TEAL AS AN INNOVATIVE TEACHING MODEL. INSIGHTS FROM "EDUCATIONAL AVANT-GARDE" MOVEMENT IN ITALY

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Since 2013, INDIRE has been carrying out research activities with the goal of identifying practices that could represent a disruptive and radical change in the traditional classroom pedagogy.
Among all the innovative teaching models, (twelve identified at present), INDIRE selected the practice adopted by a network of Italian schools and imported by the Massachusetts Institute of Technology. This practice, whose acronym is TEAL proved to be effective in changing the classroom routines and in improving students' learning achievements. In particular, Italian schools have pointed out that by using TEAL, students improve their learning experience and outcomes, feel more engaged, satisfied, aware of ICT pros and cons, and take more responsibility over their learning.

Teachers remark that a TEAL-style pedagogy helps them work closely with their colleagues because the problem-solving approach forces them to rethink their subject curriculum. Moreover, by using TEAL, the education setting is rearranged, the uses of technologies require making conscious pedagogical choices and flipping the classroom becomes more natural.

This paper analyses the original TEAL model at MIT and the derivative practices observed in the Italian schools. Even if other publications describe the TEAL Model, this paper reflects on the positive results of its impact on the Italian school system, underlying strengths and weakness of the process of innovation in schools.

1 The background: "Educational Avant-garde" Movement

INDIRE is the National Institute for Documentation, Innovation and Educational Research of the Italian Ministry of Education, University and Research that deals with a lot of educational research issues, among which innovation is specifically highlighted, as driver for a better quality in our school system. In light of these considerations, in September 2014 INDIRE, in cooperation with 22 Italian schools promoted a project, called "Educational Avant-garde"[1], aimed at finding out the most innovative ideas already implemented by the schools in different areas (organization, time, teaching strategies, use of technology etc.). Twelve innovative "Ideas" were identified, adopted by an ever-growing number of schools (416 at present). Within the Educational Avant-Garde movement an "idea" is a core category to describe an innovative teaching and learning practice. In addition, other schools can propose new "Ideas", in order to get a wide and effective picture of innovation as it is continuously evolving in our schools. The educational research question is grounded in investigating the different aspects of innovation, comparing it with other international scenarios and helping teachers and head teachers to network with their colleagues in order to share ideas, opinions and practices and try to make innovation not episodic or just an add-on, but an integrated part of the educational pathways provided. The innovative ideas rise directly from schools experience, expertise, and will to innovate their way of teaching and learning.

The experimental design consists in leading this process of innovation through: face-to-face meetings and "open-day" webinars among teachers, headteachers and researchers. They are the key features of this project, that aims at gathering needs, developments and challenges from the schools themselves, generating in this way a "bottom-up" circle which demands new innovation strategies.

2 TEAL at MIT

One of the twelve "Ideas" of "Educational Avant-garde" refers to the im-

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[1] http://avanguardieeducative.indire.it/

plementation of TEAL (Technology Enabled Active Learning) methodology in Italy, a pedagogical approach developed at MIT (Massachusetts Institute of technology) by a team led by John Belcher and Peter Dourmashkin (Belcher, 2005). The TEAL project was introduced to address a series of educational problems encountered at MIT but shared by many universities. In the existing large lecture based courses (three hours per week) in which lecturers "delivered" content, with additional smaller recitation sections (two hours per week), the failure rates were high for MIT standards (15-20% failure rates) and attendance in class was low. In end-of term surveys, students self-reported spending on average 7 ½ hours per week that includes both in-class and out-of-class work. In addition, push back from second-year faculty complained that students had very low retention rates of core physics concepts. Additionally MIT students had little experience in their first-year courses working in in teams in which they needed to develop their communication skills and ability to teach and learn from their peers in a structured classroom setting. The MIT physics department did what it does best: it tried an experiment, the TEAL project to address these difficult educational issues and solved the problem" (Normandin, 2010).

