JOURNAL OF E-LEARNING AND KNOWLEDGE SOCIETY
Vol. 17, No. 2 (2021), pp. 32-44

Distance – Learning Goes Viral: Redefining the Teaching Boundaries in the Transformative Pedagogy Perspective

Laura Branchetti[a], Roberto Capone[b,1], Maria Laura Rossi[c]

[a]*University of Milan (Italy)*

[b]*University of Salerno (Italy)*

[c]*University of Parma (Italy)*

(submitted: 27/12/2020; accepted: 27/10/2021; published: 10/11/2021)

Abstract

This work analyzes the teaching and educational approach, based on Distance Learning, used in a Mathematics class with Engineering students. Thinking critically about how we worked before the COVID-19 crisis, we try to elaborate on possible ways to overcome linear processes' inertia. The teacher's educational activities and the students' reactions are analyzed in the light of the theory of Transformative Learning. We adopt the theoretical and analytical tools provided by the theory of Interest Dense Situation and the theory of Self-Determination. A qualitative and quantitative analysis was conducted referring to a didactic experiment monitoring various elements through a questionnaire consisting of open-ended and Likert questions and thought closed questions together with the results of the midterm test.

KEYWORDS: Distance Learning, Transformative Learning, Covid-19, Undergraduate Teaching, Intense Dense Situation.

DOI
https://doi.org/10.20368/1971-8829/1135418

CITE AS
Brachetti, L., Capone, R., & Rossi, M.L. (2021). Distance – Learning Goes Viral: Redefining the Teaching Boundaries in the Transformative Pedagogy Perspective. *Journal of e-Learning and Knowledge Society*, *17*(2), 32-44. https://doi.org/10.20368/1971-8829/1135418

1. Introduction

Karl Popper, in his essay "Of Clouds and Clocks: An approach to the problem of rationality and the freedom of man" (Popper, 1966), offers us a caustic and illuminating metaphor, that of clouds and clocks. The former is considered the symbol of variability that cannot be predicted, while the latter represent the paradigm of deterministic perfection that does not permit any indeterminacy.

There are predictable events (watches) and unpredictable ones (clouds) but the behavior of clouds would be just as predictable as that of watches if we knew about clouds as much as we know about watches.

The world of watches is a deterministic, rational, organized, linear world. On the opposite, the world of clouds is irregular, unstable, chaotic, and unpredictable.

Although the analysis of learning contexts always requires adopting a perspective capable of describing and interpreting complex phenomena (Morìn, 2000), traditional forms of teaching organization, especially at the university level, are usually characterized by consolidated, predictable, and reassuring mechanisms both for teachers and students. Even with some exceptions, innovation is not easy to promote under normal conditions, and new "certainties" are needed before a change can be introduced. However, there are sometimes events that are so traumatic that they cause a change from a world of watches to a world of clouds and after those it takes a long time to reach an equilibrium which has a rational, structured and predictable shape.

The perception of the scenario we are experiencing nowadays is much more similar to what we might have in front of a gigantic cloud, which is a metaphor of the result of the explosion of the threatening COVID-19 emergency.

"In abstract terms, traditional boundaries between practices suddenly change. New boundaries are formed: physical distance and lack of easy communication and access. However, some boundaries fall away. Erasmus' saying that "space separates body, not minds" gains new meaning five centuries later" (Bakker & Wagner, 2020; p. 1).

[1] corresponding author - email: robertocapone69@gmail.com

© Italian e-Learning Association

We were suddenly faced with a drastic change in our lifestyle and the need to review our needs' priorities. The world of school and university immediately reacted to this situation: all over the world, for the entire duration of suspension of teaching activities in the physical venues, Distance-Learning methods supported by technologies were activated. The problem to face was to invent a new pedagogy and a new way to organize didactics concretely, since people were deeply impacted at the emotional and affective level.

Distance-Learning had to become a "Closeness-Learning" and, in a challenging situation from all points of view - even for teachers -, had to find new ways to allow students to enter into a relationship with other people. Anyway, this particular situation offers an opportunity to question the assumption that Presence-Learning and working synchronously is the best possible way of teaching. With this research, we try to analyze this particular aspect of Distance-Learning, rethinking critically at how we worked before the COVID-19 crisis and elaborating possible ways to overcome linear processes' inertia. We analyze, in this paper, the effect of a didactic-educational approach based on Distance-Learning, used in a Calculus II class with Engineering students in their first year of Bachelor. The teacher's educational activities and the students' reactions are analyzed in the light of the theory of transformative pedagogy (Mezirow, 1997), which will be described in section 3.1, trying to understand if the transformations in didactic can give rise to new teaching-learning methods able to survive the duration of the crisis, or if they are only ephemeral manifestations dictated by contingent needs and destined to decline. In the refinement of the analysis lens, we decided to adopt the theoretical and analytical tools provided by the Interest Dense Situation (IDS) theory (Bikner-Ahsbahs, 2004) and the self-determination theory. At first, after describing the teaching choices made by the teacher, we analyzed them in light of the IDS framework to understand how the teacher tried to answer the needs of the students, to make the students feel his presence, and to involve the students in a situation of interest. Later, the same theoretical lens was used to investigate how didactic innovation influenced students from the dialectic point of view between the need to "be present" and that of learning. Data were collected to explore these aspects through online questionnaires and analysis of activities on a social platform. From the students' answers to the questionnaire, an initial confusion for the new approach to study was followed by a natural adaptation to the unique situation in an increasingly serene atmosphere. From the analysis of the dialogues on the platform, students' need to discuss with peers and teachers seems to emerge. Moreover, compared to previous years, it is possible to notice a more significant interaction and willingness to share the difficulties that gradually arise. The analysis of students' needs in this new context led us to hypothesize that this new method can even have positive effects on learning mathematics. Indeed, the IDS framework introduces a fruitful relationship between the need to feel competent in the discipline and the perception of an interest given by the learning situation. We, therefore, hypothesized that the new need for competence generated by the situation could become an engine for students to keep up with the course and learn to maintain contact, even human, with the teacher and the colleagues. Hence, we decided to compare the results of the course's intermediate test (carried out on May 16th, 2020) with the results of the analogous tests carried out in previous years, when a Blended-Learning methodology had already been adopted. The results generally confirm our hypothesis.

