays. These efforts enable the mother to state that the level of Russian language proficiency of her children is higher or the same as the average level of a child of the same age and gender living in Russia.

Case #3 is a family from Morocco. Mother Albina is a native Russian who married to a Pakistan Sindhi when studying in the USA. The family lived in the USA for more than 15 years and then moved to Morocco when the father received a job offer from the university

located in Ifrane. There are 5 children in the family including an 8-year-old boy Tagir and two girls – 5-year-old Alsu and 2,7-year-old Rushana. The medium of communication at home is English, while mother sometimes speaks to her children in elementary Russian and father in elementary Arabic. Each summer for about one month children visit their grandparents in Russia and usually once in every three years for about three weeks they spend time with grandparents in the United Arab Emirates. The mother notes that the level of Russian language proficiency of her three younger children is much lower than the average level of a child of the same age and gender living in Russia. Oral communication of children with their parents and each other at home is carried out only in English since they do not attend any schools (both English-speaking or Arabic-speaking) being home schooled with their mother and father who are educators.

Due to the small sample size the results of the study are limited in generalizability. Data collection involved the necessity to access participants who were living in different parts of the world and in diverse time zones; therefore all communication was conducted via digital technologies (computers, mobile phones, tablets) and online (email, instant messaging, cloud services). This slowed down the data collection process but enabled the researchers to involve participants from abroad.

## 3. Results

### 3.1 Digital technologies in the life of a bilingual child

The survey results demonstrated the level of technology usage by children of 8 years old or younger whose parents and educators responded to the questionnaire. The study shows that most of these children use digital technology for less than 1 hour per day (48%, 12 respondents) or do not use it at all (8%, 2 respondents), which could be due to the early age of the children. Children of five respondents (20%) use computer or mobile technologies 2-3 hours a day, four children (16%) – 1-2 hours a day. Only one child (4%) uses digital technology for more than 3 hours a day (see Fig. 1).

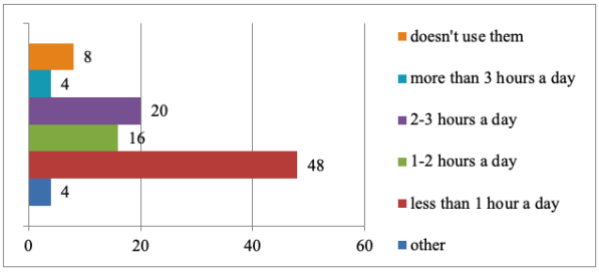


**Figure 1** - Answers to the question "How often does a child use computer and mobile technologies?" (%)

The questionnaire also indicated that about half of the children surveyed (52%, 13 respondents) do not use a computer, tablet or mobile phone to develop Russian speech. Twenty percent of children (5 respondents) use computer or mobile technologies to develop children's speech for a maximum of 30 minutes a day; 8% (2 respondents) – 30-60 minutes a day; 12% (3 respondents) – 1-2 hours a day. One respondent (4%) replied that his/her child uses digital technology to develop speech 2-3 hours a day, one (4%) – more than 3 hours a day (see Fig. 2).

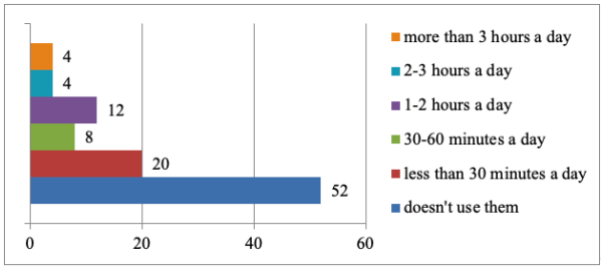


**Figure 2** - Answers to the question "How often does a child use computer and mobile technologies to develop Russian speech?" (%)

The study revealed that the vast majority of respondents prefer to use traditional (non-digital) learning tools, namely printed books (80%, 20 respondents), children's games (20%, 5 respondents), cartoons and puzzles (4%, 1 respondent). One respondent (4%) uses digital games and digital resources in joint activities for the development of Russian speech of a child; another respondent (4%) explained that he uses them extremely rarely. One parent noted that his child is listening to Arzamas radio, namely the "Children's room" section (see Fig. 3).

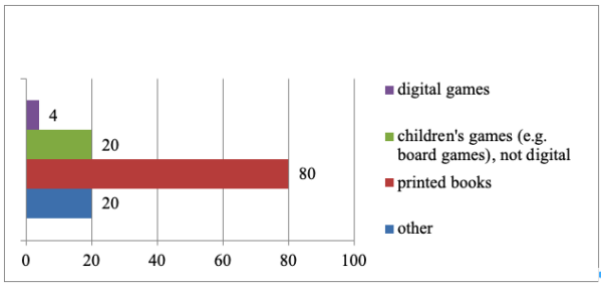


**Figure 3** - Answers to the question "What educational materials do you use with your child to develop Russian speech?" (%)

The survey results are supported by the results of the case study.

Alia, mother of the two boys living in Turkey (case #1) explained that she prefers to use traditional (non-digital) teaching tools, namely printed books. However, there are cases of technology usage to study English. In her interview Alia stated: *"We [child 1 and mother] did crossword puzzles on the tablet together; we tried to find correct words. If there was a word unknown to my child, I explained it to him"*. Despite the fact that the children are not active users of digital resources, the mother readily agreed to participate in the case study and to test the online resources she had never used before. It was clear from the interview that Alia

believes that digital resources can be useful for the development of Russian language and culture of her children; however, to achieve a positive result, the interaction of children and technology, according to the mother, should be accompanied by active participation of the parent. She also expressed her interest to learn about Russian language resources for children.

In December 2019, the mother organized mini-lessons of Russian for her children, 4-year-old Erik (Child 1) and 7-year-old Denny (Child 2), with the use of digital technologies: the children were given tasks on a tablet. The resource chosen was the *Playground* section on an online platform *Education in Russian* developed in Pushkin State Russian Language Institute [http://rus4chld.pushkininstitute.ru/#/playingfield/game ]. The lessons were recorded by the mother with a smartphone.

In total, we received five videos but two were excluded from the selection because of uncompleted character. The total duration of the three videos is 7 minutes:

- Video 1 (duration 2:11): Child 1 solves riddles together with his mother [http://rus4chld.pushkininstitute.ru/moduleload?id=Zagadki_po_priznakam];
- Video 2 (duration 03:29): Child 2 performs the task Mothers and babies together with his mother and Child 1 [http://rus4chld.pushkininstitute.ru/moduleload?id=Mamy_detki];
- Video 3 (duration 02:21): Child 2 performs the task Can or can't together with his mother and Child 1 [http://rus4chld.pushkininstitute.ru/moduleload?id=Mozhno_nelzya].

In case #2, Alina also expressed her concern with the use of (computer, mobile, online) technology in the early age. In fact, she was firm about the need to limit their boys' exposure to technology. Having an education in linguistics and language teaching, experience teaching Spanish as a foreign language and a certificate of a Russian language teacher, she makes much effort for creating appropriate environment for maintaining and developing Russian language skills of her children. In her interview, she confessed that she prefers a printed book and live communication for learning Russian (and other skills) rather than using digital resources. Despite the fact that the children can use a computer, tablet or mobile phone, Alina limits the usage of digital technology, as she prefers to use traditional (printed) teaching tools. However, she uses audio devices like an iPod for listening fairy-tales and music. She also practices recording her own voice or her older son's voice while reading most favourite stories and fairy-tales to be able to replay later.

For the purpose of this case study Alina decided to use a digital resource *Live Fairytales,* which is a state-funded online Russian language school for 3-5-year-old children (https://skazki.pushkininstitute.ru). A mother and her two children, Faris who was 5 (Child 1) and 3-year-old Amir (Child 2), had Russian language lessons on a computer (laptop). Three videos were recorded with a total duration of 38:23 minutes.

- Video 1 (duration 19:57): Child 1 and Child 2 complete the tasks of Module 1 *My family* with their mother [https://skazki.pushkininstitute.ru/skazki/#/module/1_1/startPage]. She asks additional questions, draws children's attention to some details and characters and cheers up her children. Children listen to the information about the main character's family and a fairy tale and then answer questions by selecting the right card.
- Video 2 (duration 07:13): Child 1 and Child 2 complete the tasks of the first part of Module 4 *New Year*; mother asks Child 1 to read the titles in the module, asks both boys to describe pictures and helps them by asking supporting questions [https://skazki.pushkininstitute.ru/skazki/#/module/1_4/startPage]. They then decorate the Christmas tree dragging Christmas decorations according to their size, shape and color.
- Video 3 (duration 11:13): Child 1 and Child 2 perform the task of the second part of Module 4 *New Year* [https://skazki.pushkininstitute.ru/skazki/#/module/1_4/lesson/2 / task / 1 / scene / 2]. The resource tells a fairy tale and then children supported by their mother complete comprehension tasks: answer character's questions by selecting the right card and coloring the picture.

Albina from Morocco does not limit technology usage of her children as strongly as Alina. But she still does not feel very positive about the use of technologies for teaching a child something. The main reason for it, as she confessed in an interview, is that introducing a computer into teaching something means introducing the negatives of the computer; moreover, it might be difficult to police a child especially the young one. At the same time, she admits: *"Maybe it's because I haven't found any kind of really engaging programme that I am just blown away by. Maybe if I did find something like this then I would overlook the negatives of the digital means of presenting information in general."* Moreover, she agrees that digital technology can perform as a tool for maintaining bilingualism but has only limited potential. For example, she has used Russian-speaking cartoons that she found useful but only because she did a lot of her own work speaking continually and involving children into active interaction.

In her case Albina used the online platform *Education in Russian*. She and her children, Tagir who was 8 (Child 1), Alsu who was 5 (Child 2), and Rushana who was 2,7 years old (Child 3) at the moment of the study, had Russian mini-lessons in the section *Russian for our Kids* [http://rus4chld.pushkininstitute.ru/#/]. Three videos were recorded with a total duration of 17:49 minutes.

- Video 1 (duration 03:21): Child 3 performs tasks of the *Summer Day* lesson on painting the landscape together with his mother [http://rus4chld.pushkininstitute.ru/moduleload?id=Raskr_LetniyDen]
- Video 2 (duration 05:14): Child 2 and Child 3 perform the *Mothers and babies* task on matching adult animals and their cubs together with their mother [http://rus4chld.pushkininstitute.ru/moduleload?id=Mamy_detki];
- Video 3 (duration 09:14): Child 1 and Child 2 perform the task of the *Summer Day* lesson on painting the landscape together with their mother [http://rus4chld.pushkininstitute.ru/moduleload?id=Raskr_LetniyDen].

To sum up, the survey and the study of cases demonstrate that parents are not very enthusiastic about the introduction of digital technology in general and for learning Russian in particular. Parents and educators do not encourage children to use these tools, preferring printed books, board games and live communication in family as major means of creating learning environment conducive to heritage language acquisition. Children's early age seem to be the major factor that impacts low usage of technology. On the other hand, parents show little knowledge of educational resources meant for very young Russian language learners.

### 3.2 Digital screens as mediators of knowledge

In the following sections, the four digital screen characteristics – *seeking, rewards, identification,* and *screen magic* (Meskill, 2007; Meskill et al., 2020) – are used to analyse *child-technology-mother* interactions video recorded in 3 cases.

*Seeking*

Seeking for new knowledge through interaction with the digital screen were evident in all three cases examined. The children clearly derived producerly pleasure through guided seeking.

[*Case #3. The screen shows a picture that a child has to paint following the prompts.*]
Resource [*sets the task in Russian*]: First choose the color and then paint. I will prompt you. Goose's beak paint red.
Mother [*repeats in Russian*]: Goose's beak paint red. [*Speaks English*]: So, you will choose the color…
Child 1 [*knows the colors, answers in Russian*]: red. [*Speaks English*]: red color.
Mother [*Speaks English*]: So, you choose the color and then you have to color it. [*Repeats in Russian*]: Goose's beak paint red. Who is goose? Where is goose?
Child 1 [*points at different pictures, asks in English*]: This? This?
Mother [*speaks Russian*]: Yes. Now what is goose's beak? What can be red?
Child 1 [*Speaks English*]: Beak! (Case #3, Video 1).

The next example illustrates activity that a mother performs with two children at the same time.

[*Case #1. A child has to drag the pictures depicting activities (such as reading, cycling, sweeping the floor, etc.) to their matching location – either 'indoors' or 'outdoors'*].
Mother [*speaks Russian*]: Where do we ski? (*pointing to the picture depicting skiing*)
Child 1: Where do we ski? Indoors or outdoors? *(asks the questions in Russian accompanying them with expressive facial and body movements)*
Mother [*repeats in Russian*]: Where do we ski?
Child 2 [*pointing to the picture depicting skiing in the snow answers in Russian*]: Snow.
Mother [*speaks Russian*]: Yes. Is it indoors or outdoors?
Child 2 [*answers in Russian*]: Snow.
Mother [*asks in Russian*]: Where does it snow? Indoors or outdoors?
*Child 2 clicks on the picture depicting skiing.*
Resource [*in Russian*]: Skiing.
Mother [*speaks Russian*]: Where does it snow? It snows outdoors. Drag the picture. (Case #1, Video 3).

As we can see, the less proficient the child in Russian, the more he depends on the resources and affordances at hand, i.e., on-screen images and audio, his parent and sibling. The younger child seems to be unfamiliar with the word 'skiing' in Russian; however, he knows the word 'snow' and operates with this word to participate in the task. Both the parent and older child outpace the digital resource and provide initial language support by naming the activity and possible variants of its location. The application names the activity only when the child clicks on the picture.

In general, both children derive pleasure through this seeking activity: the older child is delighted by being *the more knowledgeable other* (Vygotsky, 1978) who can assist and guide the less proficient brother; the younger child is happy to be allowed to click the buttons and do this interactive seeking activity on his own.

*Identification*

This dimension refers to the feeling of relatability, when the user is able to identify oneself with or relate to what happens on the screen. Children usually identify with the digital characters that 'reside' in the resource, the so-called learning buddies (McCloud, 1993). In Case #1 identification was manifested when the older child communicated directly with the digital character – an animated girl Masha who asked him riddles:

*[A child has to solve a riddle. There are four flashcards on the screen.]*
Masha: *I have some riddles for you. I'll think of an object; you have to guess what it is. It is wooden and brown. It has four legs.*
*(The boy clicks on the picture of a table).*
Masha: *Yes, that's right. It is a table.*
Child 1[*speaks Russian in a disappointed voice*]: *Oh,*

*that was easy.*
Masha: *It is juicy, round and orange.*
Child 1 [*answers in Russian*]: *Of course, it is a … (clicks on the picture of an orange).*
Masha: *Yes, that's right. It's an orange.* (Case #1, Video 1).
In Case #2, we also see how a child speaks to digital characters as if they were their buddies. The following transcripts provide an example of a child responding to the screen character Masha spontaneously as if she was real:
Masha (*on screen speaks Russian*): What's your name?
Child 2 [*speaks Russian*]: Amir. [*The boy gives an answer without any hesitation*].
Masha [*on screen speaks Russian*]: You have a very beautiful name. *(The child is very pleased. He smiles and looks at his mother).* (Case #2, Video 1).

*Rewards*

The rewards dimension of producerly pleasures is clearly intertwined with seeking. In our case, digital rewards took many forms, both verbal (e.g. 'Well done!') and non-verbal (e.g. characters start moving or images start flashing, etc.). The children were rewarded when they correctly comprehended and produced Russian and when they successfully identified and manipulated onscreen material. The pleasure of these linguistic/digital successes was immediately observable as there were gasps of thrill and delight, smiles and laughter, and spontaneous applause.
[*A child has to match mother animals and baby animals. When the child clicks the correct buttons, on the screen an animated gosling comes up to its mommy goose.*]
Mother [*speaks English and then translates into Russian*]: Hey, the gosling cames to its mommy!
Child 2 starts smiling and clapping his hands. (Case #1, Video 2).

Some modern digital educational resources designed for children employ rewards to motivate the users to complete the task. In case #2, the digital online activity used for language learning used gems (diamonds) that a child received from a dragon Zmej Gorynych after the completion of an activity. In the next example we can see how both participating children want to get diamonds.
Masha [*on screen speaks Russian*]: Hello, I am Masha. I am four years old. How old are you?
Child 1 [*whispers in Russian*]: Five.
Mother [*addressing the younger child in Russian*]: Who is it on the pic?
Child 2 [*in Russian*]: Six!!
Mother [*speaks Russian, in surprise*]: Oh really? You are six?
Masha [*there are flashing cards on the screen while she is counting in Russian*]: How old are you: one, two, three, four, five?
Child 1 with the help of his mother chooses the card with number 5.
Zmey Gorynych [*speaks Russian*]: Wow! You are five already! Here is a gem for you!
Child1 [*speaks Russian, in excitement*]: It's Zmey Gorynych!
Mother [*in Russian*]: Yes, he gave you a gem.
Child 2 [*in Russian*]: And I get a gem! (Case #2, Video 1).

*Screen Magic*

The magical effect of the screen was very well illustrated in all three cases. Video recorded activities reveal that there is pleasure in co-viewing or co-experiencing digital worlds. In Case #1 we see how a younger child climbs to his mother's laps when she starts doing language activities on the tablet with her older son. We see that the same happens in Case #2 and Case #3.

In most cases, a mother and children gather around a single screen as a group with the purpose of interacting with the screen and with each other. For example, in Case #1 we observe children stretching across the table to get closer to the screen not to miss something. When they see a new page or a new task they exclaim "Oh!" or "Wow!" in excitement. Moreover, they want to navigate and control what is happening on the screen by themselves.
Mother [*pointing at the screen to the button "enter" speaks Russian*]: Press! We'll enter the fairytale.
Child 1 [*presses the button*].
Mother [*in Russian encourages him while the page is loading*]: Oh! Somebody might appear! It might be Baba Yaga… Or somebody else? Maybe a goblin? [*there is a technical problem and the system asks to register*] Ok, hold on, mom should register here…
Researcher [*offers her help and reaching for the laptop*]: Ok, let me help you.
Mother [*speaks Russian*]: Ok, Lidia will help us.
Child 1 [*in a stubborn voice speaks Russian*]: No, I will! (Case #2, Video 1).

## 4. Discussion and Conclusions

The survey results show a generally positive attitude of parents who raise Russian heritage speakers outside of the Russian Federation to digital (computer, mobile, online) education technologies. In practice, however, parents are often reluctant to use these tools to develop the speech of their own children preferring a printed book and live communication. Partially this seems to be due to the early age of learners and parents' concern with the negative impact of digital environment to children's health. Moreover, it became obvious that many parents are poorly informed about the availability of high-quality digital resources for the development of Russian speech in pre-school children. Some parents may also not see the need to replace traditional media to digital as they do not see the advantages of such replacement nor do they know much about how to properly do it. Meanwhile modern studies show that children of the digital age, that is, the so-called *digital*

*natives*, can effectively interact with multimodal and interactive learning tools, including for the purposes of supporting active bi- and multilingualism (Cummins, 2008; Lohe & Elsner, 2014; Meskill & Mossop, 2000).

The results of the study confirm previous research that indicates the importance of creating the *child-technology-teacher* dialogue and the need for mediation by an adult (teacher, parent) in a situation where a child interacts with a computer or tablet screen (Meskill et al., 2020; Rosen & Jaruszewicz, 2009; Sadykova et al., 2019). The right choice of a digital tool that enables such mediation might be critical for productive interaction to happen. The child reacts well to screen activities that involve her/him into active interaction with it and provides pleasurable experiences through the situations of seeking, identification, and rewards. The magic of screen may engage the child into child-to-screen interaction that simulates real communication and supports language production and engagement with the language content.