The TEAL methodology had its origins in the Studio Physics courses developed at RPI(Cummings *et al.*, 1999) and the Scale-Up physics courses at North Carolina State University (Beichner & Saul, 2002). TEAL employs the interactive group structure with an emphasis on hands-on desktop experiments pioneered by the Studio Physics courses and added several new components. Cognitive psychologists have identified a strong connection between visual abilities and learning science (Kozhevnikov *et al.*, 2002). So a fundamental pillar of TEAL methodology is the use of visualizations and simulations in order to understand better and manipulate physics concepts, diagrams and graphs. Two– and three-dimensional visualizations, animations and simulations with the use of technologies allow students to explore and fully understand phenomena, reactions and events in real time and in a natural dimension. " … Our contention is that visual imagery can help make the abstract concepts encountered in electromagnetism more concrete…" (Dori *et al.*, pp 249-50). In addition, concept questions with "clickers" using the Peer Instruction methodology developed by Eric Mazur (Crouch & Mazur, 2001) were integrated into the Teal Methodology. A series of project-based experiments developed by John King, Philip Morrison, Phyllis Morrison, Anthony P. French, and Peter Dourmashkin for first–year physics courses at MIT, along with new "hands-on desktop experiments" were adapted for TEAL. Finally, team-based teaching that included faculty, graduate students teaching assistants, undergraduate teaching assistants and technical instructors, were employed in the TEAL classroom. All of these innovations were based on educational research outcomes from the Physics Education Research community (McDermott & Redish, 1999).

The introduction of TEAL resulted in improved learning outcomes at MIT (Dori & Belcher, 2005): teaching has become more interactive focused on helping students learn content rather than the delivery of content; class attendance is approximately 85-90%, teachers and students have acquired a higher level of awareness in the use of classroom technologies such as "clickers" and the associated methodology of peer instruction; the rate of failure in first-year physics courses has decreased from 15-20% to 3-5%; 75% of the undergraduate teaching assistants are now women providing role models and acting as mentors for first-year students (each undergraduate class at MIT is currently consists of an equal number of men and women); long term retention rates of core physics concepts have improved compared to similar lecture-based courses (Dori *et al.*, 2007). Perhaps most importantly, the TEAL project has now reached a "steady-state" and is now the primary methodology for teaching first-year physics classes at MIT. This sustainability has encouraged other departments to experiment with various aspects of the TEAL methodology. The Mathematics Department at MIT now uses the TEAL methodology for an introductory probability course. This is the picture that Peter Dourmashkin from MIT has presented about how MIT has experimented with educational innovation. In particular, Dourmashkin highlighted that the development of the TEAL methodology is still an ongoing process, that requires fine-tuning a variety of active-learning elements until they work together in unison to achieve enhanced student learning.

TEAL has also served a model for many other institutions in both the USA and other countries that are institutionalizing education innovations in both STEM and non-STEM subjects, at the university level (Chile, Brazil, Singapore, and Japan) and the secondary school level (Taiwan). A new "twenty-first century" university, the Singapore University of Technology and Design (SUTD) has based their first year educational system on the TEAL methodology (Bagiati *et al.*, 2015). Because TEAL is a new teaching methodology, teacher training is essential. Dourmashkin found that teachers from other institutions were able to adopt those aspects of the TEAL methodology that worked best in their classrooms, and through their own innovations improve student performance.

This fundamental transformation requires a major change of perspective in the educational format: from the lecture-based classroom where students are passive listeners, to a problem-solving, peer-learning classroom that combines different active-learning methods with the use of technologies, that foster the students' active participation and contribution to the learning process. "TEAL is more about learning information instead of just distributing it", Dourmashkin explains.

Fig. 1 - Peter Dourmashkin and his students.

3 From MIT to "Educational Avant-garde"

Five Italian schools have promoted TEAL as an innovating "Idea", which represents an innovative teaching practice implemented in a school setting. At present a network of about 108 schools are adopting and experimenting with this "Idea". The core idea of the *Educational Avant-garde* project is that leading schools, which have achieved practical expertise in an "Idea", would share and disseminate their experience and practice with the other schools willing to experiment this innovation, in a peer-to-peer perspective. A research team (Indire researchers, head teachers and teachers) lead the process of implementing, disseminating, and evaluating the impact of teal methodology within the Italian school system. The team created a "manifesto" of the "movement" and proper "guidelines" for each "Idea", which represent the official documents of the initiative. Face-to-face meetings and online webinars are the ways through which specific teacher training sessions devoted to a particular "Idea" are organized.