In this paper, we describe in §2 a review of the literature about Distance-Learning; in §3 the theoretical framework of IDES and Transformative-Learning; in §4 the research questions we will try to answer; in §5, the context of the research, the participants, the digital resources used; in §6, the discussion of some protocols analyzed; in §7, the conclusions reached.

2. Distance-Learning: a literature review

Distance-Learning is a didactic methodology consisting of a teacher-learner interaction that does not happen in the presence (Clements et al., 2013; Borba and Linares, 2012). Since one of the earliest attempts in 1728 - this was in the Boston Gazette for "Caleb Philipps, Teacher of the new method of Shorthand", who sought students who wanted to learn through weekly mailed lessons (Holmberg, 2005) – Distance learning has made significant progress, especially with the advent of the web and the proliferation of information technologies. Nowadays, all over the world, many courses are delivered through Distance-Learning, and entire degree courses can be attended in this way. Courses can be taken in Asynchronous Online Learning (AOL) and Synchronous Online Learning (SOL) modes, depending on the student's needs. The former is learning activities in a web-based environment that provides communication between class members and interaction with the contents in time and place that are flexible according to each individual's convenience. Technologies that enable AOL include email, text messages, blogs, online discussions, wikis, streaming media, or a digital content management system. The latter are learning activities in a web-based environment that allow real-time communication between class members and interaction with the contents. Technologies that enable SOL include text, audio- and/or video-based chat, video conferencing, simultaneous presentations from physically distributed sites, and application sharing. Both these two learning

© Italian e-Learning Association

Communities of practice	Networks of practice
Members meet in presence	The members do not know each other in-person
They are groups which are closely connected within the organization to which they belong	They are groups which are mildly connected within their organization
Strong reciprocity but poor geographical distribution	Weak reciprocity but wide geographical distribution
Mainly direct knowledge flows, both implicit and explicit	Indirect knowledge flows, mediated by explicit technologies

Table 1 - Features of the communities and networks of practice.

ways contributed to the didactic action in this experimentation.

When learning in a social context, each actor of the didactic scene contributes, more or less consciously and voluntarily, to the other's growth. Thus, the act of learning becomes the result of a community of practice, within which each one interacts, participates, and contributes to defining the role of the other and one's own. According to Wenger (1999) the community of practice is a self-organized system articulated across three dimensions:

- The domain – or thematic field is what the members share, in which they participate and can evolve.
- The community is the element that stimulates interactions and sharing ideas.
- The practice is the specific knowledge that is shared and preserved.

In the community of practice, a continuous negotiation of practices and meanings is triggered, since the training-learning path becomes a place of exchange where discussion actions are required.

According to Wenger, in order to perform a task in a community of practice, the following steps must take place:

- *Reification*: to achieve a task collaboratively.
- *Participation*: an action which is at the same time collaborative but equal and personalized.
- *Negotiation of meanings*: a group reflection on what has been carried out.

With Distance-Learning, the idea of community goes beyond the possibility of a physical encounter: it is a virtual community, but the same phases described above are involved. In this case, the community of practice becomes a "network of practice". Nichani and Hung (2002) speak of a "network of practice" and distinguish it concerning a community of practice described in Table 1. Our conception of the virtual community can be interposed between the two, including both elements of one and the other. We will refer to it as a community of practice via web network.

Many studies in Italy have highlighted the importance of integrating traditional teaching with teaching provided via the web or, more generally, through the use of information technologies (Robutti, 2010; Capone et al., 2017; Taranto et al., 2018).

Studies by Albano and Ferrari have been conducted to contribute to overcome the gap between technology and educational research, as their joint use can provide unparalleled opportunities to address many learning problems related to mathematical concepts and linguistic factors, both metacognitive and non-cognitive (Albano & Ferrari, 2008).

Other studies about online education have analyzed how the learning process might change in e-learning environment, with respect to the involved actors and the relationships among them. In particular they we have considered the implication of the student, that is the interaction–relationship between the learner and the knowledge, structured through situations of action, formulation and validation, which lead the student to the construction of his own knowledge. The impact of digital technologies has consequences since both new actors (e.g., author) and new meaning of existent ones are created. Moreover, they seem to well fit the a-didactical situations (Brousseau, 1998), because they, suitably arranged by the author-tutor and as powerful tools containing knowledge, naturally foster exploration, conjecturing, explanation, verification and proof (Albano, 2005).

More recently, since Distance Learning went viral, there have been many studies conducted internationally. The authors, in another article, analyzed Engagement, Motivation and Participation through a fuzzy cognitive map with university students. They show that Distance Learning is valid as an additional and support methodology but, on the other hand, they highlight the ineffectiveness of completely remote teaching.

Therefore, a teaching method that integrates moments of distance teaching with activities carried out in the presence, in the classroom, or in other university environments, is hoped to be used as soon as the emergency is over: a mix of styles, a fluid flow of knowledge between the physical classroom and the virtual classroom. They call this Integrated Digital Learning. (Capone & Lepore, 2021).

© Italian e-Learning Association

Bakker and colleagues (2021) wondered if the pandemic changed the point of view on the themes of mathematics education research. According to the authors, the pandemic worked as a lens on the already important issues of social and educational problems. For example, designing new teaching approaches, orienting mathematics learning also towards solving social problems such as species extinction, solving climate change, building a sustainable future.

Some authors (Siregar & Siagian, 2021) evaluated the online learning of mathematics highlighting the change of the learning method. They showed the usefulness of online communication media such as whatsapp but also the lack of interaction between instructors and students. Some authors, in several countries around the world, have investigated about distance learning process of teaching during school closure (Azhari and Fajiri, 2021). Some authors highlighted difficulties due to economic factors or teachers' ability to adapt to a quick change in their teaching or difficulties due to limited access to the internet, such as the case of Indonesia.

Others have highlighted that use of different approaches to organizing distance learning during the COVID pandemic. Still others have studied how to make use of resources and laboratory activities with distance learning (Alabdulaziz, 2021).

A special issue is in press (Chan et al., 2021) by Educational Studies in Mathematics, gathering voices from researchers internationally in mathematics education about teaching mathematics during this pandemic. There are indeed many authors who have written in this past year. Ours is intended to be the voice of researchers who, like others, have had to reorganize their teaching by reporting a case study very similar to many other situations that have arisen in the world.