The cases demonstrated that digital technologies may play the knowledge mediating role as they enable the teacher (mothers in our cases) to support strong interest of a child to the content, engage young learners with pleasurable language learning activities, and enhance content base with multimodal presentation of the information.

Study results speak for the need to provide additional support to parents of heritage learners who would like to integrate technologies into their homeschooling activities. The survey and case study data revealed that the majority of parents cannot always fully develop the speech of their bi- or multilingual children, as they do not have sufficient competencies in the field of bilingual pedagogy and digital educational resources. The creation of open and accessible resources in this area, as well as (online) consultation of language and early childhood specialists, could partially compensate for this gap.

At the current post-industrial stage of development our society is faced with the need to address issues related to the processes of globalization and migration. Effecting primarily spheres of politics and economics, these processes have an impact on the education and development of children, including those who are educated in the homeschooling format. A multicultural and multilingual society is made up of families where issues of the interaction of cultures and languages are matters that require daily close attention. Families raising children in a bi- and multilingual environment must make considerable efforts to preserve heritage language of their off-springs. Our study shows that parenting efforts can include both speech development classes with traditional and digital learning tools, and activities that indirectly create linguistic and cultural environment that promotes the development of speech skills. Digital tools, however, require more time to penetrate into the everyday learning activities, while parents need additional support to learn what tools are available and how to integrate them into their home educational practices.

These results are of practical significance for formal and informal bilingual educators, teacher training institutions and parents of bi-/multilingual children.

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# Research Materials

## Appendix

### Questionnaire

1. The name of the teacher / parent (real or fictional, used for further communication)

2. The child's name (real or fictional, used for further communication). If you have several children, please fill out the questionnaire separately for each child.

3. Age of the child

4. Gender of the child
   - female
   - male

5. The child's main place of residence
   - Germany
   - Turkey
   - Morocco
   - France
   - USA
   - Other:

6. The main language of communication between the child and the mother

7. The main language of communication between the child and the father

8. The main language of communication outside the family

9. What percentage of oral conversation in the family and outside the family does the child hold in Russian?
   - 0-20%
   - 21-40%
   - 41-60%
   - 61-80%
   - 81-100%
   - Other:

10. What percentage of information (from people, books, mass media, etc.) does your child receive in Russian?
    - 0-20%
    - 21-40%
    - 41-60%
    - 61-80%

- 81-100%
- Other:

11. How do you assess the level of your child's Russian language proficiency?

- the same as the average level of a child of the same age and gender living in Russia
- lower than the average level of a child of the same age and gender living in Russia
- higher than the average level of a child of the same age living in Russia
- Other:

12. How does your child learn Russian (you can choose several answers)?

- Communicates with the mother
- Communicates with the father
- Communicates with other family members
- Communicates with other Russian-speaking neighbours, friends, etc.
- Regularly visits relatives in Russia
- Attends Russian language classes
- Studies Russian independently
- Through Russian mass media (TV, radio, etc.)
- Reads / listens to books in Russian
- Uses Russian-language social networks
- Sings songs in Russian
- Other:

13. Do you make additional effort to develop your child's Russian speech? If so, what do you do?

14. How often does a child use computer and mobile technologies?

- less than 1 hour a day
- 1-2 hours a day
- 2-3 hours a day
- more than 3 hours a day
- Other:

15. How often does a child use computer and mobile technologies to develop Russian speech?

- does not use them
- up to 30 minutes a day
- 30-60 minutes a day
- 1-2 hours a day
- 2-3 hours a day
- more than 3 hours a day
- Other:

16. What educational materials do you use with your child to develop Russian speech?

- Printed books
- Children's games (e.g. board gamed), not digital
- Digital games (computer, mobile, online games)
- Digital resources
- Other:

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17. If your child uses digital technologies for learning Russian, which ones (write the name or describe their type)?

18. Digital (computer, mobile, online) technologies are a useful means of developing the child's competencies in the field of Russian language and culture

- I completely agree
- I agree
- I disagree
- I completely disagree
- I don't know

19. There are many digital (computer, mobile, online) technologies that I can use to develop my child's competencies in the field of Russian language and culture

- I completely agree
- I agree
- I disagree
- I completely disagree
- I don't know

20. There are many digital (computer, mobile, online) technologies that allow my child to effectively acquire skills in the field of the Russian language and culture

- I completely agree
- I agree
- I disagree
- I completely disagree
- I don't know

21. When a child uses digital (computer, mobile, online) technologies for educational purposes, there is no need for intervention (mediation) on the part of a teacher (parent).

- I completely agree
- I agree
- I disagree
- I completely disagree
- I don't know

22. Please, describe in detail your typical activity where you and your child speak Russian, discuss what is happening on the computer screen, tablet or phone. What is happening on the screen at that time? What do you and your child say about what is happening on the screen and how do you interact with the resource? What knowledge of the Russian language and culture does your child acquire at that moment?

23. Please, express your general opinion on the use of digital (computer, mobile, online) technologies for the development of speaking skills and socio-cultural competencies of children learning Russian as a non-native, second native or foreign language.

24. Thanks for the answers! Please leave your email address for contacts.

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# Students' perception of e-Learning during the Covid Pandemic: a fresh evidence from United Arab Emirates (UAE)

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**Abstract**

To examine the role of online learning on student's perceptions during the recent pandemic from the 364 participating respondents' parents and students from (Grade 1 to 12). The respondents' data were analyzed through structural equation modelling (SEM) and the study confirm that 4 out of 4 of exogenous factors examined impacted learning positively, and 3 out of 4 impacted motivation positively. Besides, both study implications and limitations are also discussed under this study.

**KEYWORDS:** Online Learning, Student Perception, Student Engagement, Motivation, COVID-19, UAE.

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## 1. Introduction

The students' and children learning during the recent time has been heatedly debated among the various educators, scholars, and policymakers (Andrew et al., 2020; Aubrey & Dahl, 2008; Domingues-Montanari, 2017; Kim et al., 2019; Tottenham et al., 2019; Fawaz et al., 2021; Thach, 2021). It is believed that online learning helps the children to understand the abstract concepts along with collaborative learning, problem solving, and various creative activities (Dong, et al. 2020).

Researchers like Stephen and Plowman (2002) have suggested the argument that online learning through various digital technologies is to be observed as a multimodal lifeworld for the young children. For this reason, these should be contextualized and capitalized to support the teachers and parents as well regarding how best to utilize set of digital technologies. In addition, online learning is defined as the learning experience through utilizing the internet and related facilities where different students can engage themselves with the teachers and other students based on their time and place factors (Singh & Thurman, 2019). Meanwhile, online learning has been observed as growing with a fastest rate during the time of last and recent decade due to flexible time, place, and pace of the study along with the wider variety and quantity of information with lower financial cost for the students as well as for the educational institutions. However, researchers have shown their deep concern about the quality of education in online learning due to variety of factors. At the same time, some scholars believe that various factors like social isolation, lack of interactivity and participation along with the delayed in the timely response or the feedback have their direct impact on the title of online learning of the students. At the same time, the learning of young children has also been debated and criticize by various scholars because of variety of risk factors involved in it.

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However, in lowering the potential impact of various risk factors in online learning, the role of parents is observed as a mediator. For this reason, it is quite obligatory for the parents to examine the usage of online services by their children (Nouwen & Zaman, 2018).

Another point as observed in the present literature is that it is entirely missing while observing the student perception about the online learning during the recent outbreak of COVID-19. For this reason, present study has tried to fill this gap both in theoretical and empirical perspective specifically from the context of students of grade 1 to 12 in the region of UAE. This would justify one of the most significant contribution as provided by the present study. The empirical outcomes of the study confirm that student perception in terms of motivation and learning has been significantly affected by the variety of factors as observed under present study. The rest of the paper is organized as follows. Section two covers the research methods, framework and hypotheses, section three shows the study findings, while section four provides the discussion and conclusions.

During the recent and past time, both theoretical and empirical studies have provided their valuable contribution while observing the title of online learning. Dong et al. (2020) stated that online learning is widely promoted by the various educational institutions in the world economy comparatively to face to face learning during the recent outbreak of COVID-19. For this purpose, their study has targeted the parents of 3275 Chinese students during the recent pandemic. It is observed that most parents (more than 92 percent) reported that their children had an online learning experience during the outbreak. However, it is also observed that various parents believe that traditional learning model in the form of face to face method is more suitable for the early childhood setting. Hamilton et al., (2020) claim that Student pharmacists have significant exposure in terms of online learning in tehri relative education. To access their research questions, authors have created an online survey consists of 47 items which was delivered to schools and colleges of pharmacy students in the region of United States. For data analysis, their study has applied frequency distribution to judge the student preferences. It is found that out of total sample of 1873 students, 30 percent have shown their preferences for a blended course covering both classroom components and online components. However, 47 percent students have preferred online lectures. Additionally, the technique of utilizing the smart phones is observed as quite valuable for 57 percent students. It is concluded that pharmacy students in US have preferred blended form of learning.

Yates et al. (2020) claim that COVID-19 pandemic has resulted in the closing of New Zealand schools while covering the teaching through online and digital media. For judging the student experience about online learning during this pandemic, the study conducted by Yates et al. (2020) has utilized the framework of Kearney et al. (2012) which provides the three dimensions to focus named as personalization, authenticity, and finally the collaboration as well. For data analysis, both qualitive and quantitative techniques have been applied. It is found that authenticity and collaboration factors have their direct impact on the student learning.

Adnan and Anwar (2020) examine the online learning during COVID-19 while taking the sample from Pakistani higher education students. The findings through online survey indicate that online learning is unable to produce the valuable and desired results in the country like Pakistan due to the fact that various students cannot get the right access of internet facility along with some technical and monetary issues.

Dhawan (2020) explain that in the Indian region, the educational institutions like schools, colleges, and universities are based on the traditional approaches like face-to-face model. He further indicates that sudden outbreak of COVID-19 has dramatically changed the world specifically the education sector and WHO has already announced it as a pandemic which has challenged the education sector in all the countries. His article has covered the strength, weakness, opportunities, and threats for the e-learning models at the time of this crisis. Furthermore, his study also provides some valuable suggestion for the academic institutions regarding how to deal with such issues which are linked with the online learning model. Aliyyah et al., (2020) try to examine the perception of primary school teachers about the online learning in Indonesia for the program named as School from home during COVID-19. With the help of surveys and semi-structured interviews with the 67 class teachers in the primary schools, the results of the study confirmed that factors like instructional strategies, support, and motivation of the teachers, learning between the teachers, schools, and parents have their impact on the success factor of the student.

Meanwhile, the success of online learning factor in the region of Indonesia during this pandemic is depending upon the technological readiness along with the national humanist curriculum, collaboration and support from different stakeholders, and local community. Besides, there are studies having their theoretical and empirical contribution in the field of online learning (Agarwal & Kaushik, 2020; Agung et al., 2020; Allo, 2020; Baber, 2020; Khalil et al., 2020; Syauqi et al., 2020). To the best of our knowledge, there is a wide gap in the existing literature for examining the student perception about online learning specifically in the region of UAE. For this reason, present study has covered this gap while proposing a conceptual and empirical framework taking the students of grade 1 to grade 12 under observation for exploring the impact of four latent constructs on the motivation and learning of the students. This research would reasonably fill the available gap along with providing some useful pathways for the upcoming studies in the field of e-learning, related tools, and

techniques along with the student perception about the online learning.

## 2. Research Methods, Framework and Hypotheses

In terms of methodology, this research is quantitative in nature while following the deductive research approach. For data collection, four exogenous variables entitled as, self-perception of own general skills (five items), perception about teacher's roll (four items), perceived utility of online (four items), and learning tools (four items) were selected based on the existing literature. For the measurement of student perception, two main endogenous variables named as motivation (four items), and learning (four items) were selected and under observation. The measurement of all the stated items is based on the five-points Likert scale ranging from 1 as strongly disagree, 2 as disagree, 3 as undecided, 4 as agree, and 5 as strongly agree. After finalizing the questionnaire, the targeted respondents were students and their parents. More specifically, from grade 1 to 10, parents were selected as the targeted respondent due to the fact that respondents have their lower age for understanding and filling of the questionnaire. Additionally, for grade 11 to 12, students were targeted as key respondents. Initially 550 copies were distributed among the parents and students during December 2021 which were finally collected till February 2021. It is observed that the total number of collected copies were 423 while the remaining were not returned by the respondents. Detailed review of the collected copies indicate that 59 copies were found as not valid enough with missing information from the respondent. Finally, a sample of 364 copies were found to be valid enough with no missing data. Therefore, our study is based on the sample of 364 from both parents and students.

For data analysis, our study initially applied the descriptive statistics covering the mean, standard deviation, kurtosis, and skewness as well. After descriptive outcomes, confirmatory factor analysis was applied, and score are discussed. Finally, our study has applied the structural equation modelling under AMOS-21 to examine the direct relationship between the study variables. Figure 1 below shows the research framework along with the research hypotheses ranging from H1 to H8, where H1 means self-perception of own general skills (SPOGS) has its positive and significant impact on students' perception about online learning in terms of motivation. Similarly, H2 to H8 were developed and depicted under Figure 1.

## 3. Results

Table 1 shows the descriptive scores of the study variable, based on the total number of observations against each item, mean and standard deviation, skewness, and kurtosis. It is found that for all the items of the study variables, total number of valid observations were 364 with no missing data.

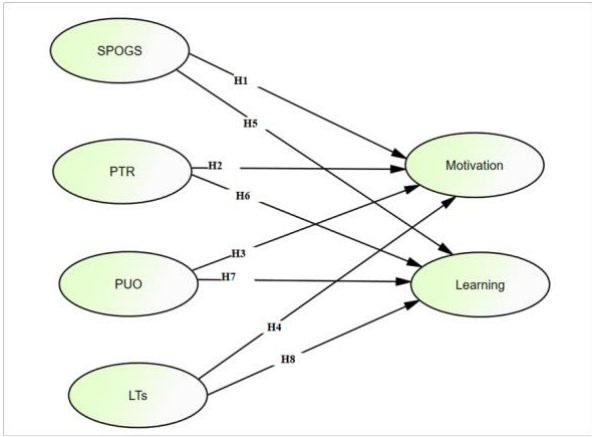


**Figure 1** - Research Framework and Hypotheses (H1-H8 showing direct relationship between the variables)
*Source: Author's Estimation.*

*Note: SPOGS means Self-perception of own general skills, PTR means Perception on the teacher's roll, PUO means Perceived utility of online, LTs means learning too.*

However, the trend for the mean score is observed as ranging from 2 to above 3. More specifically, it is found that maximum mean score for the SPOGS3 is 3.21 with the standard deviation of 1.18. On the other side, the mean trends in the data for PTR items is observed as 3.78 for PTR2 and 3.67 for PTR1 along with their relative score of standard deviation. Perceived utility of online is measured through four items with the mean score of above 3. Additionally, learning tools is measured through four items with the lowest mean score as reflected by LTs1 and highest for LTs3.

Finally, the measurement for two major endogenous variables is based on the four items based on the five-points Likert scale. It is observed that only the mean score for Learn2, Learn4 and Mot4 are above 3 whereas rest of the variables have shown their mean score of below 3. After examining the descriptive scores of the study variables, present study has examined the measurement model with the help of confirmatory factor analysis or CFA. It is observed that various earlier studies have conducted the CFA for the measurement model.

The results for the CFA outcomes are shown with the help of Figure 3. It is observed that some items were deleted from this output model like SPOGS1, PTR4, POU4, and LTs3 as well. These items were deleted due to the loadings of below 0.50. However, all those items which have provided the factor loading of above 0.50 have been considered under present study analysis.

Table 2 shows the loadings of the study items. It is observed that factor loadings for the three items of SPOGS are 0.676, 0.976, and 0.716, respectively. On the other side, the value of factor loadings for PTR are 0.662, 0.802, and 0.722 under Table 2 and Figure 2 of

| Items | N | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| SPOGS1 | 364 | 3.1841 | 1.00778 | .030 | .128 | -.751 | .255 |
| SPOGS2 | 364 | 3.2088 | 1.10113 | -.197 | .128 | -.945 | .255 |
| SPOGS3 | 364 | 3.2170 | 1.18746 | -.337 | .128 | -.832 | .255 |
| SPOGS4 | 364 | 3.1181 | 1.22634 | -.164 | .128 | -1.013 | .255 |
| SPOGS5 | 364 | 2.5247 | .93121 | .422 | .128 | -.815 | .255 |
| PTR1 | 364 | 3.6703 | .85673 | .293 | .128 | -.469 | .255 |
| PTR2 | 364 | 3.7857 | .93786 | .379 | .128 | -.433 | .255 |
| PTR3 | 364 | 2.7225 | .97203 | .345 | .128 | -.875 | .255 |
| PTR4 | 364 | 3.3214 | 1.07743 | -.109 | .128 | -1.143 | .255 |
| PUO1 | 364 | 3.4258 | 1.03253 | -.834 | .128 | .131 | .255 |
| PUO2 | 364 | 3.3407 | 1.15441 | -.380 | .128 | -.522 | .255 |
| PUO3 | 364 | 3.4038 | .97012 | -.755 | .128 | -.094 | .255 |
| PUO4 | 364 | 2.6209 | 1.04140 | .131 | .128 | -.710 | .255 |
| LTs1 | 364 | 2.6731 | 1.12827 | .403 | .128 | -.775 | .255 |
| LTs2 | 364 | 2.7115 | 1.22498 | .412 | .128 | -.841 | .255 |
| LTs3 | 364 | 3.7555 | .87707 | -.808 | .128 | .246 | .255 |
| LTs4 | 364 | 2.5632 | 1.48968 | .420 | .128 | -1.231 | .255 |
| Mot1 | 364 | 2.6209 | 1.04140 | .131 | .128 | -.710 | .255 |
| Mot2 | 364 | 2.6786 | 1.12251 | .412 | .128 | -.764 | .255 |
| Mot3 | 364 | 2.7115 | 1.22498 | .412 | .128 | -.841 | .255 |
| Mot4 | 364 | 3.6209 | 1.42941 | .426 | .128 | -1.004 | .255 |
| Learn1 | 364 | 2.5302 | 1.09427 | .468 | .128 | -.279 | .255 |
| Learn2 | 364 | 3.4698 | 1.13869 | .683 | .128 | -.296 | .255 |
| Learn3 | 364 | 2.5989 | 1.07749 | .400 | .128 | -.445 | .255 |
| Learn4 | 364 | 3.5907 | 1.08839 | .520 | .128 | -.437 | .255 |
| Valid N (listwise) | 364 | | | | | | |

**Table 1** - Descriptive Statistics.

| Items | Direction | Variables | Estimate |
|---|---|---|---|
| SPOGS2 | <--- | SPOGS | .676 |
| SPOGS3 | <--- | SPOGS | .976 |
| SPOGS4 | <--- | SPOGS | .716 |
| PTR1 | <--- | PTR | .662 |
| PTR2 | <--- | PTR | .802 |
| PTR3 | <--- | PTR | .722 |
| PUO3 | <--- | PUO | .792 |
| PUO2 | <--- | PUO | .820 |
| PUO1 | <--- | PUO | .639 |
| LTs4 | <--- | LTs | .840 |
| LTs2 | <--- | LTs | .962 |
| LTs1 | <--- | LTs | .698 |

**Table 2** - Standardized Regression Weights: (Group number 1 - Default model) CFA Loadings.

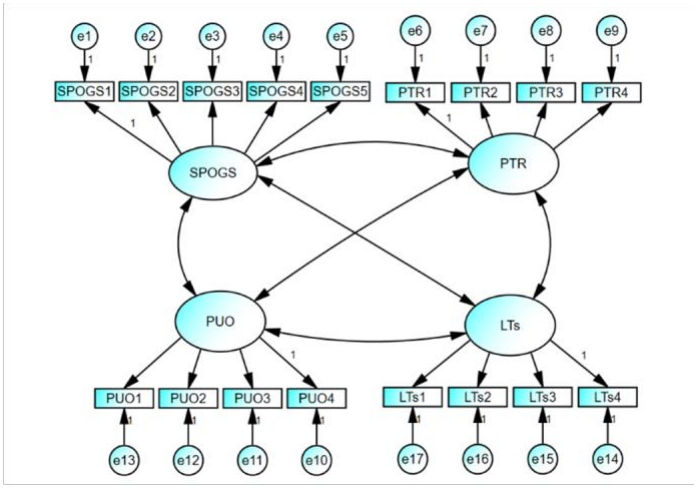


**Figure 2 -** Measurement Model Through CFA, *Source: Author's Estimation.*

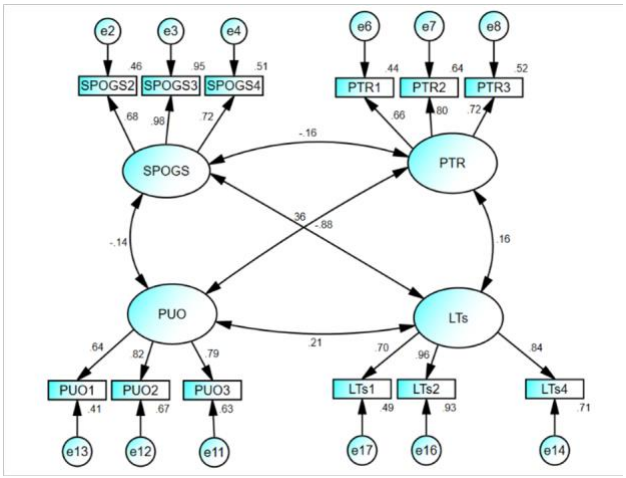


**Figure 3 -** Output for CFA, *Source: Author's Estimation*.

the study. Additionally, the factor loadings for PUO items were 0.792, 0.820, and 0.639, respectively. Lastly, the loadings for LTs items were observed as 0.840, 0.962, and 0.698, respectively.