Dourmashkin has been invited to give presentations, workshops and lectures in different Italian schools willing to experiment with TEAL methodology in their learning environments. He notes the importance of not copying verbatim the TEAL methodology but adapting the TEAL methodology to fit the Italian educational settings, allowing Italian teachers to innovate. According to Dourmashkin's inspiring inputs and suggestions, the Italian schools have adapted the American theoretical framework to their specific context and target of students. Teachers from the different schools are engaged in sharing their design of TEAL lessons, in order to benefit from each other and sort out any possible problems or weaknesses they may encounter. Even if the evaluating phase of this educational practice has not been closed, few points of the Italian

adaptation could be shared and presented for scholar and teacher discussion.

4 A typical TEAL setting in an Italian Avant-garde school

Technology has a central role in a TEAL lesson as it may offer vital tools to help students be active learners and improve their learning outcomes. However, as Peter Dourmashkin explains, it is not crucial to have a very advanced and fully equipped set of technological tools, but you can effectively teach a TEAL class even with minimum architectural elements and technological requirements such as:

- Flexible tables set out in working islands
- IWB and projection spaces, where students can show their understanding and possible misconceptions that the teacher will clarify:
- PC or device, at least one for each group;
- Personal response system (PRS), using clickers, but also some free software or apps, accompanied by peer discussion;
- Working student groups preferably consisting of three students, so that each student can fully engage in each activity.

Flexibility is the key word that Italian teachers and headteachers particularly liked from Dourmashkin's workshop presentation, as it allows the adjustment of setting, material, equipment and learning environment according to the specific needs and goals of each school. Among the teaching/learning strategies adopted in a TEAL class, the following can be considered most effective, as stated by teachers who experience the methodology in the Italian schools:

- Problem posing/solving to develop critical thinking skills
- Cooperative learning and discovery learning in small groups or in pairs
- Peer tutoring and Peer learning
- Learning by hands-on experiments to develop active involvement in the learning process
- Inductive methods: from the observation and the practice to the conceptual frame
- Concept questions with individual reflection, peer discussion, corrective feedback from the teacher
- Challenge-based learning: launching challenges to the students through a gamification process
- Project-based learning: working with the aim to produce a project through artifacts (video, tutorial etc.)
- Experimentations, visualizations, simulations
- Task-based learning: activities assigned according to specific tasks
- Interactive presentations and OER (Open Educational Resources).

5 Innovation shifts from the scientific areas to the humanistic areas

The technological enhancement of the learning process may be possible also in the humanities and in fact in any subject, as the TEAL methodology may represent the empowerment of the whole cognitive process involved in the learning. Dan Edelstein, professor at Stanford University highlights the central role the humanities play in developing innovative and creative thinking skills, underlining how the involvement of both brain hemispheres can enrich the cognitive skills and improve the learning process, " […] the humanities provide students with the best opportunities for learning how to innovate" (Edelstein, 2010).

Shifting teal from the scientific area to the humanistic area could be very challenging in the Italian context for its cultural and historical tradition.

The use of technology can have a positive impact on humanities as well as scientific ones, promoting innovation and better quality in the educational system. In particular, the teaching and learning of foreign languages was one of the first areas to be positively affected by the use of technology: for example, the corpus and concordance tools, such as the British National Corpus[2], that allow learners to understand lexical items in natural contexts are extremely useful in the learning/teaching process.

In the teaching of a foreign language, researchers are discussing and investigating the role of technology in the process of learning. Recent studies place technology enhanced language learning (TELL) in its historical context, and point out the challenges that technologically based language pose for teachers and improved performance reached by students (Walker & White, 2013). In some Italian schools registered as "Educational Avant-garde", teachers are experimenting with TEAL in the humanistic subjects, with great enthusiasm from the students, who seem to react better to the teacher's' input[3].