3. Theoretical Background

3.1 The Transformative Learning Theory

According to the Transformative Learning Theory (Mezirow, 1997), learning is the expansion of consciousness by transforming the basic worldview and specific skills of the self. In transformative learning, particular didactic conditions can occur, resulting in the process of "perspective transformation," which is articulated across three dimensions: a *psychological* dimension which involves changes in the understanding of the self; a *convictional* dimension which involves a revision of the beliefs; a *behavioral* dimension which involves changes in the lifestyle. Jack Mezirow argues that perspective transformation, which leads to transformative learning, usually results from a "confusing dilemma" that is triggered by a life crisis or a major transition, although it may also result from an accumulation of transformations into patterns of meaning over some time. An essential part of transformative learning is that individuals (both teachers and students) change their frames of reference by critically reflecting on their assumptions and beliefs and consciously implementing and realizing plans that determine new ways of defining their worlds through a rational and analytical process. The learning process is inherently linked to the idea of change, of the evolution of a status. This change includes the student's educational needs, whose analysis is essential for the effective teaching-learning process. But change is not always a transformation. In this paper, some educational elements of Distance Learning that could lead to a paradigm shift in educational teaching are analyzed, such as, for example, the use of a social platform in the learning curriculum, the use of a platform to manage some moments of university distance learning, the use of a YouTube channel to integrate video lessons with more traditional didactics.

3.2 The Theory of Interest Dense Situation

The Theory of Interest Dense Situation (IDS) (Bikner-Ahsbahs, 2004) provides tools to investigate how didactic innovation has influenced students from the debate between the need of presence and that of learning. The self-determination theory of Deci and Ryan (1985), on which Bikner-Ashbahs' IDS theory is based, claims that an individual's well-being is the result of the fulfillment of three basic psychological needs:

- need for *autonomy*: to feel free in each action and feel that one is acting by one's own will.
- need for *competence*: to believe to be able to act competently in one's own environment to carry out important tasks.
- need for *relationships*: to seek and develop safe and positive relationships with others in one's own social context.

In order to analyze the change and understand if a new methodology has the potential to generate transformation, this theoretical lens can be used to show if Distance-Learning is well-positioned to meet the needs that students had before, but also if and how these needs have changed as a result of this experience prolonged over time. The IDS theory recognizes three main elements that foster the emergence of an interesting didactic situation:

1. *involvement*: one after the other the students are involved in the activity (need for relationship);
2. *dynamics of the epistemic process*: one after the other the students construct continuously farther-reaching meanings (need for autonomy);
3. *mathematical valence*: the value of the situation is concerned with mathematics (need for competence).

© Italian e-Learning Association

In a classroom activity, involvement depends on both the teacher and the students' behavior. The teacher can be oriented by his/her expectations related to the topic or by the situation itself. Similarly, students can be influenced by the teacher's expectations or act independently of them. The situations that most effectively let an IDS emerge occur when the teacher lets the situation orient his/her behavior and the students act independently of the teacher's expectations, encouraged to express their ideas.

4. Research Questions

The questions we asked ourselves at the beginning of this research work concerned the impact that the new Distance-Learning has had on the students and how the strategies adopted to deal with the emergency have fulfilled students' needs. Furthermore, we asked ourselves whether the strategy adopted in this emergency can generate a transformation, in Mezirow's perspective, in the structure of a university course in Calculus, in the ways of interaction among students and between teacher and students. In particular, we formulated the following research questions:

What were the main changes between face-to-face teaching and Distance-Learning, in this case study?

To what extent did the new methodology satisfy the three primary needs of autonomy, competence, and relationship, and how much did it affect the students' perception of the quality of the teaching-learning activities and their interaction with the colleagues and the teacher? What aspects of this new modality were recognized as the most useful and transformative students?

To answer the first question, we analyzed the new teaching strategies used by the same teacher (RC, author of the paper) to transform a blended (face-to-face plus e-learning) into a full Distance-Learning course to fulfill the students' needs in this emergency situation. To address the second question, we investigated the factors that more affected them in this sudden change and to which extent such a change resulted in a transformation (Mezirow, 1999), through the students' evaluation of the course, asking them both general questions and specific questions about what changed in their learning. Moreover, we studied the impact of this emergency on their perception of their needs (autonomy, relationships and competence) and the way it evolved during the crisis. Finally, we analyzed how the new ways the teacher fulfilled their needs fed the interactions on the social platform and influenced the results of the mid-term test.

5. The Case Study

5.1 Context

The didactic experimentation involved the students of the first year of Mechanical Engineering and Management Engineering at the University of Salerno, attending the Calculus II course, the course teacher, two Mathematics education researchers and one master's student.

The students who were expected to attend the class were 108 (since they officially participated in the first year); 124 students were asked to login into the platform (also students of the previous years). The average number of students attending the SOL is around 90. Among the 124 students, 86 students answered the questionnaire. The university has provided some students who had socio-economic disadvantages with computers to attend the courses, so we can state that the students who did not participate in the class have not been prevented from doing it because of their condition and personal choice.

The course was carried out during the second semester of the first year, after students had attended and/or taken a Calculus I exam. The course included 90 hours of lessons, divided into 54 hours of theory lessons and 36 hours of training. Other 24 hours of exercises were conducted by the tutors, with students divided into two groups. For some years, the course has adopted a blended teaching approach, to create a student-centered learning environment that takes advantage of information technology and encourages peer collaboration. Furthermore, the emotional aspect contributing to the students' educational success has always been valued to motivate students to manage their learning process autonomously, actively and consciously. The social platform has encouraged interaction between students even in a virtual community. Active teaching-learning methodologies have been implemented. One of those is Just in Time Teaching (JiTT), which consists of exploiting the classroom feedback activities that students carry out at home to improve teaching effectiveness, optimize times during classroom activities, and increase student motivation. If we analyze a cycle of JiTT with the frameworks of IDS and self-determination, both the need for competence and the need for relationships emerge and the dynamics of epistemic processes linked to the autonomous construction of some mathematical concepts. The fact that students feel free to share their answers to the exercises shows that they feel competent on that topic. This is also due to the possibility to discuss the tasks with the teacher and peers. Furthermore, since the exercises assigned at the end of a lecture regard topics not fully introduced yet, a gradual construction of the new issue (dynamics of the epistemic process in the IDS) is reached. In recent years, several experiments have been conducted to