More specifically, the loadings for all four items of motivation were 0.865, 0.663, 0.668, and 0.934. Additionally, the loadings for learning items were 0.790, 0.844, 0.847, and 0.784, respectively. This would justify the argument that there was no need to delete any single item for both endogenous due to the issue of lower loadings, hence all four items for each of the dependent variables were considered for the structural equation modelling.

After analyzing the output for the measurement model with the help of factor loading, Figure 5 shows the structural input model of the study covering all four exogenous constructs along with the first endogenous variable named as motivation of the student which is measured through all four items along with the relative error terms. The output for this structural model has been presented under Table 3 to test the direct relationship between the study variables.

The results under Table 4 show that Self-perception of own general skills or SPOGS has its positive and significant impact on motivation. This impact is justified with the help of regression coefficient of 0.982 and standard error of 0.052. Both of these values have provided the critical ratio of 18.855 with the p-value of significant at 1 percent level of significance. It means that higher level of self-perception of own general skills is leadings towards the creation of more motivation among the students from Grade 1 to Grade 12 in the region of UAE. However, on the other side, the impact of perception on the teacher's roll-on student motivation level is observed as positively insignificant at 5 percent. The results under Table 4 have confirmed that perceived utility of online or PTR is positively and significant determining the level of motivation among the targeted sample of students. This means that for the students, the role of PTR is found to be highly significant in motivating them towards online learning. Additionally, the last exogenous variable is entitled in terms of those learning tools which are observed under online learning. It is observed that there is a significant and positive impact of LTs on motivation among the students (i.e., coefficient= 0.863, 0.270, C.R=3.196, p-value=0.000).

| *Items* | *Direction* | *Variables* | *Estimate* |
|---|---|---|---|
| Mot4 | <--- | Motivation | .865 |
| Mot3 | <--- | Motivation | .663 |
| Mot2 | <--- | Motivation | .668 |
| Mot1 | <--- | Motivation | .934 |
| Learn4 | <--- | Learning | .790 |
| Learn3 | <--- | Learning | .844 |
| Learn2 | <--- | Learning | .847 |
| Learn1 | <--- | Learning | .784 |

**Table 3** - Standardized Regression Weights: (Group number 1 - Default model).

| *Endogenous* | *Directions* | *Exogenous* | *Estimate* | *S.E.* | *C.R.* | *P* |
|---|---|---|---|---|---|---|
| Motivation | <--- | SPOGS | .982 | .052 | 18.885 | *** |
| Motivation | <--- | PUO | .128 | .625 | 0.205 | |
| Motivation | <--- | PTR | .632 | .287 | 2.202 | ** |
| Motivation | <--- | LTs | .863 | .270 | 3.196 | *** |

**Table 4 -** Structural Equation Modelling Output for Figure 4.

| **Title** | **Statement** | **Remarks** |
|---|---|---|
| H1 | Self-perception of own general skills (SPOGS) has its positive and significant impact on students' perception about online learning in terms of motivation. | Supported |
| H2 | Perception on the teacher's roll (PTR) has its positive and significant impact on students' perception about online learning in terms of motivation. | Not Supported |
| H3 | Perceived utility of online (PUO) has its positive and significant impact on students' perception about online learning in terms of motivation. | Supported |
| H4 | Learning tools has its positive and significant impact on students' perception about online learning in terms of motivation. | Supported |

**Table 5 -** Summary of the Hypotheses for the Relationship between Exogenous Constructs and Level of Motivation

| *Endogenous* | *Directions* | *Exogenous* | *Estimate* | *S.E.* | *C.R.* | *P* |
|---|---|---|---|---|---|---|
| Learning | <--- | SPOGS | .226 | .033 | 6.920 | *** |
| Learning | <--- | PUO | .879 | .074 | 11.885 | *** |
| Learning | <--- | PTR | .476 | .068 | 6.947 | *** |
| Learning | <--- | LTs | .229 | .025 | 9.082 | *** |

**Table 6** - Regression Weights: (Group number 1 - Default model).

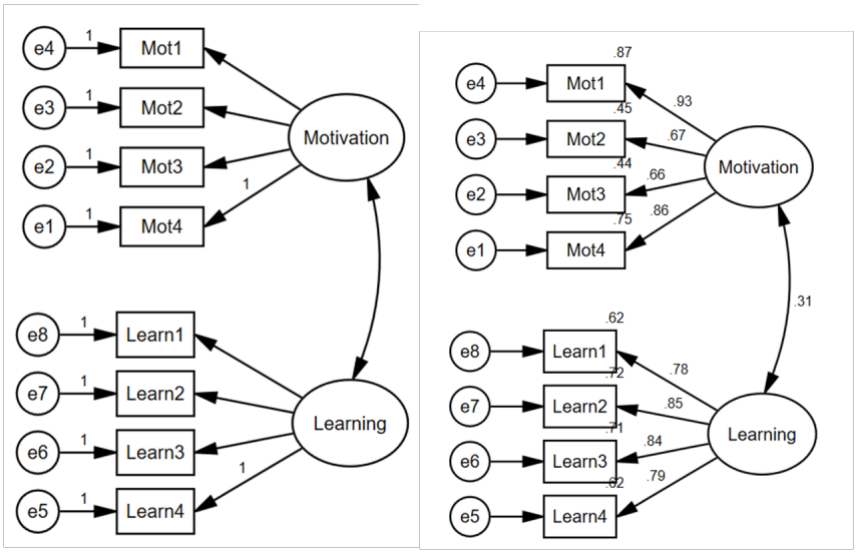


**Figure 4(a) and 4(b)** - Measurement model and loadings. Source: Author's Estimation.

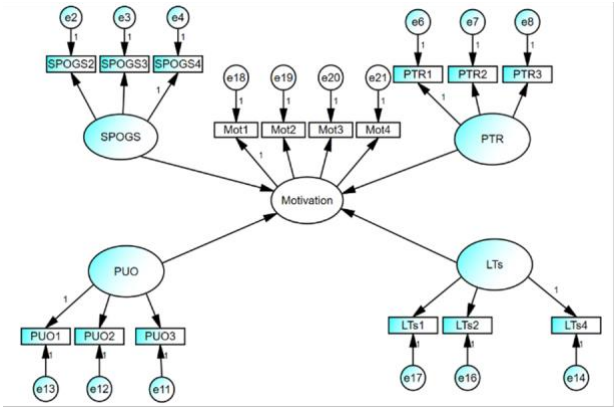


**Figure 5** - Structural Model (Input) for Key Exogenous Constructs and Motivation. *Source: Author's Estimation*.

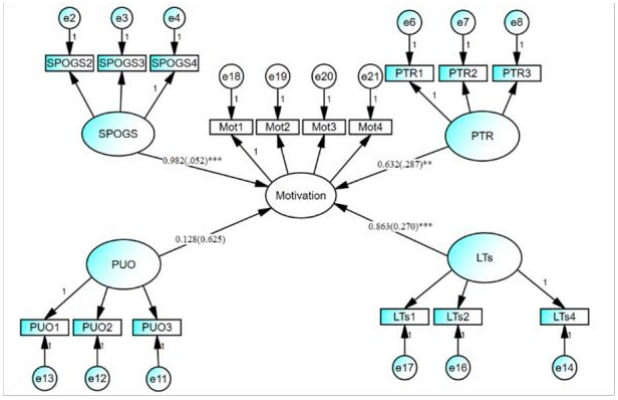


**Figure 6** - Structural Model (Output) for Key Exogenous Constructs and Motivation. *Source: Author's Estimation*.

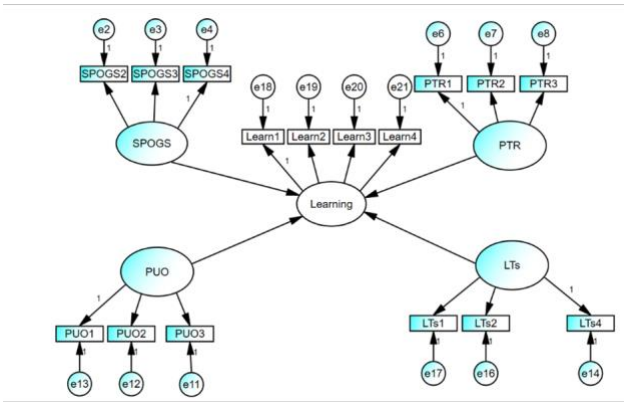


**Figure 7** - Structural Model (input) for Key Exogenous Constructs and Learning. *Source: Author's Estimation*.

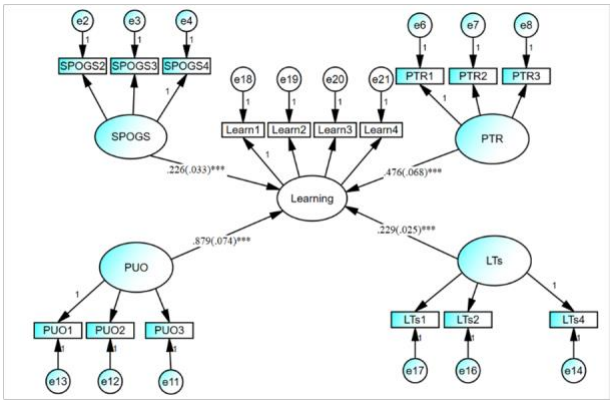


**Figure 8** - Structural Model (Output) for Key Exogenous Constructs and Learning. *Source: Author's Estimation*.

Based on the study findings under Table 4, Table 5 shows the summary of the hypotheses for the relationship between exogenous constructs and level of motivation among the students which is a first measure of student perception about online learning. The Structural input model under Figure 7 shows the relationship between four exogenous variables and second dependent variable named as learning of the students.

The results for the second structural model are shown in Table 6 of the study. It is found that there is a significant and positive impact of SPOGS on learning, providing the evidence that higher Self-perception of own general skills means higher learning and vice versa. Similarly, the results under Table 6 also confirm that Perception on the teacher's role is causing a positive shift in the level of learning with a fact that unit change in PUO is causing a change of 0.879 in the level of learning for the targeted sample under current study. Furthermore, Perceived utility of online also shows a positive impact on learning with the coefficient of 0.476 and standard error of 0.068. This would claim that higher perceived utility of online learning is putting a positive impression towards the student learning from online classes. At the same time, the findings under Table 7 are in favor for accepting the alternative hypotheses that PTR and LTs are causing more learning among the students in UAE. This statement is supported through regression estimates of 0.476 and 0.229, respectively in Table 6.

| Title | Statement | Remarks |
|---|---|---|
| H5 | Self-perception of own general skills (SPOGS) has its positive and significant impact on students' perception in terms of learning. | Supported |
| H6 | Perception on the teacher's roll (PTR) has its positive and significant impact on students' perception in terms of learning. | Supported |
| H7 | Perceived utility of online (PUO) has its positive and significant impact on students' perception in terms of learning. | Supported |
| H8 | Learning tools has its positive and significant impact students' perception in terms of learning. | Supported |

**Table 7** - Summary of the Hypotheses for the Relationship between Exogenous Constructs and Level of Motivation.

## 4. Discussion and Conclusions

During the time of recent pandemic of COVID-19, the trends in business and educational institutions have been changed dramatically from face-to-face model to online learning and teaching. This would justify the significance of online learning both in developed and developing economies on equal platform, however, the trends of online learning in developed economies is much different comparatively to one in the developing economies. This study has tried to examine the student perception about the online learning during the recent pandemic. For this purpose, four exogenous constructs were under observation to analyze the trends in two factors of student perception entitled as level of motivation and learning as well.

The results through structural equation modelling have confirmed that factors like Self-perception of own general skills (SPOGS), perceived utility of online (PUO), and learning tools (LTs) are showing their significant and positive impact on the value of student's motivation. Additionally, the impact of Self-perception of own general skills, perception on the teacher's roll, perceived utility of online, and learning tools are showing their significant and positive influence on the learning factor of the students from grade I to grade 12.

The findings under present study would be great support to various policy makers specifically in the education sector, where the role of general skills of the student, utility of online, learning tools like utilization of blackboard, zoom, and many others, and the teacher's role are good to provide some strategic guidelines. At the same time, present study has provided a good contribution in the existing literature of student perception about online learning and its key determinants both in theoretical and empirical perspective.

However, this study is also associated with the various limitations too.

Firstly, present study has considered the student community from Grade 1 to 12 with no focus on the university students.

Secondly, the sample under present study consists of students and their parents, however, future studies can also consider the sample in terms of university teachers, administration officials, and management persons as well.

Thirdly, this study is also missing while providing the cross-sectional comparisons regarding which grade students are showing their higher positive attitude towards online learning.

Based on all three limitations, future studies are highly recommended to consider them for better outcomes and some significant literature contribution both in theoretical and empirical perspective as well.

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# Adoption of social robots as pedagogical aids for efficient learning of second language vocabulary to children

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**Abstract**

In this digital age embracing robotics across various areas of life, especially intellectual ones, have reaped great benefits owing to this modern technology. Therefore, the learning field has not remained unchanged given current evolutions as the schooling conditions have been improved through these smart devices. However, teachers still face some difficulties when choosing pedagogical methods and means for effective language learning for children. Thus, this paper aims to measure the effectiveness of social robots in facilitating children's learning of a second language (L2). For this purpose, the term L2 learning and its subordinate concepts have been distinguished, and then the different methods of language learning were discussed. The latest research regarding social robots in the educational context was also discussed when reviewing the literature. An experimental study conducted on a sample of children illustrated that the use of the social robot significantly helped them in the L2 learning regarding the assimilation fast, retention, and correct pronunciation of its vocabulary. Finally, this study concludes that the social robot would be a good solution and recommends their widespread use in education given its role in improving the schooling conditions of children.

**KEYWORDS:** Social Robot, Children Learning, L2, Tangibility, Learning Outcomes.

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## 1. Introduction

It is known that the progress of communities is measured by the amount of their scientific and technological output. But, what the communities are aware of this development is influenced by the readiness of the educational system, which must keep pace with the changes taking place in the world. Especially, in light of the evolution of the means of communication that made the world just a small city. To be in permanent contact with this world, which brings us more discovery every moment, it was not only necessary to master the mother tongue but to learn another language at least to prepare oneself to follow the evolutions and to adapt to them, in addition to opening up prospects for cultural interaction (Hansen-Thomas & Chennapragada, 2018), which helps to more understanding the others.

Many people have recently become aware of the importance of languages in human life. Therefore, they have tried to teach their children another language than their mother tongue at an early age to prepare them for the future without obstacles. Thus, attempting to educate L2 for children is considered a smart step due to their peculiarities regarding the flexibility of acquiring teaching content and memorizing them in the long run. In this context, we have noted many terms frequently used in the language sciences, such as learning, acquisition, native language, L2, and foreign language. Which led us to define the scope of each concept to eliminate any ambiguity that the reader may fall into.

Language acquisition is the process that takes place normally without the need for education, as is the case when a child has acquired his or her native language. In contrast, language learning is linked to the study of the

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language through the school system, which takes place in a formal setting. The L2 acquisition is concerned with how an individual becomes able to learn a language or more and not his mother tongue, whether in language classes or through natural learning through interaction with the native speaker (Oxford, 2017).

We can also introduce the term foreign languages into our broader concept of L2's because we see learning processes as essentially identical in languages with a local presence or languages that are the most distant target despite different learning objectives and circumstances. A foreign language is the language in which the student learns formally educated on one of the school curriculum topics, the age at which foreign language instruction is offered varies according to different societies, educational philosophies, and political circumstances (Becker, 2007).

The distinction between learning the mother tongue and foreign languages depends on the environment in which one is learned. The speaker acquires the mother tongue from the environment in which it is used for normal daily communication, while the foreign language learner relies entirely on a specified number of educational classes within the school. e.g., there is a fundamental difference between the adequacy of an Italian citizen and the adequacy of a foreigner who succeeds in mastering the Italian language. This is because the Italian has an implicit knowledge of the rules of his language, while the foreign Italian grammar is known directly (explicit). Thus, we should be placed on knowing that the foreigner's knowledge of the language is direct if he or she studies its grammar and learns the language in the language-oriented educational system. But, if it learns through indulging its people and using it in their diaries as they do, here the knowledge is implicit to the unconscious, not direct.

The comprehensive plan used by the teacher to achieve the required goals of learning the language which includes methods and procedures to help achieve the goals and also includes the teacher's use of educational material teaching. Whereas, research conducted in Larsen-Freeman & Anderson (2011) has identified five methods of language teaching, namely: grammar and translation, direct, audio-oral, audiovisual, and communication.

The grammar and translation method is one of the oldest methods used in language learning, where its use in the learning of classical languages such as Latin and Greek. It is used to help learners read and tasting etiquette in the L2. This method also focused on teaching the language through translation between mother tongue and L2. This method is interested in developing the skills of reading and writing of the L2. In contrast, the direct method is based on teaching the new language directly, without resorting to another language that is often the mother tongue without having to translate from into the native language. This method depends on the learner's situation, where he creates within the department the conditions (Language bath) to acquire the language.

The main foundation of the audio-oral method is the presentation of the L2 on the educated at first sight, and the reading and writing are presented in a later period. In the first stage, the teacher's interest is limited to helping learners to master the phonetic and grammatical system of the L2 automatically and does not pay much attention at the beginning to teach the vocabulary, as it is enough to help the learner learn the system of sound and grammar of the L2 and there is no objection to resorting to translation if necessary. This method uses various instructions such as simulation, repetition, and memorization, and emphasis on the method of measurement, with less explanation and grammatical analysis. This may make the learner deal with the language studied mechanically, but it may prevent him from having the ability to free expression. On the other hand, the audiovisual method depends on the objective to be achieved or the used means. Sometimes is based on a linguistic basis or the basis of myself or be influenced by one of the ancient philosophies of education. The lesson in this method combines audio and visual and is considered integrated with the normal use of language.