6 Benefits of TEAL

Avant-garde teachers experimenting with TEAL in Italy have pointed out the positive results from using this methodology. Through quantitative and quality methods, the research team is working on the feedback gained during webinars and face-to-face meetings, showing improvements achieved in different domains, such as:
- cognitive skills (better retention, reflective learning, problem posing/solving)

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[2] http://www.natcorp.ox.ac.uk/

[3] This new horizon for TEAL methodology founds a pedagogical root in Nussbaum thought on the importance of humanities in human development and, we can add, the necessity to balance and integrate technical and humanistic knowledges and skills in a capability approach.

- social and interpersonal skills (collaboration, team building, group work, respecting rules)
- communicative skills (using the terminology of different subjects, communicating in an effective way, communicating with ICT)
- emotional and motivational skills (motivation, self-efficacy, positive attitudes towards school)
- technical skills (ability in the use of ICT, critical use of technologies, ability to choose digital contents, producing multimedia contents, co-constructing and sharing knowledge with the aid of ICT)
- organizational and managerial skills (positive relationship between the school and the territory, between school and families, collaboration among teachers, disseminating outcomes to the wider school community).

The role of the student has completely changed, as he/she becomes the real protagonist of the learning pathway, taking at the same time the role of "producer", "author" and "consumer" of the learning process and outcome (Benjamin, 1983; 1996).

7 The TEAL teacher profile

Thanks to the inspiring suggestions and hints Dourmashkin has provided Italian teachers, headteachers, and INDIRE researchers, a new teacher profile is coming out. In fact TEAL teachers have to acquire specific competences, rethinking the way they plan and implement their lessons. Bennet and Bennet (2008) suggest professionals undertake the changes they see fit. They recommend planning change by taking into account the following factors: awareness, personal feelings and beliefs, empowerment, impact. Awareness of change models can help teachers become autonomous in professional and personal development, gaining confident in new settings.

The TEAL teacher profile includes the development of a series of competences: mastery of the disciplinary contents, interpersonal and relational competences, ICT skills, and entrepreneurial competences to face innovative and flexible situations. In order to put the mosaic of competences together in the TEAL profile, Dourmashkin recommends some training pathways for teachers similar to the ones that are being implementing at MIT where newly hired teachers at the beginning of their career are supported by experts and senior teachers, through job shadowing activities that can help build confidence with the complexity of the teaching situations. Moreover, at MIT, technical support is always available during classes, so that the TEAL teacher can fully concentrate on the teaching/learning process, without losing time on managing

technological tools. Once teachers gain familiarity with the technological tools, the technical support can play a more reduced role.

In Italy the ever-growing presence of teaching assistants coming from the Global Learning Lab at MIT or from some other American universities who participate in Italian classes for some period can play a key role in the shaping of the TEAL teacher profile.

Another added value may be represented by the connection between TEAL and CLIL (Content and Language Integrated Learning), which may enable Italian teachers to deliver lessons in a foreign language, focusing on the international dimension, and on the integration of content, language and technology. This may be an effective way to implement CLIL in Italian upper secondary schools, according to the latest Reform (Law 88/89 dated 2010) that introduced CLIL methodology as mandatory in the Italian school curricula. Some teachers from "Avant-garde" schools are already delivering TEAL lessons in English using CLIL methodology.