© Italian e-Learning Association

improve the teaching action's effectiveness. In particular, in the academic year 2016/17, a blended teaching model was tested with a half-flipped teaching in the SCALE-UP learning environment (Branchetti et al., 2018). In the academic year 2017/18, a blended teaching was tested using the Just in Time Teaching and Peer-Led Team Learning methodologies integrated with the use of a social platform (Capone, 2020). In the academic year 2018/19, the experimentation went on using Augmented Reality to address some crucial topics of the mathematics course and evaluating Student Interaction and Participation with Fuzzy Cognitive Maps as a systemic structure model for analyzing critical success factors of the learning system (Capone & Lepore, 2020). This year, because of the pandemic, the teacher's aim slightly changed since his goal was to create an online community of practice to better foster students' mathematical skills while enhancing collaborative learning that would overcome time and distance constraints

5.2 Resources

The following online resources have been used: custom adaptive e-learning platform (D'Aniello et al. 2020a), Microsoft Teams, Doceri, Edmodo, the teacher's website, the teacher's YouTube channel, Geogebra AR. Some of these have already been used in previous courses as a support for face-to-face teaching. The lessons were delivered on the Microsoft Teams platform, keeping the lessons' time duration and the teaching content unchanged, but providing for more breaks during the lesson and trying to interact as much as possible with the students. The exercise sessions were conducted by dividing the students into virtual subclasses to interact with the small groups' colleagues. Simultaneously, the teacher could intervene in the various classes with coaching and scaffolding actions. Despite the impossibility of the physical meeting, it was considered important that students had the opportunity to interact and discuss with peers, following the ideas based on IDS theory. A social platform has been integrated into Teams to communicate with students in a more informal way to make them feel more the "closeness" of the teacher, tutors, and colleagues. Often, the students confronted each other about carrying out the exercises and pointed out their difficulties or commented on the other students' performance. In a non-invasive way, the teacher and tutors had the opportunity to read the comments and analyze the progress of the exercises. Students often allowed us to monitor the students' skills step by step, the difficulties they encountered, and the points to dwell on with more considerable attention. Furthermore, on the teacher's YouTube channel, video clips of the lessons and examples of exercises were uploaded. The Doceri app has been integrated into the Microsoft Teams platform and used as a digital board to create video clips with solved exercises. Some tools, among those described, were an integral part of the course already in previous years. The tasks assigned to the students described above have been designed to create the conditions for students to face problems from their perspective and in an autonomous way. One of the main goals was to create an online community of practice in which a shared experience connected students to give meaning to their learning experience.

The use of these resources is in accordance with the framework proposed by Bray and Tangney (2016). This approach focuses on the creation of activities that fall within the Transformation space: transformative uses of technology are those which allow significant task redesign (modification) or permit the creation of tasks that would not be possible without the digital tools (redefinition). These aspects have contributed to the implementation of the activities of this course especially as regards the parameter of engagement in learning mathematics.

5.3 Methods

This research is based on both quantitative and qualitative methods. The quantitative analysis concerns the data collected with the closed questions included in a questionnaire addressed to the Calculus II course students at the University of Salerno (Italy) and the mid-term test results submitted to students verifying their skills in mathematics. Furthermore, some quantitative data are collected from the answers to the questionnaire sent to the students via Google Forms.

The multiple-choice ones have been set according to the Likert scale (1932).

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
Never	Rarely	Sometimes	Often	Always
Not at all Satisfied	Slightly satisfied	Moderately Satisfied	Very satisfied	Completely Satisfied
(1)	(2)	(3)	(4)	(5)

Table 2 - Likert scales about statements of agreement, frequency and satisfaction.

The qualitative analysis follows a Content Analysis methodology. It is based on protocols derived from the dialogues on the social platform among students and between students and the teacher and the answers to the open-ended questions included in the questionnaire. Indeed, the questionnaire included both open-ended and multiple-choice questions: the former was designed so that the student's emotional state could be inferred; the latter was formulated so that it was possible to deduce elements of appreciation and criticalities of the didactical approach adopted.

© Italian e-Learning Association

The questionnaire was also designed to investigate the fulfilments of the students' needs highlighted by IDS and their perception of the changes due to the pandemic. When referring to students in their first year of university attending a Distance-Learning course, it becomes necessary to identify markers that can be associated with fulfilling the needs of *autonomy*, *competence,* and *relationships*. We decided to make the following choices:

- The need for *relationships,* as in any other age group, is identified by Likert indicators and sentences in the questionnaire, and comments in the social platforms, referring to a good quality of the discussion between teachers and students and among students themselves and the number of messages and interactions between the students.
- The need for *competence* is linked to the need of feeling to be able to face the tasks that are proposed and to the need for accountability in the group, so we looked at the number of interventions of the students in an online discussion about a mathematical task on the platforms and during the lesson (so they felt able to say something relevant about the solution), the number of students attending the mid-test.
- The need for *autonomy* is the most difficult to detect: it can be linked, for example, to personal behaviors declared in the questionnaire, or with a Likert indicator or in an open question, such as concentration, organization of their work, perseverance in the study and their difficulties (that show that a student is acting on one's own will and looks his/her way to face the new situation), personal search for other resources to meet the tasks related to the contents and easy to find for them.

A global marker that we looked at is the number of students who decided to attend the online course (AOL and SOL activities, social platform), compared to the first semester, since we considered it an indicator of the fact that the needs were fulfilled enough to convince the students that the new methodology could be useful for their learning. Indeed, the students were not obliged to attend the SOL lessons, nor for institutional constraints nor because of a lack of AOL materials.

At the beginning of the questionnaire, we asked the students if they had attended the lessons in the first semester and if they were doing the same in this second semester, and if they preferred the SOL and the AOL activities (recorded lessons and interactions on the platforms). The questions concerned the need for autonomy, the need for competence and the need for relationships, and the students' perception of their change. First, we asked an open question concerning their reactions and fears when they were informed of the new Distance Learning course and another question about how these perceptions changed over the first two months. The questions through which we investigated more precisely the needs were the following.