The communication method makes its ultimate goal to acquire the learner's ability to use L2 as a means of communication to achieve its various purposes. This method does not consider language as a set of structures and stereotypes intended for itself but as a means of expression of different language functions, such as demand, improvisation, order, prohibition, description, and report. Through the communication between the speaker and the listener or the writer and the reader are clear meanings, the listener enriches the speaker language in a lot of meanings, trying to clarify its meanings as possible.

Despite the benefits of adopting one or more learning methods, the teacher still needs effective educational tools that can facilitate the delivery of teaching content to learners. It, therefore, requires interactive tools that allow learners to consolidate the content of the lesson. Because according to Bloom's taxonomy of knowledge levels, we need to use interactive teaching tools that allow us to see, hear and touch to increase the memorization rate of learners. We, therefore, suggest using the social robot in the learning of languages, as it is the result of artificial intelligence research on the simulation of humans' behavior in their interactions with their environment, it offers an amazing sensory experience that will undoubtedly achieve the pedagogical goals set in the best conditions.

In what follows, we will present a review of the most significant research conducted on social robots for teaching L2 to children. After that, we explain our materials and methods used. At the last, we give our results obtained with discuss them. We conclude by Conclusion section.

## 2. Related Work

Nowadays, the interference of modern technologies in learning has emerged as a fertile topic that has attracted its own share of interest. Therefore, several studies have explored the effect of existing digital products on children's learning, in which most of the thematic aspects of children's learning with social robots have been addressed. In what follows, the authors will review the most distinguished works in this field to accurately identify their research hypotheses.

The investigation performed in Negrini & Giang (2019) sought to understand how pupils perceive robots as a tool to enhance their skills, including foreign language learning. The results showed a notable difference, by gender, in the perception of the skills they can improve. Similarly, a European research project called L2TOR (http://www.l2tor.eu/), an acronym for second language teaching using social robots has been launched. This project focuses on preschoolers because their adequate knowledge of the academic language is crucial to their future schooling success. However, they recognize in its entirety the importance of these devices in developing skills and keeping in tune with the times. Moreover, the research conducted by (Kanero et al., 2021) led to experimental investigation of the effect of the physical embodiment of a robot on L2 learning. They also provided an example of why embodiment does not affect learning outcomes, which gave them hope for dealing with the challenging learning conditions caused by the COVID-19 pandemic, especially since all participants in their survey were successful in learning L2 vocabulary.

Some researchers have attempted to evaluate the effectiveness of L2 tutoring supported by social robots, where they have obtained promising results that have led them to recommend its adoption in language tutoring for children (Lee et al., 2011; Kennedy et al., 2016; Belpaeme et al., 2018a; Vogt et al., 2019). Similarly, the communicative aspect of social robots and how they interact with users has been the scoop of much research regarding ICT-assisted language tutoring. For example, a field experiment using an interactive robot was conducted (Kanda et al., 2004), where it was concluded that they can be considered a social companion capable of educating children. Also, some design characteristics were proposed in Vogt et al. (2017) to build a child-friendly robot that can give them good support in L2 learning. Other researchers have also studied the interaction among children and robots during storytelling (Leite et al., 2015; Westlund & Breazeal, 2015), they conclude that interactive storytelling with multiple robots is a valuable approach to promoting social skills for children. Likewise, the effect of multiple interactions with robots on children's engagement and L2 learning outcomes has been studied, where the results obtained revealed a significant positive change in performance through the interactions (Rintjema et al., 2018).

The individual learner differences and their effect on the added value of learning an L2 using social robots have taken recently their share of researchers' concerns. Therefore, the authors (van den Berghe et al., 2021) highlighted differences in robotic effects and behaviors among children that need to be considered when designing and assessing robot-based L2 learning. Moreover, the investigations done by (Kanero et al., 2018) found that all research on social robots confirms their effective ability to fill the gaps in early language learning that human teachers cannot. They emphasized that no studies are indicating that social robots are more effective than humans, and that they can in no way replace them.

The adaptive feature of social robots of L2 tutoring for children has also been addressed in numerous recent researches. In this respect, a new approach based on Bayesian knowledge tracking and predictive decision-making has been developed to design an adaptive robot for language tutoring (Schodde et al., 2017). Other authors have gone further when they wanted to investigate the effect of robot gestures and adaptive teaching on children's L2 acquisition (Wit et al., 2018). Hence, the assessment study demonstrated good results in the adaptive tutoring condition of L2 vocabulary. Another research evaluated the effect of three scaffolding strategies (adapt, explain, and engage) on helping young children learn L2 through social robots. To reach this aim, an experimental study was conducted with very successful results across the board regarding children's engagement, learning gains and persistence, perceived learning, and re-engagement after dis-engagement (Schodde et al., 2019).

Indeed, to better understand robots supporting language learning, we suggest to readers consulting the review papers of (Belpaeme et al., 2018b; van den Berghe et al., 2019) as they include many recent studies related to social robots in an educational context and outline the features of their future use.

Despite everything said above on the advantages of using social robots in learning, it must be emphasized that the current interactive skills of these smart devices do not allow them to lead an educational process without the steering of a human teacher. Nevertheless, they can bring a qualitative addition aiming to transfer educational content to learners in optimal conditions when they play the role of pedagogical aids.

Although numerous studies have recently been conducted on social robots, they have not, in their totality, illustrating the quality of support that can be given to a child when learned L2. In other words, to what extent can robots influence learners practically when they use them as a pedagogical aid? For this purpose, we are developed research hypotheses to determine the tangible effect of the social robot on the children participating in our survey in terms of pronunciation, memorization, and assimilation skills.

The following section will exhibit the materials and methods used in the field study of the social robot by

outlining the research hypotheses, the characteristics of the target sample, and the adopted design for this survey.

## 3. Materials and Methods

This section aims to outline the characteristics of the field study related to determining the extent of the impact of using the social robot on children's ability to acquire a L2. Therefore, the authors have declared their research hypotheses at the outset and then identified the quantitative and qualitative characteristics of the target population, while clarifying the method by which this study will be conducted.

### 3.1 Research hypotheses

To discover the effects of using social robots on children's L2 vocabulary learning, a range of research hypotheses were developed, including the homogeneity hypothesis (H0).

Homogeneity in this study means that both groups consisted of a homogeneous mix of participants' personalities (see personality types in Table 1) and received the same educational material, except that the members of the EG were exclusively given an additional tool, which is a social robot.

Three research hypotheses were adopted regarding children's schooling conditions in terms of phonics, dictation, and capacity, namely:

1. Phonetics hypothesis (H1): there is no significant effect of the social robot on the proper pronunciation of the L2 vocabulary;
2. Dictation hypothesis (H2): there is no significant effect of the social robot on the memorization of the L2 vocabulary;
3. Capacity hypothesis (H3): there is no significant effect of the social robot on reducing the time to acquire a L2.

### 3.2 Participants

The target category by this study is children in their early years of schooling because there are two main reasons for this choice: (1) the distinctive feature of this age group is the long memorization time of the studied contents, as there is a pedagogical rule that says learning in childhood is like engraving on stone, and (2) trying to prepare the children's minds entering the battlefield of life and overcome the language difficulties they will inevitably encounter in the future. Indeed, the chosen sample in our field study is consistent with the findings of research conducted on (Ghenghesh, 2010; Nejadansari & Nasrollahzadeh, 2011) regarding younger individuals' preference in language learning.

A field study was conducted on a sample of 54 children to measure the effect of the use of social robots on the language learning process. Indeed, the studied sample was not large, but it was representative enough which allowed us to evaluate the positive impact of these smart devices. The authors considered the participant's gender as a non-influential factor in the process of L2 learning. The parameters of this study are listed in Table 1.

| Variables | Description |
|---|---|
| Educational stage | Third primary grade. |
| Sample size | 54 children. |
| Targeted language | English. |
| Length of study | 8 weeks. |
| Curriculum | 100 words. |
| Participants' Personalities | Sensitive, Kinetic, Stubborn, Quiet and Bold. |
| Gender | Male = 19 pupils;<br>Female = 35 pupils. |
| Experimental Group (EG) | This group benefited from the social robot as a pedagogical aid throughout their second language learning process (N=28). |
| Control Group (CG) | This group studied the second language without relying on the social robot (N=26). |
| Test rating scale | Percent. |
| Survey goals | Perceived usefulness; Perceived interaction; Perceived impact on children assimilation; Attitude towards robotics; Satisfaction; Intent to continue using social robots. |

**Table 1** - Parameters of study.

### 3.3 Design

This study aims to know how to help children enrich their L2 vocabulary in terms of writing and correct pronunciation, and did not address its grammatical and morphological aspects. To do this, participants were first divided, as they wished, into two groups: experimental group (EG) and control group (CG). Then, every child was given a uniform curriculum of 100 cards containing a spoken word in English and its meaning in the participants' native language and was asked to study it carefully within an eight-week period. Participants were then asked, as a pre-test, to read the English words on their cards to see how well they were pronounced.

Moreover, the authors provided the EG exclusively with a social robot called EMYS to determine how it affects the L2 learning process (Emys, 2018). It's a friendly robot head designed in 2018 to teach foreign languages to children in a fun and engaging way. It can move, speak and interact with users by displaying various emotions and using its expressive face. Figure 1 shows a social robot teaches a child a new language.

Eventually, a reading test was repeated as a post-test to assess the extent to which participants' language practice had improved. Also, another test was performed by asking participants to write the English words with

corresponding meaning to their mother tongue to check the extent to which they had acquired the L2 and preserved its terminology. Besides, the time invested in L2 learning by each child was calculated.

**Figure 1** - EMYS robot teaches children new languages.

## 4. Results

The results obtained from the field study were encouraging for adopting social robots in children's L2 learning. In fact, the gathered data were processed using a statistical method called one-way analysis of variance (ANOVA) as they are based on the following assumptions: normality, independence of the sample, and equality of variance. It allows measuring whether there are statistically significant differences between the means of several unrelated groups. Concerning this study, F-test was calculated with a significance level of 0,05.

The results of the reading and writing tests, as well as the recorded learning times and the pronunciation progress for every child participating in the study, will be presented in what follows, where:

- N: Cardinality of the sample;
- M: Mean;
- SD: Standard deviation;
- P-value: Probability value;
- F-test: Fisher test.

### 4.1 Reading pre-test

Initially, each child was given a set of words and asked to read them to measure their ability to read L2 vocabulary. The reading pre-test results showed a high degree of convergence which supports the credibility of this study, where the EG members were delayed by a slight percentage of their counterparts on the CG by 1,69% (see Table 2).

| Groups | N | M | SD | P-value/ F-test |
|---|---|---|---|---|
| Experimental | 28 | 39,93 | 8,35 | 0,492 / 1,005 |
| Control | 26 | 40,62 | 8,37 | |

**Table 2** - Basic statistics for both groups in reading pre-test.

### 4.2 Reading post-test

It is another test similar to the reading pre-test that took place after the end of the study period. Table 3 shows that both groups had high scores, where a significant advancement was recorded for the EG members over their counterparts, with a rate of 11,89%.

| Groups | N | M | SD | P-value/ F-test |
|---|---|---|---|---|
| Experimental | 28 | 67,61 | 9,82 | 0,421 / 0,923 |
| Control | 26 | 60,42 | 9,43 | |

**Table 3** - Basic statistics for both groups in reading pre-test.

### 4.3 Writing test

It is a retention test in which participants had to write a set of words of the L2 they had studied. It turned out that the whole children scored closely, and the EG members had slightly outperformed their counterparts in conservation ability, which amounted to 4,83% (see Table 4).

| Groups | N | M | SD | P-value/ F-test |
|---|---|---|---|---|
| Experimental | 28 | 54,11 | 7,28 | 0,188 / 0,702 |
| Control | 26 | 51,62 | 6,10 | |

**Table 4** - Basic statistics for both groups in writing test.

### 4.4 Pronunciation progress

This factor is the result of dividing the reading post-test by its pre-test, it allows to measuring the extent to which children improved their pronunciation of L2 vocabulary. Table 5 illustrates that EG members who received social robot services significantly improved their speech skills compared to others, with a rate of 40,74%.

| Groups | N | M | SD | P-value/ F-test |
|---|---|---|---|---|
| Experimental | 28 | 224,28 | 117,59 | 0,206 / 0,72 |
| Control | 26 | 159,35 | 89,56 | |

**Table 5** - Pronunciation progress for both groups.

### 4.5 Learning time

It is the sum of time invested by the child to learn the L2. Table 6 shows a significant decrease in learning time recorded by EG members compared to their counterparts, with an estimated rate of -7,92 %.

Figure 2 shows graphically the effect of adopting social robot in L2 learning for children.

| Groups | N | M | SD | P-value/ F-test |
|---|---|---|---|---|
| Experimental | 28 | 55,72 | 1,33 | 0,01 / 2,52 |
| Control | 26 | 60,52 | 2,11 | |

**Table 6** - Learning time for both groups.

## 5. Discussion

Very encouraging results have been obtained, motivating the educational community to adopt robotics in language learning for children. In what follows, the authors will be discussing the study results and determine the extent to which the null hypotheses previously identified are disproved.

### 5.1 Phonetics level

The hypothesis concerning the no-effect on the pronunciation of L2 vocabulary was disproved, as the calculated factor of pronunciation, progress showed a significant improvement for the children who used the social robot. According to the authors, this advance is due to the role played by this machine to stimulate the children's mimesis aspect and helped them to reach an advanced level in the pronunciation of L2 vocabulary.

The phonetics level is consistent with the results of (Gordon & Breazeal, 2015), who proposed a Bayesian teaching robot based on actively learning children's word reading skills. This level also conforms to the work in Eun-jahyun et al. (2008), which compared the effects of a language learning program using an intelligent multimedia robot on children's language skills.

### 5.2 Retention level

The hypothesis of no effect on the ability to memorize the L2 vocabulary was also refuted because the writing test performed in this study illustrated a noticeable improvement in memorization resulted from the adoption of robotics in the learning process. This positive effect is due to the role played by these machines in attracting children's attention and urging them to focus while they are taught the L2 vocabulary. This is congruent with research conducted by (Leyzberg et al., 2012; Schodde & Kopp, 2018) wherein authors proved that the physical presence of a robot teacher increases cognitive learning gains, including memorization ability.

### 5.3 Engagement level

The hypothesis of no effect on the time invested in L2 learning was refuted, as this study recorded a significant reduction in schooling time following the adoption of a social robot. Such reduction in learning time is explained by the fact that the use of these smart devices in the learning process as a pedagogical aid improved the level of assimilation of the teaching contents by the children. This result does support the research studies carried out in Bourguet et al. (2020).

## 6. Conclusion

The present paper provided reliable results indicating that the use of social robots in children's L2 learning enhances the effectiveness of the educational process and significantly improves learning gains. As well as,

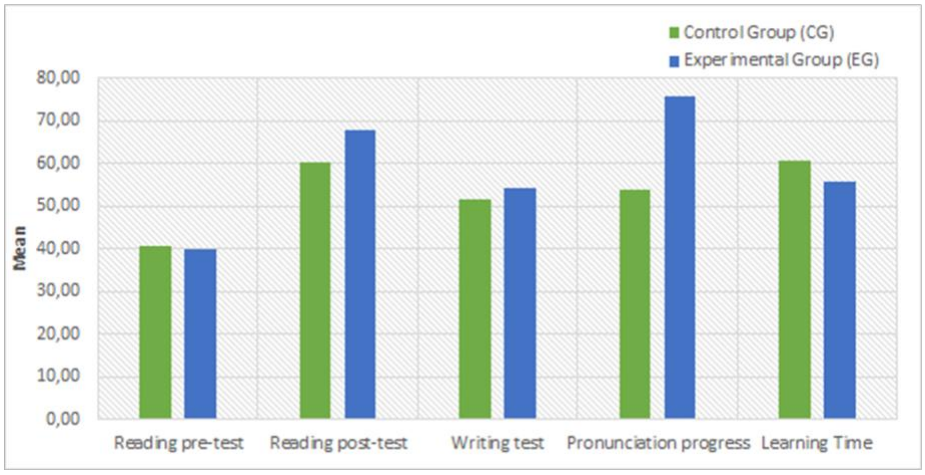


**Figure 2** - Graph of the impact of social robot on L2 learning for children

given the facilities offered by the social robot through its support for L2 learning to children, the authors are compelled to recommend it to widespread use of what it can provide in terms of quality in the learning outcomes and comfort in the schooling conditions.

The somewhat price of these smart devices can be a hurdle to their adoption in learning, especially in poorer regions of the world. To overcome this dilemma, the authors suggest urging governments to allocate budgets to provide such equipment to their public educational institutions or to solicit the help of international charitable organizations interested in the learning domain.

Finally, we can consider the social robot as a good investment, regardless of its cost, because it offers a unique educational experience that has a good impact at all levels.

As future work, we are working to apply the system of intelligent tutoring (Belazoui et al., 2021) as a foundation of social robots that provide access to information on the web automatically and offer them to children's L2 learning as additional information sources.

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# Distance Educational Links: a qualitative study on the perception of kindergarten teachers

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**Abstract**

The outbreak of novel coronavirus infection that originated in 2020 resulted in the immediate closure of all Italian school services for several months. Children who attend ECEC (Early Childhood Education and Care) services have particularly suffered from not being able to take advantage of consolidated distance learning models specifically designed for them. The main priority was to re-establish the bond between them and the teachers so that the educational path they embarked on did not disappear from their daily lives. To this end, LEADs (Distance Educational Links) have been established in Italy, a new relational modality involving children, teachers, and families, who could rely exclusively on communication through digital devices. The research presented here explored what happened during the first lockdown phase, corresponding to the start of LEADs, and during the resumption of the school in presence. The study aimed to detect and record reactions, experiences, and changes in children, families, and teachers, with attention to new pedagogical and social practices and a main focus on the unprecedented use of technology as the primary tool to maintain the bond. IT devices revealed new potential as relational and educational resources, making them indispensable during emergencies, not only for basic communication but also for recreating the setting in which bonding occurs and is built. Bonding was possible even at a distance because technology supported it. The unprecedented involvement of families as educational partners, the rethinking of teachers' roles, and close collaboration among colleagues emerged as equally significant results.

**KEYWORDS:** Educational Links, Teacher Concerns, Qualitative Analysis, Infant School, Covid 19.

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## 1. Introduction

Since the beginning of March 2020, we have fallen into a condition of extreme uncertainty and we faced unprecedented health, political and social emergencies. At the end of February 2020, in Italy all educational services were abruptly shut down. The World Health Organization (WHO) on March 11, 2020, has declared the novel coronavirus (COVID-19) outbreak a global pandemic. Since that moment, our lives have been drastically changed in every aspect, and in terms of rhythm, time, space, relationships, distances (Scarpini, 2020).

Daily life, social relations, and pedagogical-didactic practices undergone transformations that forced educators and teachers to rethink roles, settings, methodologies, and teaching and learning tools. In particular, ECEC professionals had to modify their actions entirely, without being able to rely on tested systems of e-learning and distance learning, since educational links focused on presence are the fulcrum of the educational process in kindergarten. The Covid-19 pandemic and the consequent lockdown drastically changed the world and the experiences of children, who, enclosed in their own homes, were deprived of open spaces, contact with the outside world, nature, educators, and peers. Without any warning, they experienced a detachment from a context of daily habits and practices, that exhibited the symptoms of total eradication. The closure of the services deprived children of the possibility to continue their path of growth and learning. Opportunities for development and experiences generated by playing and exercising

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movement, suddenly vanished (Deluigi, Marino, 2020). Like everyone else, children experienced intense and sudden emotions such as sadness, fear, anger, but in a phase of life during which they are invited to open up to the world and to discover.

