Bringing game elements to the classroom: the role of challenge and technology

Elementi di gioco in classe: il ruolo della sfida e della tecnologia

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ABSTRACT This paper illustrates a teaching methodology which implements some motivational mechanics of games to help overcome the widespread lack of interest of students and make learning engaging. A learning cycle that promotes three main transformative dimensions within the overall learning process is detailed: from deductive to inductive teaching; from transmissive to constructivist teaching; from summative to formative assessment. Some concrete examples of learning activities are provided. Finally, the implications of the methodology resulting from a quasi-experimental study conducted in a high school are discussed. The study compared two classes, experimental and control, in relation to the following variables: self-determination towards studying, basic psychological needs, and support for autonomy. The results show that there are significant differences in the analyzed variables, suggesting that the proposed methodology could be effective in determining positive changes in motivational dynamics.

KEY-WORDS Gamification; Educational Technology; Teaching Innovation; Inductive Learning; Formative Assessment.

SOMMARIO L’articolo illustra una metodologia didattica che applica i meccanismi motivazionali del gioco per cercare di superare il diffuso disinteresse degli studenti e rendere coinvolgente l’apprendimento a scuola. È dettagliato un ciclo di apprendimento che promuove un processo di innovazione lungo tre dimensioni: dalla didattica deduttiva a quella induttiva; dalla didattica trasmissiva a quella costruttivista; da una valutazione sommativa a una formativa. Vengono forniti e discussi alcuni esempi concreti di attività didattiche. Infine sono presentati i risultati relativi alle implicazioni motivazionali della metodologia emersi da uno studio quasi-sperimentale condotto in una scuola secondaria di secondo grado. Lo studio ha messo a confronto due classi, sperimentale e di controllo, in relazione alle seguenti variabili: motivazione ad apprendere, bisogni psicologici fondamentali e supporto all’autonomia. I risultati evidenziano come nel confronto si riscontrino differenze significative sulle variabili analizzate, suggerendo che la metodologia proposta possa essere efficace nel determinare cambiamenti positivi nelle dinamiche motivazionali.

PAROLE CHIAVE Gamification; Tecnologie Educative; Innovazione Didattica; Apprendimento Induttivo; Valutazione Formativa.

1. BACKGROUND

The increasing growth of new media represents a true challenge for schools as education struggles to recognize new ways of gaining and spreading knowledge, and merging them with everyday teaching (Antinucci, 2001; Serres, 2013). The classical teaching-learning cycle of silent listening in the classroom, individual study of the presented contents and traditional oral and written assessment is becoming increasingly distant from the cognitive practices experienced by students outside of school (Prensky, 2006, 2010; Gee, 2003; Jenkins, Purushotma, Weigel, Clinton, & Robison, 2009). The hyperlinking of the Web, the interactivity of virtual and augmented reality, the emergent narrative of videogames and serious games are some of the most significant products of the digital culture that show how crucial the learner's central role has become in actively building their path to knowledge (Gee, 2003; Jenkins et al., 2009).

This gap between in-school and out-of-school experiences could negatively affect students' motivation, an aspect which is widespread in school, with heavy implications for students' learning and experience (Ames, 1990; Maehr & Meyer, 1997; Covington, 2000; Legault, Green-Demers, & Pelletier, 2006).

The passive role reserved to students within traditional teaching methods limits the satisfaction of the basic psychological needs: autonomy, competence and relatedness (Deci & Ryan, 2000). The need for autonomy is limited by the common hetero-directed practices; the need for competence is inhibited by essentially requiring students to reproduce given knowledge; the need for relatedness is compressed by processes that do not encourage student-student and student-teacher relations.

Implementing these processes in the classroom requires a profound rethinking of consolidated teaching approaches. However, school innovation strategies often follow a techno-centric orientation, by which we mean the introduction of digital technology in the classroom aimed at reproducing traditional teaching practices. This occurred when replacing the blackboard with the Interactive White Board (IWB), classroom lessons with video lessons and textbooks with ebooks without a methodological redesign to justify the adoptions and make them productive in terms of learning processes and outcomes (Russell, 1999; Nichol & Watson, 2003; Calvani, 2007; Ranieri, 2011; Abeysekera & Dawson, 2015).