The questions related to the need for *autonomy* are:

- "From a university point of view, did you think that you would have lost something important for your concentration and ability to organize your study routine?";
- "Has anything changed in terms of concern over concentration and ability to organize your study routine since the beginning of this experience?".

The questions related to the need for *relationships* are:

- "How frequently do you discuss with your colleagues about the course's teaching activities?";
- "From a university point of view, did you think that you would have lost something important for your daily life, your relationships with your classmates and teachers at university?";
- "Since the beginning, has anything changed in terms of the quality of your daily life, of your university relationships with colleagues and teachers?"

The need of *competence* was investigated looking for sentences that were related to the markers we listed above, in particular considering the open answers to the following question:

"If you were asked to suggest something to a teacher about Distance Learning, what would you keep and what would you change to make a student feel more engaged, competent, and trustful in this new modality, also considering your mates' opinions?"

The questions aimed at investigating the students' perception of the change, in psychological, conventional, and behavioral terms, are the following:

"From a university point of view, did you think that you would have lost something important for:

- Your daily life and your relationships with the teacher and the mates?
- Your mood?
- Your concentration and ability to organize your work?
- The quality of your overall training, which would have been better without this experience?
- The quality of the teaching?
- The free time and time devoted to your studies?

For all the previous aspects, we also asked: "Since the beginning, has anything changed?". Some of these elements also emerged from the dialogues among students on the Edmodo platform. As for the analysis of the mathematical competence, we measured it with a mid-term test compared with the one of 2018/19, and

© Italian e-Learning Association

we could also compare them in terms of the results of the two cohorts.

6. Results and Discussion

In this section, data from a qualitative analysis (Sect. 8.1) and a quantitative analysis (Sect. 8.2) are reported highlighting main research findings.

6.1 Quantitative Analysis

First of all, we report some data about the students' participation in our survey, compared to the number of students in the course. Observing the data about the average frequency, we observed not only the same percentages of students attending the lessons but, in the questionnaire, a higher quantity of students answered to have very frequently attended the lessons in the second semester than in the first one (74 in the second semester, 71 in the first one).

A first global observation showed that the physical distance had led students to participate more actively in the educational proposals. For example, we noticed that the interaction among students through the social platform, has been more frequent than in past years. Indeed, the average number of accesses to the platform was much higher this year, 12 in 2018/2019 and is 62 in 2019/2020, while the average number of students attending the lessons was approximately the same in 2018/2019 (calculated using the number of accesses with the badge to the rooms during the lesson time of this course) were 90 on 130, while in 2019/2020 (calculated using the counter on Teams) were 90 on 124. We can thus state that this year, in the emergency, the platforms have become real virtual communities of practice, satisfying the need for interaction and discussion with the peers and the teacher. Moreover, we interpret the large number of interactions concerning mathematical tasks and their solutions, in a context usually devoted to social interaction, as a global indicator of the fulfilment of the need of competence, since the students showed to feel confident to be able to say something relevant and disciplinary grounded about the task proposed by the teacher. We did not find any information about the need of autonomy in this first set of quantitative data. Students' answers to open questions about educational needs follow. When asked how frequently peer discussions were conducted through Distance Learning about the course's teaching activities, 69.77% of students answer 4 or 5 on the Likert scale.

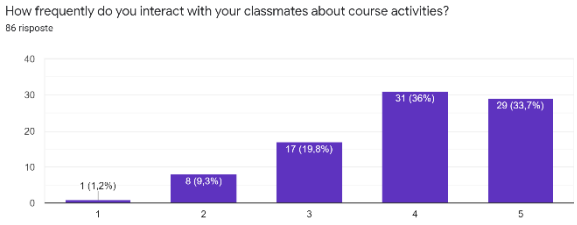

Figure 1: Students' response to the question: How frequently do you interact with your classmate about course activity?

Hence, it emerges that the need for relationships is fulfilled even in Distance-Learning.

Since the teacher has suggested students to exchange their solutions to the exercises, the number of comments under the posts with assigned tasks has increased considerably, so it seems that the students trusted the teacher and appreciated the way he interacted with them and for this reason they accepted to use the interact on the platforms.

In the questionnaire, we asked:

"From a university perspective, you thought you were going to miss something important to:

- your daily life, your relationships at the university with peers and professors
- your mood
- your concentration and ability to organize yourself
- The quality of your overall education, which would have been better without this experience
- teaching quality
- The time studying that would have taken the most time out of your life outside of the university"

Students had to answer each point with a value from 1 to 5.

Focusing on the perception of the impact of the change on the quality of the teaching-learning in the present situation and on the students' careers, at the beginning of the emergency, around 66% of the students thought that the quality of the overall training would have been significantly compromised by the new way to deliver the lessons (4-5); in particular, for 57% of the students, Distance-Learning was a concern especially about the effectiveness and overall quality of the courses, that would have decreased without any corresponding change in the requests during the exams.

© Italian e-Learning Association

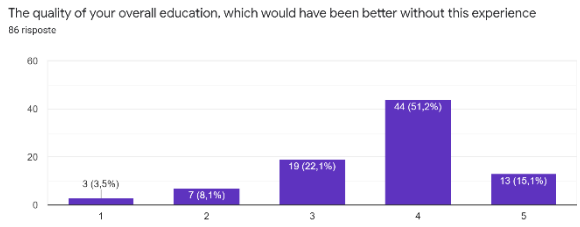

Figure 2 - How the students answer about the quality of their education without the pandemic.

The percentage drops considerably after the start of the course. Students seem to feel reassured that the quality of their education will not be compromised.

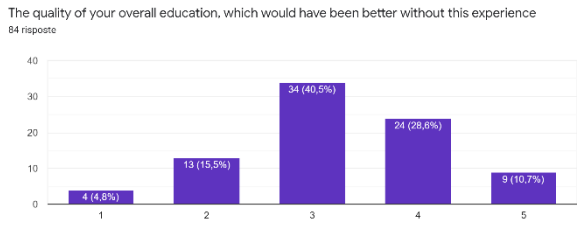

Figure 3 - How the students answer about the quality of their education without the pandemic after the start of lessons.

About the need for autonomy, we report some students' opinions.

When the emergency began, more than half of the students (around 66%) thought they would have lost out both in concentration and organization.