The emergency forced teachers to redesign the educational and care approach towards children, to try to respond effectively to the emerging needs. The main priority was to guarantee the right to establish meaningful relationships with peers and adults who are expected to provide protection and safety. Children are also entitled to play, to collect concrete experiences, so bringing the physical dimension back to the center of the learning process was also a major priority. Therefore, it was required to immediately find new ways to perpetuate the missing care relationships and to resume school-family dialogue (Gigli, 2020).

To avoid the risk of prolonged deprivation, education professionals questioned how to reconnect long-distance relationships. For primary and secondary school, an approach defined as Distance Learning (DaD) was used, while for the age group from zero to six years, an untested method was established. Conceived on the lockdown, it was called Distance Educational Links (LEADs). This definition was created because the educational aspect at this age is grafted onto the emotional and motivational bond. It is therefore a primary need to re-establish and maintain a bond between teachers and children, teachers and parents, teachers among themselves, parents among themselves (Commission for Childhood Integrated System Zero-six, 2020). Criticality was immediately found around emotional ties, a central aspect of education in kindergarten. Very young children need solid points of reference, stimuli, reassurance, serenity, protection, and acceptance of their uniqueness, to allow the promotion of their potential (Ceccacci, 2020). Education professionals tried to reinvent, in a few weeks, the educational relationship, to recover the severed emotional, social, and pedagogical bond. Never has an adjustment in educational theory and practice had to be so rapid, sudden, and intense.

In every crisis lies an opportunity: the educational services may explore alternative approaches that bring schools and homes closer together, and governments can pursue quality, equity and well-being starting from the youngest citizens (Gouëdard et al. 2020).

The research I present here originated from the need to observe and monitor this epochal change. The study aimed to detect and record reactions, experiences, and changes in children, families, and teachers. We wanted to draw a map of the new pedagogical and social practices, with a particular focus on the tools used to maintain the bond. Since we cannot return to the world as it was before (International Commission on the Futures of Education, UNESCO, 2020), it was imperative to understand what was happening, in order to imagine the school of tomorrow and redesign the educational future of children, considering limits, positive aspects and possible growth opportunities.

## 2. Background

### 2. 1 ECEC services in the time of Coronavirus: the birth of LEADs

On May 6, 2020, the Commission for the Integrated System of Education and Instruction from Birth to Six, released the document Pedagogical Guidelines on Distance Education Links. A different schooling model for ECEC, based on the assumption that children's need for relationships has never failed, despite the emergency. This document aimed to stimulate educators to rediscover the value of teamwork, promote good practices for the care and education of children and strengthen the thread of relationships. The final goal pointed to maintain or reconstruct the bond made up of emotions, looks, voices, closeness, sharing, and complicity that constituted daily life before the emergency. (Commission Childhood Integrated System Zero-Six, 2020). LEADs came to life in the absence of the body, movement, embraces, in a virtual environment – an undefined space – in which bewildered teachers acted and looked for new ways of staying in touch with parents and children (ibidem) so that they would not feel alone in the absence of ordinary connection. Previously, families used to enter school bringing in their educational models, cultural roots, habits, and values. With LEADs, the school entered families and allowed parents, for the first time, to witness the relationships that teachers create with their children. Schools entered children's homes and homes entered educational services (Chieregato, 2020). LEADs required the mediation of family members, who became the sole point of reference for children, and new educational partners for teachers. A need to construct new meanings, organizational possibilities, and forms of participation emerged (Commission Infancy Integrated System Zero-sei, 2020). LEADs can be defined as a presence at a distance (*ibid.*), a contradiction that is made possible today through technological devices. With the birth of LEADs, projects were immediately activated to monitor this epochal change and the attempts made to maintain the bond through distance.

SIRD (Italian Society for Educational Research), a scientific board that associates university teachers and researchers in the field of educational research, promoted a national survey to initiate a comparison of the distance teaching methods adopted by schools and individual teachers during the lockdown period, between April and June 2020. The collected data show how the emergency required a reshaping of teaching models, involving especially preschool and elementary school professionals, through platforms, interactive

apps, virtual classrooms, and close collaboration with parents. (SIRD, 2020).

The study Children and Lockdown, the parents' word (Mantovani et al, 2020), was undertaken by the spin-off Bambini Bicocca in collaboration with the Department of Human Sciences for Education "Riccardo Massa" and the Italian Society of Pediatric Primary Care (SICuPP) of Lombardy and took place in July and August 2020. The sample examined nursery and preschool children and SmartWorking parents (Mantovani et al., 2020). The research aimed to collect data to understand the changes that occurred in the daily lives of children, to address actions of assistance, support, and multidisciplinary accompaniment (pediatric, and pedagogical) to families, during the phase of return to post-pandemic social life.

CREIF (Center for Educational Research on Children and Families of the University of Bologna), investigated ways to support families and strategies that schools set in motion to reach and support them (Chieregato, 2020). The field research was carried out in May and June 2020 and analyzed not only critical issues, but also strengths and positive aspects detected during the first phase of the emergency, aiming to trace and, subsequently, spread good educational practices based on the arose problems and needs.

Distance learning and the consequent newly shaped virtual environments pushed teachers and families to test themselves with new methods of teaching, communication, and, especially, relationships. Habits were suddenly overturned, and new priorities appeared, but also did discrepancies connected to our social and cultural system (Ardizzoni, Bolognesi, Salinaro & Scarpini, 2020). Rapidly dismay and disorientation gave way to adaptation, and attention was turned towards potential possibilities, and not only to what seemed to be lost, in a true act of resistance.

### 2. 2 From the disappearing classroom to the virtual classroom

The contemporary world, characterized by both real and virtual dimensions, witnesses the introduction of technological tools and electronic communication in every aspect of life. Technology has not only an informative or entertainment function, but it's a tool that modifies and shapes reality. The field of education is also pervaded by its influence and there's a rising wave of questions about epistemological approaches and psycho-pedagogical models involving it, investigating how an educational use of technologies and multimedia can contribute to the achieving of a pluralistic and inclusive education (Maragliano, 2019). Recently, research on the role, risks, and potential uses of digital media in early childhood has augmented, aiming to explore how children's environments have become increasingly permeated by digital technology (Knauf, 2016). The focus has been on how relationships among children, families, and educators, in preschool settings viewed as micro-communities of practice, transform, and evolve with the introduction of technological devices. These studies highlight how the virtual expands the space of the real classroom. it is in the classroom that students meet, talk to each other, accomplish tasks, give presentations, play, read, listen, sing, talk, and eat snacks together. Online tools extend this space into the virtual sphere, but the classroom remains the reference point in the real and in virtual life (ibidem).

The effect of the pandemic was to completely disrupt this perspective, making the classroom a non-existent place for several months, with the virtual space being the only reality left. The classroom, a physical place, setting, and established microcosm, disappeared overnight, and with it an entire emotional, relational world vanished. In experiencing a place, we do not just occupy a physical space, but we attribute meanings to it, often affective and emotional ones. We organize the place and share it with others (Ceppi & Zini, 1998), so what has been lost with the pandemic is an entire universe of meanings. Children's daily lives were disrupted, and a cohabited universe disappeared without warning overnight. They found themselves living in homes with very different spaces, equipped with resources that weren't always entirely adequate. (Deluigi & Marino, 2020). Before the pandemic, research focused on the use of technology to support family engagement, to suggest ways to engage the family more, and then to model learning in the classroom (Zywica, 2016). With the arrival of the pandemic, the use of technologies was rethought in real-time to adapt them to the new emergencies, confirming, albeit, in a critical context, that school is, potentially, the greatest generator of demand for innovation, and therefore for digital evolution (PNSD, 2018).

## 3. Theorical Framework

Childcare services for children from zero to six years of age are the first place of encounter with others outside the family. It is in this context that relationships with peers based on shared experiences and dialogue begin to be built and the sense of belonging to a community grows. The relational aspect always plays a crucial role: the center of any educational process is the human relationship between a student and a teacher (International Commission on the Futures of Education. UNESCO 2020). The teacher is at the same time a guide and a facilitator of learning in a continuous spiral process of co-construction of knowledge (Edwards, 2017), in which the teacher stimulates the thinking that comes from doing, supporting the formation of a meta-reflective and critical thinking, and teaching not only to learn but also to understand (Zecca, 2012). The teacher is a mediator on the didactic and affective-relational

level and creates a positive climate, acceptance, and a context in which differences are valued so that everyone can express themselves freely (Nigris et al, 2016), and meaningful learning takes place. An educational event is first of all a relational event that cannot be investigated outside the complexity of the relationship itself. For this reason, social relations are considered a fundamental element that contributes to the creation of cooperative contexts and widespread confrontation (MIUR, 2012). A positively rich relational climate allows the child to develop greater self-confidence and resistance to frustrating and tiring situations, leading him to observe, listen, explore the outside world and, consequently, acquire and construct meanings (Mantovani, 2004).

The educational alliance between school and families, which focuses on trust and exchange and makes it possible to grow together, is at the heart of the pedagogical reflection. A close relationship between the two contexts, focused on the child's wellbeing, consents to get to know the specificities of each family's reality. In the educational context, family refers not only to parents but also to grandparents, babysitters, and all the adult figures who support them. Studying the child involves at the same time studying the adult in relation to the child: the relational dimension, therefore, emerges as a central and crucial object of investigation.

With the sudden discontinuation of school attendance, the school-child-family bond has been profoundly transformed and has been relegated entirely to the contribution of technology as a relational tool that is not accessory, but fundamental, generating new study themes to be explored.

## 4. The research

Once LEADs were established, observing and analyzing how the relationship between educational services, children and families was being recalibrated become a priority, especially in the light of mandatory use of technologies as the only possible connection.

The research entitled LEADs at pre-school was therefore initiated and carried out in two phases, the first took place from March to May 2020 and the second in January 2021. The survey involved teachers of pre-schools in the Lombardy region of Italy.

The research was a qualitative field study, focusing on changes in the relationship between children, families, and teachers, aiming to understand what had happened to this relationship during the period of closure of the educational services.

At first, the main objective was to understand how the schools had reacted to the unexpected closure. We were interested in how they acted to maintain the educational bond with the children and their parents, reshaping the educational project and introducing the use of technological tools. At the same time, we explore the experiences of those involved, to understand the strategies implemented to reach all the children, especially the most fragile ones, to maintain continuity, frequency, and quality of the relationship.

In a second moment, with the resumption of the activities in presence, we wanted to observe how the relationship had been rethought in the light of this

experience. We investigated the reorganization of the services and how the professional role of the teacher had been recalibrated. Critical issues, strengths, and positive aspects were analyzed, as well as possible opportunities for growth. The research was participatory and shared by the teachers, who personally felt the urgency of answering new questions and seeking solutions.

## 5. Research method and tools

The research methodology adopted was a quality approach. We gathered data through the conduction of

THEMATIC CATEGORIES

| Phase 1 | Phase 2 |
|---|---|
| ○ Strategies activated by teachers at the beginning of the pandemic<br>○ Critical issues that emerged during lockdown<br>○ Teachers' emotional experience in the first phase of the lockdown<br>○ Perception of the emotional experience of parents and children<br>○ Positive participation of families in the attempt before and during the first weeks of LEADs<br>○ Collaboration between teachers<br>○ Children's feedback and documentation<br>○ Evaluation and self-assessment | ○ Teachers' emotional experience at the beginning of the pandemic and its evolution during LEADs<br>○ Teachers' difficulties with new communication modes<br>○ Evolution of strategies and choices activated during LEADs<br>○ Criticism of LEADs<br>○ Teachers' reasons for low family participation in LEADs<br>○ Positive participation in LEADs<br>○ Reaction to LEADs by children with BES<br>○ Collaboration between teachers during the lockdown and at the resumption of in-presence activities<br>○ Difficulties in teachers' use of technology and preparation of digital materials |

**Table 1** - Categories emerged from the first phase and used to organise the focus groups during the second phase.

focus groups, an effective method to obtain feedback, to elaborate qualitative results, to give rise to research hypotheses, to transpose complex information regarding the motivations, habits, experiences, knowledge, and expectations of a target, and to probe in-depth specific themes (Stuart & Shamdasani 2014) in numerous fields of social research. The focus group technique provides in-depth information in a relatively short period of time. It represents a useful method to explore in-depth opinions, attitudes, or behaviors of a certain community and to investigate the attitudes underlying human thought and behavior (Trinchero, 2004).

The data collected were analyzed using phenomenological approach, leading to interpretative results.

The focus groups were formed by a group of preschool teachers located in the Lombardy region, who collaborate with the traineeship office of the degree course in Primary Education Sciences at the University of Milan-Bicocca.

Educators with similar experience, position, and background were selected: 18 teachers and two headteachers belonging to 18 schools for the first phase, 11 teachers belonging to the same school complex for the second phase. The socio-cultural and economic situation of the reference area is homogeneous and has a similar demographic distribution of users. All the teachers were selected as privileged witnesses of this research because of their more than ten years of experience, together with their considerable expertise in the field of education for three to six-year-olds.

The research project was designed to explore two distinct moments of the pandemic emergency.

### 5.1 The first phase of the research

The first phase of the research took place between March and May 2020, the period corresponding to the first Italian lockdown, and involved 18 teachers and two headteachers from 18 schools (state and charters, both municipal and managed by private companies). We held 3 focus groups. In this phase of the research, a monitoring assessment was carried out based on an open narrative of the teacher's experience, focusing on the practices they were implementing. Therefore, a precise outline with structured questions was not defined. These 3 focus groups promoted a reflection on the experience at the heart of the pandemic, i.e., before the Ministry issued the LEAD document on May 6, 2020.

### 5.2 The second phase of the research

The second phase of the research took place in January 2021, the month corresponding to the resumption of in-presence activities and involved 11 teachers from the kindergartens of Fino Mornasco (Como), engaged in two focus groups. This second phase was designed to monitor the evolution of topics and issues that emerged during the first survey, in the light of teaching activities resumed and the LEADs document. It was a qualitative study focused on the theme of educational links at a distance, to reveal all its facets in detail.

### 5.3 Procedure and data collection

All focus groups, in both research phases, took place on the Google Meet platform, according to recent restrictions due to the containment measures of Covid-19 infection. The online meetings were recorded to keep track of the verbal exchanges. They were then fully transcribed following the ethical regulations for social research and analyzed using Atlas.it software, to carry out a qualitative thematic analysis (Kuckartz, 2014). Data were organized in thematic macro-categories, used to categorize the results at the end of the first phase and also as a targeted outline to sort out the second phase of research.

Tables were then created to collect data, divided into four columns, containing: the name of the teacher, in the transcription of the focus, one the short answers, and, in the last one, the corresponding category.

In the second phase of the project, to deepen optimally the theme of LEADs and to receive complex information about motivations, habits, experiences, knowledge, and expectations of the target, an outline was elaborated in the form of three open questions. It was used during the interviews and re-modulated to adapt the explorations to the discussion in progress, to probe in-depth some specific themes.

Below are the three questions proposed during the focus groups of the second phase of the research:

- Thinking about Distance Educational Links (LEADs) and your professional experience during the lockdown, what are the first words that come to mind? Everyone can write them down and then we will talk about it.
- Considering that the screen puts a distance with our interlocutor, what strategies have you put in place to maintain the bond between teacher and child?
- Were you able to reach all the children? Can we explore this issue further?

## 6. Results

The crucial goal of LEADs, which was highlighted several times by all the teachers participating in the focus groups and which agrees with conclusions stated in the research *Children and lockdown* (Mantovani et al., 2020), was to recreate the emotional bond with the children and re-establish relationships that had suddenly been broken. The compromised rapport

represented the major criticality, underlined by the need and urgency to reach all the children. Many difficulties, also due to the digital divide and absenteeism due to conditions of socio-economic and cultural disadvantage exacerbated by the emergency, were reported.

In both phases of the research, all the teachers found themselves having to redesign their educational paths promptly, to reach children quickly, trying not to exclude anyone, through digital technologies. In addition to analysing the difficulties experienced by the teachers and the concerns about coming back in presence, the survey examined the quality of the experiences pointing out strengths.

The data collected show that one of the main difficulties was the required use of technology. Even though digital skills are included in the European Parliament's Recommendation 2018, as the key to using technology with familiarity and critical thinking, most teachers in ECEC services have never before received adequate training in digital skills. Teachers reconsidered digital tools as indispensable for the maintenance of the educational relationship. That involved a complete change of perspective. In fact, until then, they considered technology and digital devices as unusable with such young children. The initial disorientation was replaced by an adaptation and educators looked at the potential of this critical opportunity.

The strategies used evolved based on the feedback the teachers were able to capture from parents and through careful observation of the children. All the teachers stated that one of the aspects most affected was the relationship between peers, which was difficult to enjoy through a screen at such young age. The little ones forced in front of screens exhibited the need to restore the dimension of the body and movement through dedicated activities, as well as the necessity to play.

Another aspect raised by this research was the importance of facilitating the inclusion of all children without distinction. In both phases, the development of specific modes of intervention for children with special needs stimulated their participation and contributed to the emergence of skills never observed before. All the teachers stated that they found great co-responsibility on the part of the families, especially in the cases of children with special needs, as similarly stated in the SIRD research (SIRD, 2020).

All the teachers participating in the research wanted to highlight the extraordinary collaboration experienced among themselves. The mutual confrontation and the network created between the different educational realities were crucial not only for the success of the planned activities but, above all, for the encouragement during those challenging times. This is also fully confirmed by the SIRD research, in which an extremely positive relationship between colleagues and management was highlighted.

## 7. Discussion and conclusions

Tragically, the pandemic has provided an opportunity for researchers, teachers, family members, as well as students at all levels of education, to rediscover a familiar aspect of technology in the light of newly emerging educational needs: its versatility as a relational tool. It could be a bridge to ensure the continuity of ties in the educational context. We witnessed a sudden acceleration that was also a transformation. An unprecedented task emerged within the relational dynamics in the educational field: that of maintaining the relationship, to prevent the bond from evaporating. Before the pandemic,

ECEC teachers perceived technologies as a social and information tool (school blogs, chats) unrelated to teaching, relegating any e-learning use to the school of children aged 6 and over. After the first lockdown, they discovered the educational value of digital tools, perceived as the glue of the relationship during the emergency, considering them indispensable for teaching and learning even for the youngest children. The virtual class becomes the only possible scenario for maintaining the bond with children. Before the pandemic, this was unthinkable, because in ECEC everything was delegated to the in-presence relationship that absorbed all the relational, emotional, and communication needs. For the early childhood services, a horizon of didactic and educational possibilities has opened up that had never been imagined before.

We are aware that this was an emergency teaching method since no technological tool can replace the educational relationship and physical interaction in the presence, especially because of the lack of the bodily dimension, a fundamental vehicle for relationships. (Foti, 2020). Computers or cellular devices cannot constitute a substitute for a professional kindergarten teacher who provides meaningful mediation in the kindergarten, which is mediation for verbal and emotional meaning through movement and guided activity. The virtual space cannot take the place of the kindergarten space, which is tailored to the children's age and enables a tangible and real experience. Nevertheless, we are required to be prepared for extreme situations (Alezra, 2020).

However, teachers have experienced how technologies and computer devices represent additional possibilities and new models of interaction that can be included in the communication with families and used to expand the relationship with children beyond the emergency. The link was possible even at a distance, the technology supported it. This awareness and the potential it represents are one of the most interesting results of this study. In this regard, the need to ensure the inclusion of all children has also shed light on the main limitation of this resource, represented by the unequal accessibility,

highlighting the risk of exclusion caused by the digital divide, which has become dramatically relevant.