As for videogames, they have influenced innovation in educational processes via two main lines: the creation of specific educational products, such as Educational and Serious Games, and the implementation of gamification, that is the integration of game elements into teaching activity (Deterding, Dixon, Khaled, & Nacke, 2011).

Despite high expectations (Anolli & Mantovani, 2011), the former solution was not found to be transformative and did not really spread in schools. The main reason for this lies in the low quality of most games intended for educational purposes; unfortunately, schools cannot guarantee financial returns on the huge investments that are necessary to create such high-level products. Actually, such games often propose scenarios that are not very engaging and are linked to the subject contents in a completely artificial way. Research has shown few positive results regarding students' learning and motivation from these products (Wouters, van Nimwegen, van Oostendorp, & van Der Spek, 2013; Persico et al., 2017). Despite its wider application, the second strategy, gamification, has also produced uncertain results. Most meta-analysis and specific studies in the literature show that the gamification process has little effect in terms of motivation, satisfaction, empowerment and academic achievement (Dicheva, Dichev, Agre, & Angelova, 2015). How-

ever, occasionally, contrasting outcomes have also been revealed (Hanus & Fox, 2015).
These results are determined by those elements of gamification that end up stimulating a competitive feeling as an end in itself. This happens, for instance, with interactive online quizzes, such as Kahoot[1]. Leaderboards and badges encourage most students to commit themselves to excel, while merely demotivating others who perceive themselves unable to reach the top positions. These factors, if not adequately managed, risk distracting students' attention from learning objectives and instead move them towards an ephemeral desire to conquer the top of the leaderboard, fostering extrinsic rather than intrinsic motivation (Mekler, Brühlmann, Tuch, & Opwis, 2017).
Innovating teaching practices by relying on the aspect of intrinsic motivation that characterizes all videogames, namely challenge, is considered most productive (Schwartz, Lin, Brophy, & Bransford, 1999; O'Mahony et al., 2012; Hamari et al., 2016). Overcoming obstacles, defeating enemies and reaching a goal, perhaps after numerous attempts, produces an intrinsic pleasure that derives from the sense of competence that players experience from the awareness of being able to improve their ownpower , and being able to carry out activities better than when previously attempted. Learning new things, and being able to solve new problems produces, as a reward, a dopamine rush, which generates pleasure (Schultz, 2007; Willingham, 2009).
We believe that this aspect of videogames could be productive in inspiring a path of innovation in education that shifts teaching practices from the transmission of knowledge to intellectual achievement gained by addressing cognitive challenges. By designing educational activities with a good "game design" that is able to engage students, just as videogames do, in their zone of proximal development (Vygotsky, 1980), we can promote the development of new skills through collaborative problem solving and teacher support. We argue that in this way we can produce the pleasure of learning in the classroom by intrinsically motivating students and overcoming widespread disaffection towards educational activities.

2. OVERTHROWING THE TEACHING-LEARNING CYCLE

To acheive the above, we propose a transformation of the learning cycle as shown below.
The traditional teaching-learning cycle at school follows three main steps: frontal lesson, individual study, and final assessment. This means that the learning process starts with content presentation that, being based on presenting from the beginning the type of codified knowledge consolidated in textbooks, is purged of the intellectual processes which led to it. This practice, while very common at school, is today largely criticized for smothering the natural eagerness to "uncover" that is inherent to human nature. In this way students obtain answers to unexpressed questions, thus altering the instinctive learning process that originates from the need to solve a problem, to satisfy a curiosity, and to follow a spontaneously arising interest, that exists within all of us. The desire to know, whether it be spontaneous or induced by the teacher, motivates students to find solutions, to come up with interpretations, to make explanatory assumptions, and through these courses of action, to *learn*. Denying this experience heightens the risk of not turning on those cognitive channels that allow for meaningful learning (Ausubel, Novak, & Hanessian, 1968), or tiggering those emotional feelings (ranging from curiosity to satisfaction) which derive from the pleasure of uncovering new knowledge.
To overcome these issues, we suggest a shift from the traditional teaching-learning cycle to one consistent with the current socio-cultural ecosystem. This cycle is focused on developing students' critical thinking, problem solving skills and creativity through their active involvement, and leverages intrinsic motivation.