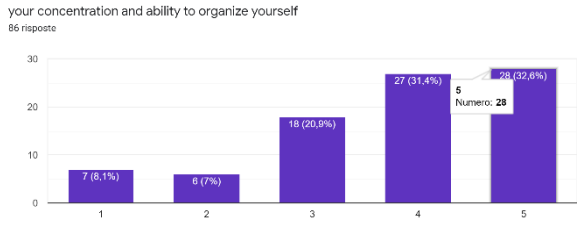

Figure 4 - Students' concerns about concentration and the ability to organize themselves.

We then asked whether, once they had started the course, their perceptions of the above points had changed.

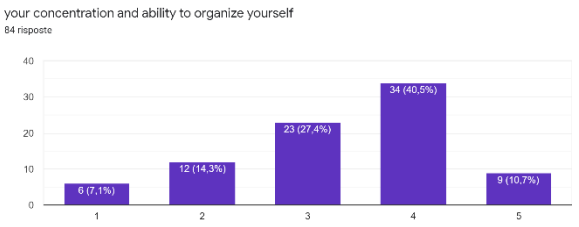

Figure 5 – Students' concerns about concentration and the ability to organize themselves after the start of lessons.

This percentage dropped considerably after a month of Distance-Learning, even if the engagement, according to the students, has dropped.

The need of competence is shown by analyzing the intermediate test results and comparing them with those obtained the previous academic year. An overall improvement of a few percentage points can be observed. The table shows the comparison between the mid-term test results in 2018/2019 and 2019/2020.

Mark	A. Y. 2018/19	A.Y. 2019/2020
Fail	32%	26%
D (Initial)	22%	19%
C (medium)	30%	29%
B (High)	12%	20%
A (Advanced)	4%	6%

Table 3 - Comparison between results of mid-term test in 2018/19 and 2019/20.

This improvement – to be further investigated considering that the student population of the two years is not the same – may be due to a greater fulfillment of the need for competence that is much more intertwined with the need for relationships.

6.2 Qualitative Analysis

Some considerations emerged from the students' open answers in the questionnaire. Here we show some students sentences some of which are repeated by multiple students. The following open-ended questions were asked in the questionnaire and the most significant responses were collected.

1. After experiencing distance learning for the first time, has anything changed from your initial perception? Are you more relaxed or more agitated, and what made you change your mind and feelings eventually?
2. At the moment, how do you feel, what do you feel you have solved and what do you feel you still need to work on in order to be more comfortable in taking classes, dealing with the teacher, dealing with peers and studying?
3. If you were to give some advice to faculty who do distance learning, what would you feel like

© Italian e-Learning Association

suggesting based on this experience you're having, exchanges with other classmates, thinking about different ways faculty have interacted? Is there any that you've found most helpful in making students feel more engaged and more confident, anything that you've found very annoying, etc., and how would you change it?

4. Explain, in a few lines, after having made the reflections suggested by the previous questions, your opinion on the online education referred to the course of Calculus II, highlighting your feelings, the positive aspects and also giving any suggestions to improve the interaction and the quality of lessons and materials.

The students mentioned the need for a relationship as the aspect of Distance learning that was more at risk and one of the leading causes of their fears. From these students' words, it emerged that the main concern at the beginning about Distance-Learning regarded the absence of opportunities for discussion: the students feared that their need for presence and closeness could not be satisfied. Some students' sentences concerning the need for relationships are reported in the following sentences:

Student 1: My worries were related to not being able to discuss with colleagues in the classroom, maybe even at the end of the lesson, as I always did before, and certainly do the same with the teacher.

As soon as the new methodology was imposed, almost 80% thought they would have lost significant terms (4/5) something important for their daily lives and relationships with classmates and teachers. Still, half of them (40%) changed their opinion after two months: even if they confirm in the open answers that they miss the human interaction with the others, their perception about the conservation of the quality relationships with the peers was more positive. Moreover, the fact that the students shared the exercises' solutions on the forums showed they felt competent in the mathematical contents addressed. Hence, it seems to reveal that their need of competence was satisfied by the teacher in this way, since asking questions mirrors a previous reflection on the topic and demonstrates that the students are acting somehow competently, even if they never mentioned it in their sentences. Many students stated that the interactions are more difficult with Distance-Learning and recognize a vital importance to eye and human contact, which cannot be replaced with digital means. However, this concern has changed after an initial period of Distance-Learning. Indeed, they seemed to be satisfied with the atmosphere of calm and serenity perceived during the lessons and with the teachers' dedication to interact with the students, making "the distance less aggressive". This is an example of a students' sentence:

Student 2: I'm getting used to this type of lesson. The difficulties are decreasing. I am more serene because even if some concept is not perfectly clear to me in a synchronous way, I can get excellent explanations from the teacher or listen again to the lesson asynchronously.

The AOL lessons seemed to be appreciated by the students, even if most of them declared to prefer the SOL lessons. Answers like the one given by Student 3 after having lived the Distance-Learning experience show that the possibility of re-watching the lessons and independently recovering the missing passages of the notes is a stimulus for a more profound learning. Given the possibility of re-watching the teacher's theoretical explanations and to discuss on the platform about the assigned exercises, the individual study resulted to be strengthened and enriched. These aspects are also related to the behavioral dimension of transformative learning. Indeed, the difficulties of Distance-Learning have transformed into opportunities to be preserved also as good practices in face-to-face teaching.

Student 3: My concern was that of being penalized from the didactic point of view, given the change we were facing, and the objective difficulties presented by distance lessons, both for us as students and for the teachers. Furthermore, my concern at the beginning also regarded the great veil of uncertainty about the exams.