As far as younger children are concerned, we have witnessed an unprecedented call to arms: families have become essential partners during the lockdown. They had to take an active role in helping their children. They became indispensable intermediaries in the virtual extension project since children could not be delegated the responsibility of response and participation, as was the case for students in higher orders. Such active participation of the families led to exchanges of information but, above all, to support also on a psychological and emotional level. The family discovered itself to be an important part of the learning setting.

The positive participation especially of pupils with special needs, who have benefited from the situation of reduced social noise finding a space in which they can emerge and make their voices heard, opens up new scenarios to expand the possibilities of ever more careful inclusion, which we hope will be explored.

The dimension of confrontation and collaboration between teachers, which was crucial during the crisis, has imposed itself as a new standard, creating a need to increase dialogue and boost teamwork, which cannot be ignored in the future, and which must become a theme for rethinking the way we experience reciprocity between colleagues.

School is a vibrant center of social development that encourages people to see education as a resource in life. Sharing is the basis of a common path for families, pupils, and teachers. School is the contest where we can find the strength to deal with the problems related to the pandemic, to bring back to the center of attention the importance of relationships (Mazzeo, 2020).

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# The impact of e-Learning during COVID-19 on teaching daily living skills for children with disabilities

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**Abstract**

The aim of this descriptive research was to identify the impact of e-learning during the COVID-19 pandemic in teaching daily living skills (DLSs) for children with disabilities (CDs). The sample consisted of 84 CDs enrolled at the Arab Village Center for Special Challenges in Jordan. The DLSs scale developed to assess living skills consisted of 40 items representing three subdomains: personal skills, home activity skills, and environmental-societal skills. Due to the COVID-19 pandemic, the scale, in the form of a questionnaire, was hosted on Google Drive and sent to parents of CDs by WhatsApp. The results indicated that the impact of e-learning in teaching DLSs for CDs was low. Additionally, the results also indicated that there were no significant differences due to gender, age, nationality, and type of disability. Accordingly, as a result of the research, the investigator recommends activating e-learning methods in Jordanian special education institutions and conducting e-learning-based workshops for employees in these institutions.

**KEYWORDS:** E-Learning, COVID-19, Children with Disabilities, Daily Living Skills.

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## 1. Introduction

The 21st century has witnessed political and economic transformations, cognitive and technological developments that force the individual to reconsider his/her own knowledge and acquired skills. Educational institutions today are required to respond to these transformations that engendered qualitative and quantitative changeover in human knowledge and technological revolution in information and communications technology. The world still witnesses the repercussions of a new industrial revolution, which has been called the "fourth industrial revolution." This digital revolution makes technology viable for diverse aspects of life. The revolution now has become one of the challenges that should be confronted by a change in educational systems, including technological preparation and empowerment programs for teachers and learners that contribute to building generations who are able to keep up with the latest developments (El-Dahshan, 2020). Accordingly, the astonishing technological progress in information and communication caused by this revolution may be positively reflected in education systems. Digital learning, artificial intelligence, augmented reality, and the Internet are among the requirements of fourth industrial revolution. Thus, a teacher in the Arab world needs to change his/her role from a traditional teacher to a more skillful teacher who is keen on using and employing technology in new ways. This conversion requires bringing about a radical change in pre-service and in-service teachers' preparation programs by creating academic programs and college courses that meet the requirements of the fourth industrial revolution.

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If this technological and industrial revolution has occasioned radical changes in different life aspects, educational institutions must be more flexible and responsive to the transformations; that is, higher education outcomes are inputs of different life sectors and the labor market. Educational theorists believe that it is possible to benefit from information and communication technology (ICT) in improving the educational process. Through it, the quality of interactions between learners and different sources of knowledge can be improved. ICT is a cornerstone of the 21st-century skills that have now become the most outstanding feature of general and higher education institutions worldwide. Hence, these institutions must include ICT in learning and teaching to prepare a generation armed with knowledge and the ability to deal with the language of the technological age and digital culture. This may contribute to generating structural changes in the individual's life and styles due to the information and technology revolution (Combi, 2016). Therefore, the educational institutions must amend their educational policies by developing contemporary methods for employing ICT based on practices and comprehensive reforms to curricula, and teaching strategies (Al-Khatib, 2009). Therefore, this adjustment in educational policies will help design a technology-based curriculum that improves students' higher-order thinking skills (Appavoo, 2020).

Education is one of the sectors affected by ICT. educational leaders seek to provide an interesting learning environment for students through the use of computers, the Internet, and other multimedia in the educational process. Therefore, it is assumed that educational institutions provide educational environments and instructional strategies such as e-learning (Thorpe & Godwin, 2006).

E-learning is based on employing electronic media in the process of communication between the teacher and the learner, on the one hand, and between the learners and the educational institution to which they belong, on the other hand. E-learning is based on employing computers and the Internet in the educational process at general and private educational institutions (Keržič, 2018), so that mediation takes place between the teacher and the learner in order to activate the learner's role in the educational process. Also, e-learning is a set of educational strategies and methods based on hypermedia as a technology-supported learning system that facilitates access to learners anywhere and anytime via the Internet. E-learning uses multimedia, electronic libraries, and electronic learning platforms that support and enhance the educational process. The use of technology in educational institutions has contributed to changes in teaching methods. Instead of an educator who uses traditional teaching methods, the learner has become the center of the educational process (Shabani et al., 2020).

E-learning depends on a set of methods: synchronous learning, in which a teacher interacts with learners distantly, through e-learning platforms and virtual classrooms at different sites, and asynchronous learning, in which the teacher interacts with learners via recorded lectures, e-mails, Internet sites, and instructional media (Duncan et al., 2012; Spiceland & Hawkins, 2002; Zingaro & Oztok, 2012). E-learning may also be blended, which combines direct, traditional, classroom teaching and synchronous and asynchronous e-learning (Kaur, 2013).

Due to the increasing percentage of CDs, and the subsequent need for the best services to be offered to them, there is an urgent need to use technology-supported learning in special education classrooms, as well as to identify the effectiveness of e-interventions for these children (Knight et al., 2015). To substantiate the effectiveness of these e-interventions, special education teachers should autonomously strive to acquire and employ the necessary technological skills; that is, these programs, like others, must respond to the priorities of the technological revolution and to 21st-century knowledge and skills (Al-Zoubi, 2019). E-learning can lead to many benefits for CDs, as it helps them complete various tasks in addition to increasing independence and reducing dependence on others (Cihak et al., 2008; Riffel et al., 2005).

E-learning enhances the inclusion of CDs. Online educational and training lessons can provide interactive opportunities for CDs who face health and physical disabilities that prevent them from attending classes in special education centers (Debenham, 2002; Di Iorio et al., 2006). In this regard, the effective use of technology may help enhance DLSs of CDs, increase their chances of integration into society (Soderstrom, 2011), and provide an acceptable level of competency for tasks that may be inaccessible without these technologies (Gilette & Depompei, 2008).

CDs are likely to acquire independent, personal, and academic skills if they are given opportunities to learn and apply them (Westling et al., 2014), and it must not be forgotten that CDs face disorders in psychological processes that may contribute to preventing them from acquiring DLSs and independent behavior (Hume et al., 2014). These children may face social difficulties and psychological and emotional problems that lead to a decrease in their adaptive behavior and cognitive skills (Kraper et al., 2017), so the adaptive life skills assessment process is important for CDs and their families to develop training and treatment programs and to access funding resources for such programs (Temple et al., 2013).

Curricula and methods of teaching CDs are important topics for teacher training. They must address motor skills (gross and fine motor skills); language skills that include receptive and expressive language; and academic, vocational, and social skills (Al-Khatib et al., 2018). Independent skills must also be addressed, and

they include self-skills and DLSs (Al-Khatib & Al-Hadidi, 2020; Al-Rousan et al., 2015).

DLSs contribute to the lives of CDs because they shape their behaviors and help them to carry out their various social roles. These skills hold a special place for CDs who have a disability in one or more aspects of human development. That is why we find that life skills represent the cornerstone of curricula and education for children with intellectual disability; that is, they are the basis for other forms of skills, such as academic, social, professional, and motor skills. Additionally, teaching CDs and getting them to acquire DLSs will help in their adaptation to different life requirements and situations. In other words, CDs need organized foundations to maintain an acceptable level of health and adaptive performance that enables the child to perform these skills independently, and this is one of the basic considerations in supporting children with developmental and other disabilities (Stabel, 2013).

DLSs comprise a wide spectrum of personal care activities that take place through home, school, and community institutions for CDs (Burns el al., 2019). CDs often face problems in learning daily and professional life skills that allow them to live and work more independently (Carothers & Taylor, 2008), and DLSs include activities related to personal hygiene, self-care, wearing and dressing, eating, commuting, walking around, using the toilet, home safety, and housekeeping (Stabel, 2013).

DLSs for CDs can be taught using behavior modification methods based on behavioral analysis, skills analysis, shaping, chaining, and positive reinforcement (Neidert et al., 2010). Interventions using repetition, simulation, role-playing, community education, and prompting are effective methods of teaching DLSs (Landon-Hays et al., 2006). The major point that should be considered during the implementation of behavior modification strategies is the role of basic academic skills in shaping DLSs (Obiakor & Bakken, 2019; Purcell & Taber-Doughty, 2018). Other researchers go beyond the effectiveness of academic skills to highlight the effects of language communication on improving the DLSs of these children (Gargiulo & Bourck, 2019). Through the development of verbal and nonverbal language communication skills, CDs can be provided with DLSs (Tabacaru, 2016). However, other researchers have highlighted the role of motor skills in providing CDs with DLSs (Obiakor & Bakken, 2019). The development of general and fine motor skills encourages CDs to engage in a variety of behaviors such as playing and recreational activities, personal hygiene, and other DLSs (Obiakor & Bakken, 2019). Still other researchers believe that adaptive social skills effectively contribute to improving DLSs of CDs and positive behavioral aspects (Behroz-Sarcheshmeh et al., 2017). Adaptive social skills teach CDs positive behaviors such as self-control, persistence, and problem-solving techniques (Purcell & Taber-Doughty, 2018).

Regardless of the deficits of CDs, attention must be paid to developing DLSs in the early stages of childhood. The acquisition and teaching of these skills are accompanied by the activation of academic, social, linguistic, and motor skills. In other words, it is preferable not to teach DLSs as separate from other skills. For this, DLSs are one of the areas of adaptive jobs, which are composed of skills important for independent living and employment. The acquiring, maintaining, and generalizing of DLSs helps in reducing dependence on others and promotes quality of life for CDs (Bal et al., 2015). Although improvement can accrue to CDs with advancing age, the majority of them suffer from difficulties and challenges in performing DLSs (Hong et al., 2015), and many of them show significant weakness in this area. Nevertheless, these skills remain the basis compared to other communication and socialization skills (Fabrizio & Bamond, 2008). The ability to master DLSs is a critical outcome for CDs as they move into adulthood, during which time they move from acquiring DLSs to mastering other life skills (Hallahan et al., 2014).

Developing DLSs is a significant therapeutic priority for CDs (Matson et al., 2009). DLSs are essential to enhance personal independence that reduces learned helplessness. Over the past four decades, attention has been directed to developing effective educational strategies to teach DLSs to children with developmental disabilities (Westling et al., 2014). In this regard, Kilincaslan et al. (2019) showed that CDs have difficulty mastering DLSs.

Jordanian institutions and centers of special education seek to provide the best opportunities of learning for CDs through programs that aim at providing the maximum level of self-efficiency for them, which contributes to their inclusion in the various sectors of society. The level of these centers and institutions' use of ICT in the process of teaching CDs may vary. There may be variant views among those who are in charge of these institutions and centers on the most effective teaching methods and strategies. One group may see that traditional teaching methods and strategies are best in teaching DLSs, while another group may believe that it is possible to use e-learning methods as an alternative type of teaching. Perhaps one thing we have learned from the COVID-19 pandemic is the validity of online engagement, which would argue in favor of those who advocate the employment of e-learning in special education programs.

In fact, the COVID-19 pandemic has exceeded the barriers of place and time due to its rapid spread, which has negatively affected general education systems in various countries. This pandemic forced Arab educational systems to use e-learning methods in teaching CDs (Al-Zoubi & Bakkar, 2021). As a result, the Jordan suspended studies in general and higher education institutions. Thus, Jordan began implementing e-learning methods to ensure the continuity of instruction in its educational institutions.

This approach toward e-learning may pose a problem for Jordanian institutions and centers of special education that apply traditional instruction methods with CDs, because the nature, type, and severity of disability may compel such providers to resort to traditional methods. Despite the challenges that Jordanian institutions and centers of special education may face, the trend points toward e-learning, which may provide strategies for teaching CDs through new educational methods such as audiovisual materials, illustrations, and attractive virtual electronic channels.

Therefore, e-learning during COVID-19 pandemic may improve DLSs for CDs. Perhaps the education process in Jordanian special education institutions and centers will shift from the traditional method based on indoctrination to an interactive style accompanied by audiovisual and tactile effects that contributes to teaching independent for CDs. On the other hand, Jordanian special education centers and institutions' tendency to adopt e-learning during COVID-19 pandemic may have negative impacts on teaching DLSs for CDs. Most CDs during COVID-19 have been denied face-to-face or direct instruction that relies on individual and small group instruction. In other words, CDs need the special education services provided to them by schools, civil society organizations and service providers, which have been reduced due to the restrictions of this pandemic (Fontanesi et al., 2020). The online schooling and video conferencing may not be appropriate for some categories of CDs (Aishworiya & Kang, 2021). CDs have experienced a decline in their academic achievement during this pandemic (Whitley et al., 2021).

The current research seeks to identify the impact of e-learning on teaching DLSs to CDs. This research identified e-learning methods implemented during the COVID-19 in the Arab Village Center for Special Challenges in Jordan. This center provides special education services for children with intellectual and physical disabilities and autism from Jordan and some Arab countries. These services were provided face-to-face and direct teaching. This method is used in teaching CDs in Jordanian residential institutions. But during the pandemic outbreak, this center stopped direct teaching and returned CDs to their families. Therefore, Arab Village Center for Special Challenges has resorted to using synchronous and asynchronous e-learning methods in order to continue providing special education services for CDs. In other words, this center used virtual classes, Moodle, Edmodo, and social media with CDs and their families during outbreak of this pandemic.

## 2. Materials and Methods

### 2.1 Research Design

The descriptive case study was used in the current research (Mills et al., 2010). The case study is one of the types of correlational studies in descriptive research. The case study approach is concerned with studying the case of an individual, group, or institution by collecting information about the current situation and previous situations in an in-depth manner (Crowe et al., 2011). In other words, the case study is one form of evaluation research through the diversity of information and comprehensiveness of treatment.

### 2.2 Participants

The research population consisted of 91 CDs enrolled in the Arab Village Center for Special Challenges in Jordan for the 2019/2020 academic year. Of the overall population, which represented a convenience sampling approach, 84 CDs were selected as study participants, confirmed by their parents' response to an online instrument.

### 2.3 Instrument

The DLSs scale for CDs was developed after reviewing the theoretical literature and previous studies (Hill et al., 2017; Pepperdine & McCrimmon, 2018; Sparrow et al., 2016; Wu et al., 2016; Wynkoop et al., 2018). A draft version of the scale consisted of 43 items distributed into three subdomains related to personal skills, home activities skills, and societal-environmental skills. To verify the face validity of the scale, it was submitted to five referees from the college of education at Sultan Qaboos University. Based on referees' comments, the final version of the scale consisted of 40 items distributed into three subdomains: personal skills (14), home activities (13), and societal-environmental skills (13). To verify the reliability of the scale, it was administered to a pilot sample of 35 CDs enrolled in one of the Jordanian special education centers. The reliability was verified using an internal consistency coefficient (Cronbach's alpha). The values of the reliability coefficients for each subdomain were as follows: personal skills (0.77), home activities skills (0.75), and societal-environmental skills (0.73). The scale uses a 4-point Likert scale (always, often, sometimes, and rarely). To explore the level of e-learning's contribution toward teaching DLSs for the CDs, three levels (high, average, and low) were determined, with the ranges of 1–1.99, 2–2.99, and 3–4, respectively.

### 2.4 Procedures

- Official approvals were obtained to conduct this research.
- The questionnaire was hosted on Google Drive, with an invitation distributed to parents through WhatsApp, in cooperation with the Arab Village Center for Special Challenges.
- Parents were asked to respond to the questionnaire in accordance with the instructions.

- The time period for data collection was 21 days.
- SPSS (version 21.0) was used to analyze data, which included means, standard deviations, independent t-test, and one-way analysis of variance (ANOVA).

## 3. Results

*The first question*: What is the impact of e-learning on teaching DLSs for CDs during the COVID-19 pandemic? To answer this question, means, standard deviations, and the level of contribution were extracted according to the scale subdomains. Table 1 illustrates this. Table 1 shows that means of the impact of e-learning on teaching DLSs for CDs were low on each subdomain of the scale. Personal skills came first, home activities skills came second, and societal-environmental skills came third.

| Subdomain | Mean | SD | Level |
|---|---|---|---|
| Personal skills | 1.69 | .331 | Low |
| Home activities skills | 1.44 | .212 | Low |
| Societal-environmental skills | 1.40 | .288 | Low |

**Table 1** - Means and Standard Deviations according to subdomains.

*The second question*: Does the impact of e-learning in teaching DLSs for CDs differ due to gender?. Means and standard deviations were calculated, and a t-test was used according to the subdomains. Table 2 illustrates these results.

Table 2 shows that there were no significant differences in the level of the impact of e-learning on teaching DLSs for CDs according to gender for all subdomains, such that df (82) = (-0.836, -0.142, and -0.677), and P = (0.406, 0.888, and 0.500), respectively.

*The third question*: Does the impact of e-learning in teaching DLSs for CDs differ due to the type of disability?. Means and standard deviations were calculated, and univariate analysis was used according to the subdomains. Table 3 illustrates these results. shows that there were apparent differences in the DLSs according to the type of disability in terms of the subdomains. To uncover the significance of these differences, an ANOVA was used. Table 4 demonstrates these results. Table 4 shows that there were no significant differences in the DLSs due to the type of disability.

| Subdomain | Gender | N | Mean | SD | T | Sig. |
|---|---|---|---|---|---|---|
| Personal skills | M | 51 | 1.67 | .342 | -.836 | .406 |
| | F | 33 | 1.73 | .314 | | |
| Home activities skills | M | 51 | 1.40 | .298 | -.142 | .888 |
| | F | 33 | 1.41 | .277 | | |
| Societal-environmental skills | M | 51 | 1.43 | .249 | -.677 | .500 |
| | F | 33 | 1.46 | .137 | -.836 | .406 |

**Table 2** - T-test results according to gender.

| Subdomain | Disability | N | Mean | SD |
|---|---|---|---|---|
| Personal skills | Intellectual | 37 | 1.67 | .332 |
| | Autism | 23 | 1.69 | .362 |
| | Physical | 24 | 1.74 | .307 |
| Home activities skills | Intellectual | 37 | 1.41 | .305 |
| | Autism | 23 | 1.40 | .287 |
| | Physical | 24 | 1.38 | .273 |
| Societal-environmental skills | Intellectual | 37 | 1.40 | .262 |
| | Autism | 23 | 1.51 | .171 |
| | Physical | 24 | 1.43 | .141 |

**Table 3** - Means and Standard Deviations according to the type of disability.

| Subdomain | Resource of Variance | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| Personal skills | Between groups | .070 | 2 | .035 | .313 | .732 |
| | Within groups | 9.043 | 81 | .112 | | |
| | Total | 9.113 | 83 | | | |
| Home activities skills | Between groups | .014 | 2 | .007 | .079 | .924 |
| | Within groups | 6.911 | 81 | .085 | | |
| | Total | 6.924 | 83 | | | |
| Societal-environmental skills | Between groups | .152 | 2 | .076 | 1.724 | .185 |
| | Within groups | 3.580 | 81 | .044 | | |
| | Total | 3.732 | 83 | | | |

**Table 4** - ANOVA Results According to the Type of Disability.

*The fourth question*: Does the impact of e-learning in teaching DLSs for CDs differ due to age?. Means, standard deviations, and t-test were used. Table 5 illustrates these results. Table 5 shows that there were no significant differences in the level of the impact of e-learning on teaching DLSs for CDs according to age.