8 Some provisional outcomes in the TEAL adoption process in Italy

Italian schools participating in the "Educational Avant-garde" Movement are localizing the "Ideas" according to their contexts, school levels, resources and preferences. It is therefore very interesting for INDIRE researchers to observe the adoption process since it can tell a lot about the scalability, potential and up-scaling of every single "Idea". As for the TEAL "Idea", one commonly reported outcome from lower and upper secondary school is the inclusive potential of this practices, which seems to accommodate several learning styles and preferences. Teachers report that by working with the TEAL methodology, weak students and special needs students feel more included since everyone can find his/her own role and give his/her specific contribution. It is important that teachers work on the grouping of students since this can affect the results: heterogeneous grouping seems to work better because the "zone of proximal development" (Vygotsky, 1986) is most solicited when students have different profiles, levels and approaches. In the adoption process, TEAL has been piloted in lower secondary and primary schools, proving that the TEAL methodology seems to be valid with younger students as well. Before the "Educational Avant-garde" Movement disseminating the "Idea", in Italy TEAL had only been used in upper secondary schools (mainly technical schools). In particular, one school[4] in Molise (Southern Italy) adopting TEAL is implementing it in all its school levels (from primary to upper secondary). They have decided to go for a systemic approach, by implementing the "Idea" in all classes of all school levels, by presenting the practice to families and by organizing Open Days

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[4] Istituto Omnicomprensivo Guglionesi (CB), http://www.guglionesi.com/index5.asp

to present this educational innovation to the local community (other schools, local school authorities etc.). They have also created a common repository to share documents and documentation and asked for regional funds to create TEAL classrooms. Their choice is due to the fact that they observed immediate positive feedback in the TEAL adoption, especially as for students are concerned. In fact, students reported to be happier and more concerned compared to traditional lectures since they are active and asked to be more responsible as to their learning process.

Finally, one last remark that comes from schools adopting more "Ideas" is that the TEAL is "naturally" linked with other "Ideas", in particular with those concerning an innovative approach as for the time, the place and the organization of learning. TEAL appears to work well in conjunction with the "Flipped classroom" Idea, with the "Digital educational contents" Idea and with the "Flexible educational setting" Idea, suggesting that all these "ideas" are pieces of a same puzzle on innovative educational models: no matters where the school starts its innovation process, certain trajectories will appear anyway since they are all interweaved aspects.

A provisional conclusion of this year experimentation of TEAL shows that this "Idea" is highly scalable, effective and popular among students. The only challenging aspect is the amount of time teachers need to implement their teaching performance in this sense, even though a school systemic approach can help by maximizing the outcomes and minimizing the efforts of teachers and staff.

9 The "coaching" format

As mentioned before, the aim of "Educational Avant-garde" is to build up a community of practice, sharing the same idea of innovation at school and the same belief in new innovative and challenging teaching strategies, methodologies, spaces and times.In order to reach this aim and to help "adopting schools" get in touch and receive assistance from INDIRE researchers and from the "leading schools", a "coaching format" has been designed, according to the "Deming Cycle" (Deming, 2000), which provides the following steps:

P - Plan: planning the different aspects of the "Idea".

D - Do: implementing the "Idea" in the school.

C - Check: assessment; collection of data; evaluation of the outcomes.

A - Act: improvement actions after the feedback from the previous step.

The "coaching format" includes a series of webinars run by the "leading schools" and the researchers about the different steps, showing materials, practical examples, good practices, in order to help "adopting schools" to plan,

implement, assess and improve Teal methodology in their classes.

"AE Talks", live webinars with experts on transversal topics are a highlight of this format, offering teachers the opportunity to interact in synchronous with experts and with colleagues and sharing ideas about the topics and about the different problems faced during the innovation pathway.

Conclusions

The Avant-garde" initiative was activated by INDIRE and the Italian school network in September 2014, so the process of innovation is just at the initial step.

The TEAL "Idea" which is one of the 12 "Ideas" the "Movement" is based on, can be considered one of the most powerful and most challenging, as it entails a wide range of teaching/learning skills and allows a rethinking of learning pathways implementing real innovation at school with the aim of making radical change to the educational system with the goal of truly preparing students for the 21st century.

Even if a complete evaluation of TEAL impact on teaching and learning in the Italian schools is not ready, we can suggest that TEAL methodology is helping schools to become more attractive and engaging, decreasing the rate of ESL (Early School Leaving) and increasing the students' and parents' level of satisfaction.

These first results encourage us to disseminate and share the TEAL experience in order to support the "Educational Avant-garde" Movement and to sustain innovation in school, enhancing this process also through critical comments and reflections coming from the scholar and teacher community of our readers.

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