39% of the students changed their opinion after a few lessons. We found some possible motivation for this change in the answers to the open-ended questions. For instance, a student stated that he felt to be "protected", since the quality of teaching had been preserved, as can be read in the following sentence:

Student 4: Concerning the beginning, I feel more reassured because the teachers have tried as much as possible to take care of the problems due to distance, and they made themselves available. Hence, for the quality of teaching, I feel quite protected. (…)

Moreover, some students pointed out some positive aspects of the new Distance-Learning modality: the embarrassment decreased, which also facilitated the teacher's interactions. The same fact of asking questions or making comments, for example, about an exercise's solution, actually fulfills the need for competence. This attitude can also be interpreted in the light of the psychological dimension of transformative learning: during face-to-face lectures, shyness prevailed and held back students in asking questions and sharing solutions to the exercises, while with Distance-Learning they have gained confidence and awareness of their own abilities, also thanks to the wider availability of time for individual study. This aspect also seems promising from the perspective of reasoning in terms of a change that can transform the students' behavior towards the teacher. This result confirms the teacher's great relevance, both in terms of

© Italian e-Learning Association

satisfying the need of relationship and competence. The two protocols listed above have highlighted that the students encounter more significant difficulties in organizing and staying focused at home:

Student 5: It is a distressing situation. However, attending the lessons online allows us not to lose our everyday life. I am concerned that I cannot stay focused during classes at university.

Let's compare the initial sense of disorientation and the greater serenity after a couple of months. It seems that Distance-Learning has created a new educational equilibrium, giving a new meaning to presence, as is highlighted in the following sentence:

Student 6: I felt disoriented. Not attending the lessons anymore in presence led me to change my routine, aware that the classes would have never been the same again. I had to reorganize myself. At first, I was afraid that the direct relationship between teacher and student would have weakened. It is not easy to communicate with 100 students on an online platform. Another fundamental point is the number of hours spent in front of the computer. Five hours in front of the computer are much more exhausting than 5 hours in the classroom.

Student 7: Of course, online lessons are a great opportunity in this period. They allow us to move forward and, in a certain sense, to distract ourselves in this critical situation…

These sentences seem to reflect the conventional dimension of transformative learning. The initial uncertainties, fears, and distrust toward the effectiveness of Distance-Learning seem to have been softened after having experienced it. These fears led to a revision in terms of their beliefs that led the student to discover that they could accept the new situation, find new resources, and become aware of their needs explicitly and thoughtfully. The students mentioned some problems concerning the SOL lesson in Distance-Learning:

- The perception of the increased rapidity of the lesson.

Student 8: My only concern at the beginning was the fact that, inevitably, distance learning would have seriously compromised the quality of teaching, regardless of the teacher. I notice the main difference is that distance lectures are faster than traditional ones.

- The need of improving the students' autonomy and competence in this new setting.

From the open-ended questions emerges the request to solve the assigned exercises individually and, only after this attempt, to correct them. This request corresponds both to a need for competence, as the students want to feel able to move in their field of study and a need for autonomy.

7. Conclusions

This paper has highlighted how Distance-Learning, already widely adopted in the past, has been characterized in this historical moment with a new meaning. Distance-Learning was essential for strengthening the relationships. In Italy, a note from the Ministry for Education, University and Research delivered on March 17th, 2020, demanded the entire educational community activate Distance-Learning to keep the school communities alive and create a sense of belonging that could face the risk of isolation and demotivation. Due to the pandemic's worldwide spread and its consequences, the learning environments, the teacher-learner relationship and the very organization of teaching times, and the methods for students' assessment had to be restructured. This process had to consider students' needs and requests that are usually not fulfilled with the completion of the course's program. This new form of Closeness-Learning required to make the educational contents functional for an effective learning process, emphasizing their educational value but also taking care of the students' interest and needs since more than ever, the time spent attending the course was for the students a life experience in a dramatic period, where we all got lost and had to reconstruct our relationship with the others, our work, and our daily life. This research had both nomothetic and idiographic goals. On one side, one aim was to shed light on an entirely new educational reality generated by the emergency due to COVID-19. On the other side, we wanted to abstract from this specific situation some elements that could be transferred to different contexts, in particular at the university level. To do this, a qualitative and quantitative analysis was conducted referring to a didactic experiment with a class of Calculus II of the degree program in mechanical and management engineering at the University of Salerno (Italy). Several elements were therefore monitored during the entire course. The students were given a questionnaire consisting of open-ended and Likert questions. The answers to the closed questions and the midterm test results were the quantitative analysis data. The answers to open-ended questions, together with the students' dialogues on the social platforms, have made it possible to make a qualitative analysis of the students' reactions and adaptations and their opinions about this new teaching-learning experience, with the lenses of transformative pedagogy, IDS (based on the theory of self-determination). We observed that the students, in their responses, tried to make comments that could not be interpreted as arguments in favor of transforming the face-to-face or blended version of the course into a Distance-Learning. They demonstrated that they resisted and avoided that this change could become a global transformation of the previous methodology.

© Italian e-Learning Association

However, some elements seem to be useful to integrate with traditional teaching and can be considered transformative: The possibility of reviewing the lessons and having slides and brochures available has given students the confidence and autonomy to refine their notes. Moreover, private messages to the teacher allowed students to have an individual interaction with the teacher, with greater freedom of expression. These elements seem to satisfy the need for relationship and competence. The teacher's role has been instrumental in guiding students to accept changes a little at a time and positively impact student outcomes. After almost two months of Distance-Learning, with lectures delivered on the Teams platform and exercises shared on the Edmodo page of the course, it can be observed that the atmosphere among the students is much more serene than at the beginning when concerns and uncertainties were prevalent. The need which was fulfilled the most was that of relationships: positive connections were developed between the students, who helped and supported each other in solving exercises, and also with the teacher, who was always available to answer doubts and clarification and capable of creating an environment in which students could feel involved. The overall teaching quality does not seem to have been particularly affected: the students feel to be competent in the process of solution of the exercises. We hope that the analysis of students' needs and their fulfillment through Distance-Learning can give rise to unexpected connections. We refer to the relationships that allow access to a client through IT protocols or software. We also refer to synaptic connections able to produce cognition and generate positive emotions that reduce the feeling of being victims in the throes of fear and anguish, making us act in a non-adaptive way. The Distance-Learning, using an oxymoron, became a Presence-Learning. The platform allowed to obviate the lack of face-to-face confrontation, satisfying the primary need for relationships among students and the teacher. We believe that this use of the platform can be an element to be valued even when face-to-face teaching will be reintroduced, to bridge the difficulties due to home-university distance, or to study rooms that are not always designed to support constructive peer discussion. The possibility of participating and sharing solutions in a virtual forum has also stimulated the need for competence, which undoubtedly benefited from the availability of didactic resources and recordings of the lessons. Therefore, it would be desirable to preserve this aspect even when this emergency phase will be overcome, given the close link between the need for competence and a gradual deepening of learning. Undoubtedly, we hope to return to face-to-face teaching. Human values and relationships take on a concrete and visible shape, without completely removing the potentialities that emerged with Distance-Learning but, on the contrary, integrating the two methodologies' strengths.