*The fifth question*: Does the impact of e-learning in teaching DLSs for CDs differ due to the nationality?. Means and standard deviations were calculated. Table 6 illustrates these results. Table 6 shows that there were apparent differences in the DLSs according to the nationality in terms of the subdomains. To discover the significance of these differences, an ANOVA was used. Table 7 demonstrates these results. Table 7 shows that there were no significant differences in the DLSs due to the nationality.

| Subdomain | Age | N | Mean | SD | T | Sig. |
|---|---|---|---|---|---|---|
| Personal skills | 5-9 | 48 | 1.68 | .336 | -.366 | .715 |
| | 10-14 | 36 | 1.71 | .328 | | |
| Home activities skills | 5-9 | 48 | 1.40 | .295 | .084 | .933 |
| | 10-14 | 36 | 1.40 | .283 | | |
| Societal-environmental skills | 5-9 | 48 | 1.43 | .248 | -.352 | .726 |
| | 10-14 | 36 | 1.45 | .153 | | |

**Table 5** - T-test Results According to Age.

| Subdomain | Nationality | N | Mean | SD |
|---|---|---|---|---|
| Personal skills | Jordanian | 19 | 1.60 | .383 |
| | Saudi Arabian | 27 | 1.72 | .296 |
| | Libyan | 17 | 1.67 | .339 |
| | Kuwaiti | 21 | 1.77 | .316 |
| Home activities skills | Jordanian | 19 | 1.42 | .337 |
| | Saudi Arabian | 27 | 1.39 | .280 |
| | Libyan | 17 | 1.40 | .269 |
| | Kuwaiti | 21 | 1.40 | .287 |
| Societal-environmental skills | Jordanian | 19 | 1.40 | .277 |
| | Saudi Arabian | 27 | 1.44 | .232 |
| | Libyan | 17 | 1.48 | .175 |
| | Kuwaiti | 21 | 1.44 | .141 |

**Table 6** - Means and Standard Deviations According to Nationality.

| Subdomain | Resource of Variance | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| Personal skills | Between groups | .320 | 2 | .107 | .969 | .412 |
| | Within groups | 8.793 | 81 | .110 | | |
| | Total | 9.113 | 83 | | | |
| Home activities skills | Between groups | .012 | 2 | .004 | .045 | .987 |
| | Within groups | 6.913 | 81 | .086 | | |
| | Total | 6.924 | 83 | | | |
| Societal-environmental skills | Between groups | .057 | 2 | .019 | .411 | .745 |
| | Within groups | 3.675 | 81 | .046 | | |
| | Total | 3.732 | 83 | | | |

**Table 7** - ANOVA Results According Nationality.

## 4. Discussion

The results revealed a low level of impact of e-learning in teaching DLSs to CDs during the COVID-19 pandemic from parents' perspective. In other words, the e-learning methods used by the Arab Village Center did not contribute to the teaching and acquisition of personal skills, home activities skills, and societal-environmental skills. The results also showed that there is no statistic due to the nominal variables included in the current research. Perhaps the spread of the COVID-19 pandemic revealed the lack of readiness of Jordanian special education institutions and centers to use e-learning methods in the educational process. This may lead us to acknowledge the inability of special education institutions to keep up with the requirements of the fourth industrial revolution, which is negatively reflected in empowering CDs to meet its requirements and ramifications.

The results of the current research shed light on electronic professional development programs for special education teachers by making use of international expertise and experiences. Electronic professional development is considered a lifelong learning method so that special education teachers can educate themselves through self-learning methods and training programs module (Al-Mamari et al., 2020), thus constituting proactive steps to keep up with the requirements of the fourth industrial revolution. At the international level, we find that this revolution has changed the educational innovation landscape;

educational systems have come to rely on artificial intelligence and digital physical methods by employing creative and innovative educational methods that improve students' learning for future life (Aida, 2018). In this context, Al-Zoubi (2019) emphasized the existence of administrative, technical, and personal obstacles that limit the use by teachers of students with learning disabilities of the Edmodo platform in a resource room program.

At the level of Arabian ethnicity, we note that there are no clear Arab visions and aspirations to deal with the requirements and challenges of the fourth industrial revolution, but some countries, such as the United Arab Emirates, have adopted a strategy to deal with the requirements and repercussions of this revolution, among which is the use of ICT in the education system (Hassan, 2019). And at the national level, Jordan has paid attention to the requirements and challenges of this revolution through international, Arab, and national forums and conferences. In spite of the achievements made at various global, Arab, and national levels, the fourth industrial revolution has created a number of challenges on general and higher education systems, which have imposed on the special education teacher the need to acquire contemporary teaching methods and strategies that will positively affect the outputs of the education sector. Dipace (2013) emphasized training staff members and educators of students with special needs in ICT.

The electronic professional development of the special education teacher has become an important requirement in light of the contemporary roles and future responsibilities entrusted to him/her. From this standpoint, the role of scientific research and Arab conferences is crucial in shedding light on how to include the requirements of the fourth industrial revolution in special education programs. The Sixth International Conference on Information and Communication Technology held at Sultan Qaboos University highlighted the importance of using ICT in educating CDs, facilitating their access to the Internet, and applying technology in the field of special education (Al-Zoubi, 2019). Alfawair (2016) revealed that 90% of the special education service providers in early intervention programs possess a low level of ICT employment skills, and for this reason a study by Almaamaria and Al-Taj (2017) emphasized the importance of focusing special education teacher training programs on the applications of educational technologies and technological innovations in different educational situations. In other words, the use of technological innovations in education and training programs for CDs has not received sufficient attention from research (Cheng & Lai, 2020). Al-Sardeah (2019) indicated the existence of training needs among teachers of students with special needs related to learning skills, innovation, life skills, and digital culture. In this regard, Al-Khatri et al. (2020) emphasized the effectiveness of in-service training programs on improving knowledge and performance competencies for Omani special education teachers.

Consequently, we find that many international special education organizations as well as proposed and enacted special education laws have emphasized the importance of special education teachers to embrace assistive technology. The Individuals with Disabilities Education Act (IDEA) recommended the importance of using technology in education programs for CDs (Ahmed, 2018), while the Council for Exceptional Children (CEC) standards included a set of criteria; among them, the most important is a standard for ICT (Lombardo-Graves, 2017). These standards are among the main requirements for pre-service and in-service programs for preparing special education teachers.

The importance of using e-learning in programs for CDs should be emphasized; its use is considered a basis for achieving educational goals and enhancing the learning process through the use of special technological innovations with these children. The use of multiple technological means in e-learning contributes to helping CDs learn better, regardless of their abilities, aptitudes, and learning styles. Thus, the use of e-learning with children with special needs facilitates the educational process, providing these children with an opportunity for understanding, comprehension, and participation (Cavanaugh et al., 2013), in addition to overcoming academic achievement problems. On the other hand, training and health education programs may contribute to improving the health skills of CDs (Shih & Chang, 2005; Kumar et al., 2013). Many studies have examined the effectiveness of assistive technology, multimedia, video, and iPads in teaching DLSs to CDs (Cruz-Torres et al., 2020; Edrisinha et al., 2011; Riffle et al., 2005; Van Laarhoven et al., 2009; Van Laarhoven & Van Laarhoven-Myers, 2006; Wu et al., 2016; Wynkoop et al., 2018).

The COVID-19 pandemic has imposed on institutions and centers of special education emergent technological transformations and challenges that require more reflection in preparation for developing educational plans and strategies that keep up with these transformations and challenges. Despite the negative psychological, social, academic, and health dimensions that the pandemic has left on special education programs in particular and public and higher education institutions in general, this incites us to highlight the positive role of the pandemic as a facilitator of change to the education system that has until now been based on traditional teaching methods and strategies. Therefore, this pandemic may have the largest role in bringing about change and qualitative transformation in the structure and philosophy of the education system in Arab and Jordanian institutions and centers of special education, and perhaps directing the education path toward new requirements. In this regard, Guillen-Gamez et al. (2020) recommended improving the educational quality

of pre-service teachers by training them in digital competencies.

The transformations and challenges due to the COVID-19 pandemic may stimulate a comprehensive Jordanian and Arab review of the education philosophy in special education programs that affects its inputs, processes, and outputs. Likewise, this may require a comprehensive review of legislation around education for CDs at the Arab and global levels.

## 5. Conclusions and Recommendations

The results of the current research validated the effectiveness of using ICT in special education programs, its positive effects on social, academic, and psychological aspects, and its effective role in providing CDs with DLSs and independence skills. The results argue that those in charge of special education programs should build a strategy for employing various e-learning methods to meet the requirements of the fourth industrial revolution in Jordanian special education institutions and centers, especially since most of these institutions follow traditional teaching methods with CDs due to type and severity of the disability. At the same time, there is nothing to prevent these institutions and centers from heading toward employing e-learning methods in teaching CDs. Organizing training workshops may contribute to providing workers in Jordanian special education institutions and centers with the skills to employ e-learning in the education of CDs. And introducing courses in pre-service preparation and training programs for special education teachers may help teachers keep up with the requirements of the fourth industrial revolution. Finally, in regard to study limitations, the small size of the research sample and its deliberate selection by the Arab Village Center for Special Challenges, as well as parents' self-selection in responding to the research tool, may limit the generalization of results to various Jordanian institutions and centers of special education.

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# Research Materials

## English version of Daily Living Skills Scale

*Personal skills domain*

| *Items* |
|---|
| 1. Showing a desire for eating when seeing the food |
| 2. Using the spoon for eating properly |
| 3. Eating appropriately |
| 4. Drinking liquids by using the cup correctly |
| 5. Expressing the need to go to the toilet |
| 6. Defecating in the toilet |
| 7. Controlling during short periods of sleep (involuntary urination) |
| 8. Washing the body properly |
| 9. Brushing the teeth properly |
| 10. Wearing the shoes properly |
| 11. Taking off the shoes properly |
| 12. Wearing the clothes properly |
| 13. Taking off the clothes properly |
| 14. Wiping the nose with tissues |

*Home activities skills domain*

| Items |
|---|
| 15. Putting personal things in their place |
| 16. Helping with household chores when asked |
| 17. Helping in preparing the food |
| 18. Helping in lifting breakable items |
| 19. Making up the bed when asked |
| 20. Dressing his/her hair properly |
| 21. Helping in cleaning the house |
| 22. Using the Cooker/ Microwave properly |
| 23. Using cleaning tools properly |
| 24. Recognizing the dangerous materials |
| 25. Taking care of his /her clothes |
| 26. Putting the toys back in their places |
| 27. Throwing the garbage in the trash |

*Societal-environmental skills domain*

| Items |
|---|
| 28. Realizing the dangers of things in the environment |
| 29. Avoiding entering unclean places (containers / sewage) |
| 30. Realizing the importance of money |
| 31. Recognizing the money denominations |
| 32. Realizing the clock function |
| 33. Answering the Mobile calls properly |
| 34. Initiating phone calls with others |
| 35. Looking at both sides before crossing the street |
| 36. Recognizing the current day of each week |
| 37. Identifying directions (right-left) |
| 38. Distinguish between the four seasons |
| 39. Showing his/her feelings to others (joy / sadness) |
| 40. Accepting money/food from strangers |

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## Arabic version of the Daily Living Skills Scale

*Personal skills domain*

| Items |
|---|
| 1- يُظهر رغبة للطعام عند رؤيته |
| 2- يستخدم المعلقة في إطعام نفسه |
| 3- يتناول الطعام بطريقة صحيحة |
| 4- يشرب السوائل من الكوب بطريقة صحيحة |
| 5- يعبر عن حاجته للذهاب إلى الحمام |
| 6- يقضي حاجته بالحمام |
| 7- يضبط نفسه خلال فترات النوم القصيرة ( التبول اللاإرادي) |
| 8- يغسل أعضاء جسمه بطريقة صحيحة |
| 9- ينظف أسنانه بطريقة صحيحة |
| 10- يلبس حذاءه بطريقة صحيحة |
| 11- يخلع حذاءه بطريقة صحيحة |
| 12- يرتدي ملابسه بطريقة صحيحة |
| 13- يخلع ملابسه بطريقة صحيحة |
| 14 يمسح أنفه باستعمال المناديل |

*Home activities skills domain*

| Items |
|---|
| 1- يضع أشياءه الشخصية في أماكنها |
| 2- يُساعد بالأعمال المنزلية عندما يطلب منه ذلك |
| 3- يُساعد في تحضير مائدة الطعام |
| 4- يُساعد في رفع الأشياء القابلة للكسر |
| 5- يرتب سريره عندما يطلب منه ذلك |
| 6- يهتم بتصفيف شعره |
| 7- يُساعد في تنظيف المنزل |
| 8- يستخدم الطباخ (الغاز- الماكرويف) |
| 9- يستخدم أدوات التنظيف بطريقة صحيحة |
| 10- يعرف المواد الخطرة |
| 11- يعتني بملابسه |
| 12- يُعيد ألعابه إلى أماكنها |
| 13- يرمي القمامة بسلة المهملات |

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*Societal-environmental skills domain*

| **Items** |
|---|
| **1- يُدرك خطورة الأشياء المحيطة به** |
| **2- يتجنب ارتياد الأماكن غير النظيفة( الحاويات- الصرف الصحي..)** |
| **3- يُدرك أهمية النقود** |
| **4- يعرف فئات النقود** |
| **5- يبدي فهماً لوظيفة الساعة** |
| **6- يرد على الهاتف بطريقة صحيحة** |
| **7- يبادر بالاتصال الهاتفي مع الآخرين** |
| **8- ينظر بالاتجاهين قبل عبور الشارع** |
| **9- يعرف اليوم الحالي من كل أسبوع** |
| **10- يعرف الاتجاهات ( اليمين- اليسار)** |
| **11- يُميز بين فصول العام( صيف- شتاء....)** |
| **12-يُظهر مشاعره للآخرين ( الفرح- الغضب- الحزن..)** |
| **13- يأخذ النقود / الطعام من الأشخاص الغرباء** |

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# Moving between the boundaries of physical and digital contexts: a case study about a shared project by a group of children

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**Abstract**

Children are immersed in a world that is characterized by the continuous interplay of physical and digital dimensions, material objects and virtual realities. This article is centered on an experience with a group of 9-11 years old children where they worked on a shared project that they created together from the beginning, based on the constant flow of ideas and cooperation between individuals, small groups and the larger group, in dialogue with time, between real and virtual dimensions. The role of the adult as an attentive, participatory observer, resource and co-researcher with the children created an inclusive, child-centered atmosphere which kept the children's relationships and collaboration with each other at the heart of the experience. The digital realm was a resource and a material that enhanced the children's play, their ideas and allowed them to give shape to their project by broadening their range of action and the expressive possibilities. Using digital materials and tools and the effects they produced created a playful, immersive and narrative setting which inspired the children to interact with, play with, study, design and modify a hybrid reality which was both physical and digital at the same time.

**KEYWORDS:** Physical Materials, Digital Realm, Hybrid Context, Children's Play, Group Learning, Reggio Emilia Approach.

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## 1. Introduction

Children are immersed in a world that is characterized by the continuous interplay of physical and digital dimensions, between material objects and virtual realities. Research has shown that although children have greater access to digital tools and materials, which also greatly impact their play and consequently their learning processes, "it is not so much the *types* of play that have changed as a result of new digital contexts as the *nature* of play." (Marsh, 2016, p. 242-243). In reference to Vygotsky's (1978) theories that play is the main activity in cognitive and imaginative development, Edwards (2013) noted that it is important to redefine the correlation between traditional play – i.e. construction, make believe, etc. – and 'converged play' – i.e. play with 'multi-modal', 'global-local' and 'traditional-digital' characteristics.

One way to approach this hybrid dimension is to consider the digital realm as a resource and a material that can enhance and broaden children's play, their ideas and allows them to give shape to their projects. In the Reggio Emilia Approach, children are offered opportunities and time to play, explore and reflect on these phenomena and discover the possibilities that each language can offer them (Rinaldi, 2021). In the same light, digital tools and the effects they produce can create playful, immersive and narrative settings which can inspire children to interact with, play with, study, design and modify a hybrid reality which is both physical and digital at the same time.

Very young children can manipulate playful physical-digital contexts while older children can create and modify them with greater intentionality [For example, see https://scintillae.org/en/project/buttons-and-elephants/]. This article is centered on an experience with a group of 9-11 years old children who created an original, playful context between physical and digital

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dimensions. Photographs, videos and pen-and-paper observations evidenced the fluidity with which they acted in small and big groups on a shared project that they created together from the beginning, based on intense exchange, listening, collaboration and compromise, in constant dialogue with each other and between real and virtual dimensions [This terminology is closely associated to the typical working methods of the Reggio Emilia approach to education]. In this contemporary physical-virtual setting, the experience discussed below "draws on both the digital and non-digital properties of things and in doing so moves fluidly across boundaries of space and time in ways that were not possible in the pre-digital era" (Marsh, 2016, p. 250).

## 2. Reference framework

Recent research has documented and studied different aspects of the development and impact of the digital realm on children's play, learning and social, cognitive and emotional development (Vecchi et al., 2018; Marsh, 2016; Edwards, 2013, Flecha et al., 2020). "(Children) establish relationships with what is new, and invent new relationships with what they have already seen, using their capacity for opening up new scenarios in the world that surrounds them" (Cagliari in Vecchi et al., 2018). Digital contexts are no different. They are something new that children can interact with in a generative way, but they are also something known, which can be reinvented. In 2020 the European Commission conducted a study entitled "Effects of technology use on children's empathy and attention capacity" in formal, non-formal and informal learning environments. It identified some guidelines regarding children's empathy and attention capacity that mirror and confirm the underlying principles of the case study presented in this paper. "Digital technology has the effect of increasing children's empathy when its content, use and interactions are prosocial (because) the inclusion of all voices (fosters) the creation of dialogic environments in which (all) participants organize themselves and make decisions on a consensual basis" (Flecha et al., 2020, p.6). In our research group, the creative and unconventional use of a range of digital tools and materials allowed the children to develop and enrich their shared project, both working on their own and in small and large groups, especially in conjunction with physical materials.

Their level of engagement was very high throughout the experience, not because they had access to different devices per se, but because of the open-ended, inclusive atmosphere and the time they had to explore and experiment with the range of physical and digital materials available to them. Using physical and digital materials in this way led to possibilities for creative expression, while also fostering soft skill development like teamwork, collaboration, dialogue, negotiation, flexibility and adaptability, respect, mutual listening, creativity, communication skills and problem solving, which are among the fundamental, transversal skills. "Technology, which can be digital but not only, is a natural connector, an alphabet, an expressive material which can be manipulated, bent, reinvented. Through an unconventional approach, trial and error and exchange, we can foster a natural relationship with technology that promotes a complex, systemic vision of the world. A new empathy, with and thanks to the digital dimension, maps out the future of relationships between children and between children and technology" (Manera et al., 2021).

## 3. Methods

### 3.1 Research question

The research question that guided us during this experience was: *How is it possible to facilitate the use of digital and non-digital tools and materials as expressive means in children's play?*

To answer this question, the atelieristas chose to work with a small group of 6 children aged 9-11, where in-depth case study methodology was implemented. According to Peter Gray (2012), an American professor and researcher, "children are designed, by nature, to play and explore on their own, independently of adults. ... (If children are) free to pursue their own interests through play, (they) will not only learn all they need to know, but will do so with energy and passion. Children come into this world burning to learn, equipped with the curiosity, playfulness, and sociability to direct their own education." (Gray, 2012, p.6).

From the authors' experience and observations, play includes sharing and agreeing on ideas, projects, rules, roles, materials, times, words, looks, emotions; making discoveries, testing hypotheses, dialoguing with others, maintaining an open mind, listening to others and to each other, following wherever the experience takes us: to a new, unknown world.

When observing the intermingling of play between physical and digital dimensions, one of the keys to answering our research question had to do with the dimension of time. Extended time allowed for a spontaneous approach to the digital dimension, which at first was exploratory and then became intentional, where adults, through observation and questions, supported the process. Another important key was the constant flow of ideas and cooperation between individuals, small groups and the larger group in sharing information, negotiating, making decisions to create a project that truly included contributions from each person, becoming a unique expression of that particular group.

The role of the adult, as an attentive and participatory observer, resource and co-researcher with the children,

added to creating an inclusive and child-centered atmosphere which kept the children's ideas and autonomy at the center of the experience. Of course, the selection of digital tools and materials available to the children - and their prior knowledge or experience with them, or their real-time exploration and discovery of the ways to broaden of their range of action and the expressive possibilities thanks to them – also played a key role in the development of their group project, as will be discussed in more detail below.

### 3.2. Research context

A group of 6 children (5 Italian and 1 Japanese) between the ages of 9-11 attended a week-long Summer Camp (from 8-12 July 2019) at *scintillae*, a research project and space jointly promoted by Fondazione Reggio Children and the Lego Foundation, physically located at the Loris Malaguzzi International Centre in Reggio Emilia (Italy).

The *scintillae* project aims to create and offer contexts where the expressive potential of play and digital tools generate ideas, connections and new knowledge, and is based on the assumption that the playful dimension is part of everyday learning and that children actively build, through reciprocity and sharing, a model of the world through play (Figure 1). In our digital age, *scintillae* represents a learning context characterized by a natural and playful approach to digital technology, where the physical and digital worlds interact, creating unexpected and unusual encounters for learning, designing and constructing knowledge together.

In this experience, the children conceived of and developed the idea and the specific project they wanted to work on, based on the request of the *atelieristas* that they create a new playful context for children and adults who would visit *scintillae* in the future. The group was invited to use whatever physical and digital tools and materials available in the space to realize their shared project, as discussed below. The space was set up with both physical and technological/digital tools and materials. Physical materials included pieces of rubber, fabric, Lego elements, plastic and other deconstructed materials, as well as natural materials like leaves, seeds, sticks and plants. The digital devices available in the space were tablets, laptops, projectors and Light Play, a series of 3 portable, flexible lights which are coded using Scratch-like drag and drop blocks to create different sequences to personalize colors and timing [Several iPads were used for taking photos, and also to isolate details and compose images using the app Photoshop mix. Light Play is a prototype that is not commercially available, but there is an instructable available for those who want to try to make one: https://www.instructables.com/Light-Play-Set/].

## 4. Results and discussion

### 4.1 Multi-material and multi-modal collages: 4 approaches

In the experience our article is based on, the children activated individual design processes, each developing a methodology that included both physical and digital materials in the realization of the project that evolved over the time spent working together. The phases were: the design and creation of a hand puppet, the invention of group story and its settings and the recording of a short video trailer. The underlying idea was to facilitate children and adults who would use these puppets in the future, since they remained at *scintillae*. Thus, each child applied their own creative processes, both during individual work and also when working as a group to brainstorm the shared story, identify and agree on the actions necessary to carry out what they had decided and divide the tasks among themselves. Each child kept the others informed about their progress; this promoted the creation of a shared group project. The way the children worked (individually or as a group) was freely decided each morning together with the *atelieristas,* recalling what had been done the day before and planning the day's activities, creating the agenda in real time. The children organized themselves autonomously to work individually, in pairs or in small groups. The *atelieristas* made sure to verbally mirror these choices explicitly, to valorize the children's self-organization. It was important to create and support a context where the children had the freedom and autonomy to observe and choose any material or tool available for their projects. This laid the foundation for exploration, improvisation and consequently opened up new opportunities for discovery and research. The materials themselves were developed and transformed according to the children's needs and ideas. Their inventions and ideas gave rise to new creations and their ideas materialized. In this process, the partnership between physical and digital materials was particularly significant.

At our first session, the group was given time to observe, touch and imagine what the objects and materials were all around them in the space. Some materials, such as yarn, mosaic tiles and corks, were recognizable and easily linked to known uses. Others, which were unrecognizable to the children, were observed, named and utilized based on their characteristics and qualities (Figures 2, 3).

This moment for becoming familiar with the space, materials and tools available was essential in promoting the children's confidence and autonomy. They subsequently designed and produced their hand puppets, and each had a unique story and lived in a unique world which reflected the characteristics and history of each character. Each child created their puppet's world, part of the story created together, using a mixture of physical and digital materials. Their

freedom and autonomy in selecting different materials, testing them, editing and hybridizing them using different languages (analog and digital) led to the creation of multi-material and multi-modal collages (Figures 4, 5).

Anna

Anna chose an iPad as her main tool and proceeded to design the world of her unicorn Scintillae using graphic language. Given the complexity and variety of subjects in her project, the *atelierista* suggested the possibility of using the Photoshop Mix app: this allowed her to photograph, adapt and assemble different elements - "A chocolate waterfall, gummy candies, cake-houses and castles" (Anna, 9) - into a single image.

The combined, digitized materials took on new characteristics and meanings: beads became candies, a piece of light brown fabric created a chocolate waterfall, the cake-house was made of Lego bricks, with fabric as icing and a bead as a cherry. The castle was a drawing. A natural and fluid transition between analog and digital elements created the world of Scintillae the unicorn (Figures 6, 7).

Marlene

Marlene also chose an iPad as a tool to represent the green world of her snake Veleno, but unlike Anna, she decided to describe the characteristics of this world in writing:

"Oak trees are populated by poisonous snakes" (Marlene, 9)

Her search for materials to create her world began: pieces of green plastic became the foliage of oak trees, wood chips were tree trunks and the snakes were drawn, colored, photographed, isolated and added to the image. The green background is a close-up photo of the fabric of one of the hand puppets already at *scintillae*: Marlene deconstructed the puppet-object to isolate its characteristic quality in order to use it in creating her character's world.

Like Anna, Marlene's process combined digital and analog instruments and the materials present in space. The continuous exchange of ideas, techniques and languages with Anna, seated at the same table, contributed not only to their creativity, but also to their autonomy; the adult became less and less necessary until she became an observer and documenter of the processes that were taking place (Figures 8, 9).

Ludovico

Mattia and Ludovico were working at another table: they chose a computer with Scratch. Both used the same tool but with different ideas and processes.

Ludovico, for the world of his dragon Graffio, was inspired by a piece of red plastic that reminded him of "Firey rocks and spaghetti" (Ludovico, 11)

The *atelierista* suggested using the app that Anna and Marlene were using to photograph the material and import it into Scratch. Having already had programming experience with Scratch, Ludovico used the image of a piece of red plastic he had photographed as if it were a stamp. By multiplying it, he created a world of "spaghetti rocks": the food of the dragons who inhabited his world. To add more details, characters and other elements, he also decided to draw a red sun which, thanks to the app, he imported and placed on the spaghetti rocks. To portray the dragons that inhabited his world, Ludovico created a sort of bestiary of dragons made with different languages: isolated photographs of his puppet Graffio (lower right corner), a toy dragon and a sprite imported from the Scratch library (Figures 10, 11).

Mattia

Mattia's process was similar to, yet different from Ludovico's. He also chose a computer with Scratch as his main tool, given his previous knowledge of this language. Instead of starting from an existing material or object, he decided to digitally draw the basic element that characterized the world of Ermano the werewolf chicken: a chicken biscuit.

With the support of Ludovico who was working alongside him, Mattia experimented with the same code that allowed him to multiply the image: one chicken biscuit became a group of chicken biscuits. Subsequently, Mattia decided his world was not only made up of digital materials, but also of concrete ones. He identified some elements in the space - a plant and a stool - that were transformed respectively into the woods and a throne for Ermano the werewolf chicken (Figures 12, 13).

## 4.2 Using physical and digital materials as a group

The children's shared and original idea- to record their puppets and the story they invented together in a video-trailer "so that others could finish the story" (Ludovico, 11) in the future- meant that digital materials and tools continued to expand the creative process and allowed the children to realize their ideas.

For example, the scenes in the story needed to be lit. While programming the Light Play lights, Anna was in dialogue with the other children, sharing her ideas about the color sequences: these quick and frequent comparisons made the individual moments into group experiences, creating a virtuous cycle of mutual exchange and enrichment (Figures 14, 15).

**Figure 2** - The children freely observed and explored the materials available at *scintillae*.

**Figure 3** - The materials themselves were developed and transformed according to the children's imaginations.

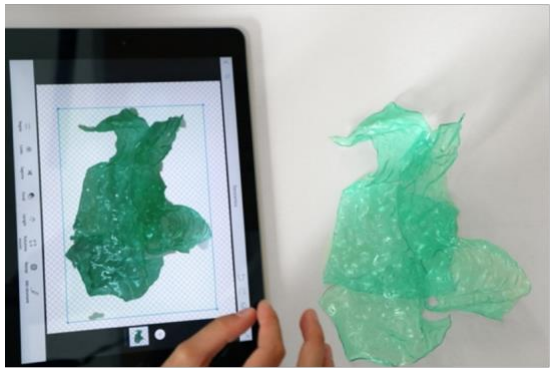

**Figure 4** - Physical objects were an important part of the children's digital compositions.

**Figure 5** - Giulia and Seryka worked next to each other, individually and also exchanging information and ideas.

**Figure 6** - Anna used a mixture of physical and digital materials.

**Figure 7** - Anna's finished composition on the iPad.

**Figure 8** - Marlene and Anna worked together at the same table, exchanging ideas.

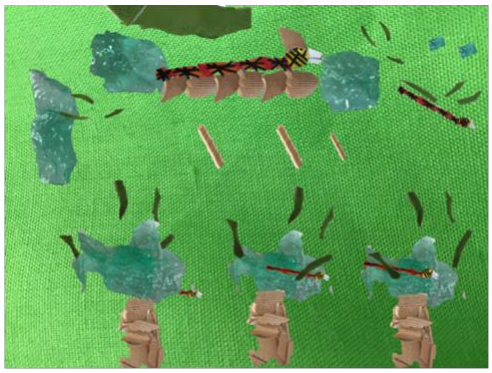

**Figure 9** - Marlene's completed composition.

**Figure 10** - Ludovico drawing the red sun visible in the final composition.

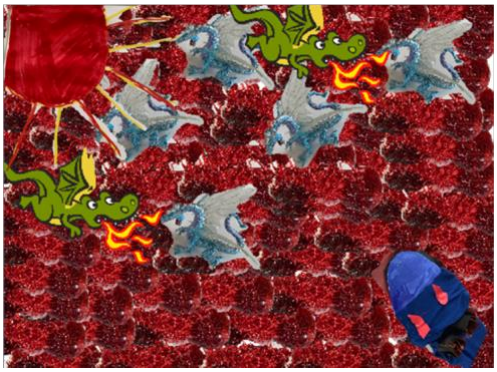

**Figure 11** - Ludovico's dragon world.

**Figure 12** - Mattia used Scratch to multiply his chicken biscuit.

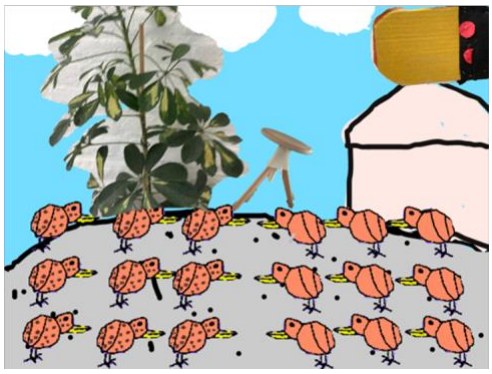

**Figure 13** - Mattia's finished composition.

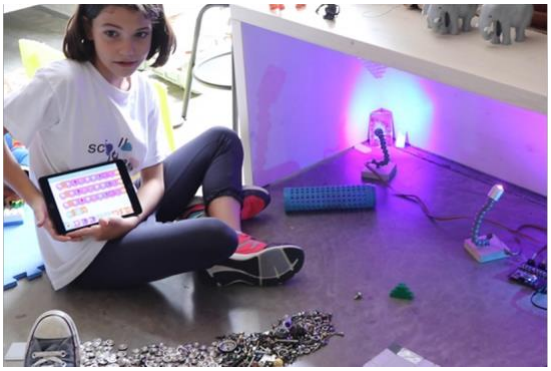

**Figure 14** - Anna programming lights to set a scene in the children's story.

**Figure 15** - The group tries out the light sequences.

**Figure 16** - Ludovico and Mattia recording a scene of the story.

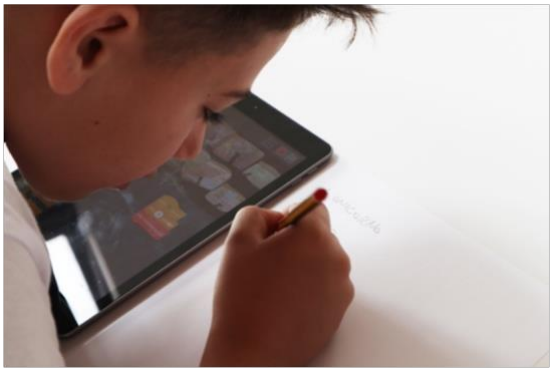

**Figure 17** - Ludovico calculating the timing between one sequence and another.

Ludovico was the "director" of the trailer: he recorded each puppet in their world separately, but with group support. After each recording, together with Mattia and the creator of the character, they watched the video and if there were details to change, they recorded it again. The group thus became a place for exchange, where the actions of each individual became material to be created and de-constructed, adding details and new ideas to improve and enrich it (Figures 16, 17).

After recording the videos, Ludovico spent some time working individually on editing the trailer. He created the sequence with the worlds of the various characters and calculated the time that elapsed between one world and another, so that each video started in an orderly and logical way.

Mattia and Marlene worked together to create some scenery for a part of the story, thanks to their common interest in using the computer as a design tool and their desire to create other characters using graphic languages. They began with Ludovico's drawing of his dragon. Both of them digitally reworked the drawing using different colors, using both a computer and a tablet. The support of digital technology allowed them to amplify their collaboration, increasing the possibilities and results (Figures 18, 19).

The final trailer of the story featured each character in their respective world, which then merged into a single, shared unicum: each part of the project worked on individually fit together perfectly in the realization of the shared project. The individual dimension was therefore necessary, both to deepen personal research on form and materials and to contribute to the functioning of the group project, making use of previously acquired knowledge and combining it with that of others (Figures 20, 21).

The continuous, fluid passage between physical and digital materials and between individual and group design processes led to the creation of a complete, rich, complex project: a story told with videos, puppets, unstructured materials, Lego, light, shadow... A story given to *scintillae* by these children, for other children who, in the future, will be able to watch and enrich it with other ideas and suggestions.

**Figure 18** - Mattia and Marlene digitally reworking Ludovico's drawing of a dragon.

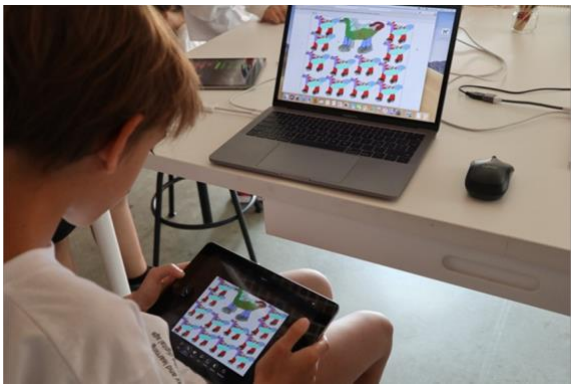

**Figure 19** - Creating the scenery for the battle scene.

**Figure 20** - Anna recording a scene of the story.

**Figure 21** - Ludovico recording a scene of the story.

### 4.3 Adults able to listen

This in-depth case study is an example of how a group of children used physical and digital materials individually and as a group to create a shared project. The intertwining on different levels between people, languages, ideas and strategies was made possible also thanks to the attentive and intentional role of the adults who were able to listen, working alongside the children. "Listening means being open to differences, recognizing the value of another's point of view and interpretation. Thus, listening becomes not only a pedagogical strategy but also a way of thinking and looking at the others. Listening is an active verb that involves giving meaning and value to the perspective of others... This kind of listening is a way of welcoming the others and their differences, and a way of welcoming different theories and perspectives." (Rinaldi, 2004, p.3).

This listening approach on the part of the adults manifested in several ways: one aspect was in the alternation between individual and group work, always keeping the children connected and interconnected, as mentioned and discussed above. The adult played an important role in helping to orchestrate this rhythm. Another aspect is the expertise and know-how in choosing certain materials rather than others and hypothesizing possible scenarios and interactions which formed the basis for setting up a context for the children. At the same time, it was essential to keep an open mind and welcome the children's intuitions, interests and ideas for enriching or modifying what we as adults might have prefigured in our minds. In addition to physical and digital materials, offering time both to children and adults was fundamental. "The most important gift that we can give to the children... is time... to offer our time to the children, because time is the only possibility for listening and being listened to by others." (Rinaldi, 2004, p.3). A time to observe, to explore, but above all a time to listen to what is happening and let go of one's initial hypotheses and deconstruct them, turn them around and recreate them continuously, together with the children and their processes.

## 5. Conclusions and suggestions

This case study brought to light and confirms elements underlined by Marsh (2016) and Edwards (2013) about the impact of digital contexts on children's play, suggesting possible directions for future research. In our experience, the children used the digital realm as a material itself, not only as a tool, not only as a medium, to create something else. Their initially exploratory approach became more intentional over time. The children, for example, not only invented names for the different light effects they created, but they also learned the rules to program them. Light Play became an important material and tool for the realization of their project, since light added a communicative and expressive value to the individual characters and the scenes of the story. In any case, there was little need for us adults to support their exploration processes, and we were able to observe the children in action. The *atelieristas* supported the children and made sure that they were aware of the potential of the digital tools and materials in relation to the projects they were working on. After acquiring the basic ideas, the children shared their knowledge with each other and even explored other possibilities that had not been explained. Due to their varying degrees of prior experience, it was always interesting to observe the mutual support and exchange among the children regarding information and strategies for using digital materials and tools. What emerged from this experience was how an invitation and the time dedicated to observing, exploring and relating to the materials were essential for building new and unexpected meanings. Playing with physical and digital materials, improvising (i.e., creating and doing something with what was available at a given moment) opened the door to immense creative and inventive complexity for both children and adults. If the digital dimension is not only a tool, but also seen as a material that can be produced, transformed, manipulated and adapted, the possibilities multiply. Subjects, materials and languages in dialogue and in play, where thoughts and intentions are mixed with invention and improvisation; research becomes play and play becomes research.

> *"To invent, then, is to find, to discover. But to find one must act, hands and mind in action, rummaging, fumbling, rooting around, in both physical and intellectual reality. (Zingale, 2016, p. 31)" (Translation by authors).*

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