References

Alabdulaziz, M. S. (2021). COVID-19 and the use of digital technology in mathematics education. *Education and Information Technologies*, 1-25.

Albano, G., & Ferrari, P. L. (2008). Integrating technology and research in mathematics education: the case of e-learning. In *Advances in E-learning: Experiences and Methodologies* (pp. 132-148). IGI Global.

Albano, G. Mathematics and E-Learning: A conceptual framework. *Fourth Congress of ERME, the European Society for Research in Mathematics Education, 17-21 February 2005*, 2005, San Feliu de Guíxols, Spain. 10 p.

Azhari, B., & Fajri, I. (2021). Distance learning during the COVID-19 pandemic: School closure in Indonesia. *International Journal of Mathematical Education in Science and Technology*, 1-21.

Bakker, A., Wagner, D. Pandemic: lessons for today and tomorrow? *Educ Stud Math* (2020).

Bakker, A., Cai, J., & Zenger, L. (2021). Future themes of mathematics education research: an international survey before and during the pandemic. *Educational Studies in Mathematics*, *107*(1), 1-24.

Bardelle, C., Di Martino, P. (2012). E-learning in secondary–tertiary transition in mathematics: for what purpose? *ZDM*, *44*(6), 787-800.

Borba, M. C., Askar, P., Engelbrecht, J., Gadanidis, G., Llinares, S., & Aguilar, M. S. (2016). Blended learning, e-learning and mobile learning in mathematics education. *ZDM*, *48*(5), 589-610.

Bikner-Ahsbahs, A. (2004). Interest-dense situations and their mathematical valences. In *Tenth International Congress in Mathematics Education, Topic Study Group, Copenhagen. [Online: http://www. icme-organisers. dk/tsg24/Documents/BiknerAshbahs. doc]*.

Branchetti, L., Capone, R., & Tortoriello, F. S. (2018). Un'esperienza didattica half-flipped in un ambiente di apprendimento SCALE-UP. *Annali online della Didattica e della Formazione Docente*, *9*(14), 355-371.

Bray, A., & Tangney, B. (2016). Enhancing student engagement through the afordances of mobile technology: a 21st century learning perspective on Realistic Mathematics Education. *Mathematics Education Research Journal,* 28(1), 173–197.

Brousseau, G. (1998).*Théorie des situations didactiques*. Grenoble: La pensée sauvage. Coll. Recherches en didactique des mathématiques.

Capone, R., De Caterina, P., & Mazza, G. (2017). Blended learning flipped classroom and virtual environment: challenges and opportunities for the 21st century students. In *Proceedings of EDULEARN17 Conference* (pp. 10478-10482).

© Italian e-Learning Association

Capone, R., Del Regno, F., & Tortoriello, F. (2018). E-Teaching in Mathematics Education: The Teacher's Role in Online Discussion. *Journal of e-Learning and Knowledge Society*, *14*(3).

Capone, R., & Lepore, M. (2020). Augmented Reality to Increase Interaction and Participation: A Case Study of Undergraduate Students in Mathematics Class. In *International Conference on Augmented Reality, Virtual Reality and Computer Graphics* (pp. 185-204). Springer, Cham.

Capone, R., & Lepore, M. (2021). From Distance Learning to Integrated Digital Learning: A Fuzzy Cognitive Analysis Focused on Engagement, Motivation, and Participation During COVID-19 Pandemic. *Technology, Knowledge and Learning*, 1-31.

Chan, M., Sabena, C. & Wagner, D. (2021). Mathematics education in a time of crisis—a viral pandemic. Educational Studies in Mathematics, (in press).

D'Aniello, G., De Falco, M., Gaeta, M., & Lepore, M. (2020a). A situation-aware learning system based on fuzzy cognitive maps to increase learner motivation and engagement. In: *Proceedings of the 2020 IEEE International Conference on Fuzzy Systems* (FUZZ-IEEE) (pp. 1–8)

Holmberg, Börje (2005). *The evolution, principles and practices of distance education*. Studien und Berichte der Arbeitsstelle Fernstudienforschung der Carl von Ossietzky Universität Oldenburg [ASF] (in German). **11**. Bibliotheks-und Informationssystem der Universitat Oldenburg. p. 13

Holmes, B., & Gardner, J. (2006). *E-learning: Concepts and practice*. Sage.

Likert R., (1932) "*A Technique for the Measurement of Attitudes*" Archives of Psychology, Vol. 140, No. 55.

Mezirow, J. (1997). "Transformative Learning: Theory to Practice". *New Directions for Adult and Continuing Education, 74*, 5–12.

Morin, E., La tête bien faite. (2000). *La testa ben fatta: riforma dell'insegnamento e riforma del pensiero*. Milano: Cortina.

Nichani M., Hung D., *Can community of practice exist online?Educational Technology*, pag. 49 - 54, 2001, vol. 42, n. 4.

Popper, K. R. (1965). Of clouds and clocks: an approach to the problem of rationality and the freedom of man. *Thinking clearly about psychology: Essays in honnor of Paul E. Meehl. Matters of public interest. University of Washington Press, Seattle, WA*, 100-139.

Robutti, O. (2010). Community of learners with technologies. *Investigação em Educação Matemática*, 51.

Ruiz, J. G., Candler, C., & Teasdale, T. A. (2007). Peer reviewing e-learning: opportunities, challenges, and solutions. *Academic Medicine*, *82*(5), 503-507.

Siregar, G. M. A., & Siagian, M. D. (2021, May). Evaluation of online learning for mathematics education students. In *Journal of Physics: Conference Series* (Vol. 1882, No. 1, p. 012064). IOP Publishing.

Taranto, E., Arzarello, F., & Robutti, O. (2018). MOOC as a resource for teachers' collaboration in educational program. In *Proceedings of the re (s) sources 2018 international conference* (pp. 167-170).

Wenger E., *Communities of practice: the social fabric of a learning organization*, 1996.

 © Italian e-Learning Association