[1] https://kahoot.com/

The suggested approach overthrows the classical teaching-learning cycle by introducing one that conceives learning as a challenge for students as they are asked to walk along a path designed to actively rebuild contents.
This methodological proposal moves from a deductive approach, which begins from the study of theoretical knowledge and then focuses on its application in specific contexts, towards an inductive approach, whereby learning starts from presenting case studies for students to face and solve. This then leads to the building of theoretical knowledge. We are talking about an educational approach belonging to psycho-pedagogic reflection, from Bruner (1961) to all the subsequent developments which have led to the consolidated methodology of "Problem Based Learning" (Savery & Duffy, 1995).
Today, however, digital growth is breathing fresh life into this process. While new technologies encourage an inductive approach, they also bring to class useful tools to simplify the adoption of this approach.
A paradigmatic example of the inductive approach experienced by new generations outside school is provided by videogames which, without any prior explanation, systematically challenge players to try out their problem-solving skills or to find ways to reach the game's goals.
In the same way, with a learning path properly designed and facilitated by the teacher's scaffolding, acquiring understanding of subject contents could become learning goals for students to conquer. We do not propose turning class activity into scientific research, as we are aware that this is unproductive (Willingham, 2009); rather, we propose a teaching method such as "guided reinvention" as Freudenthal (2006) proposed for teaching maths.
Performing this transposition is not so simple. To formulate challenging questions and meaningful problems with appropriate complexity that are aimed at addressing a defined subject content requires specific skills different from those gained from an educational background and work experience based on declaratory methods. Handling a class that works with the active learning approach represents a further challenge for many teachers. Teachers may be afraid of losing control of their students and are often worried about the amount of time involved. Besides, formative assessment too requires a whole re-thinking. We believe, however, that today's changing context both requires and makes this approach more feasible.
We have therefore designed a new learning cycle consisting of three steps: (1) throwing down the *challenge*; (2) driving the *challenge* and (3) closing the *challenge* (Cecchinato & Papa, 2016).

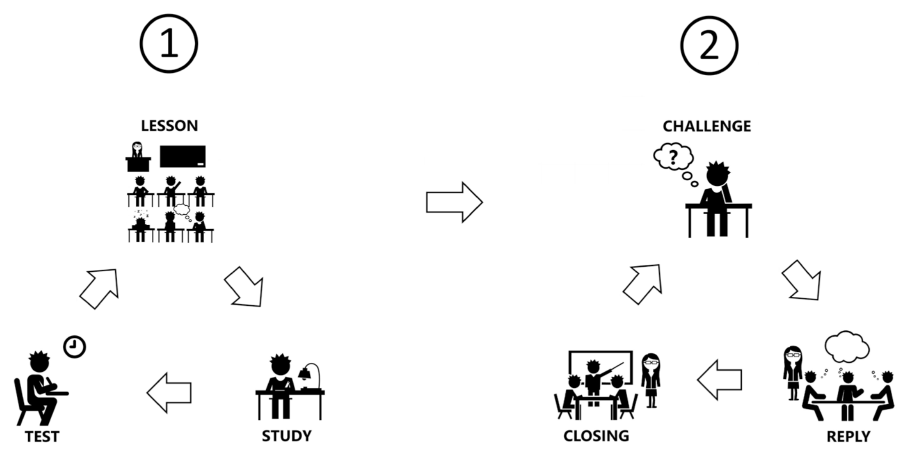

Figure 1. Learning cycle shift.

2.1. *Throwing down the challenge*

Our proposal does not involve bringing videogames to school, nor even serious games; rather, it involves recreating the motivational mechanics and inherent logic that lie behind them. In videogames the player does not conceptually learn tricks and solutions prior to playing. If that were the case, in a blink of an eye games would lose all the appeal they exert on people, especially young people. Learning, instead, happens directly in the field by facing scenarios and overcoming problems that arise, step by step, whereby one challenges their own skills, insight, and experience, while trying to identify the required strategies to achieve the goals. These are the motivational elements of challenge that, when properly designed, prompt players to invest time, energy and involvement. Typically, videogames are engaging and catalyse teens' energy to get past levels and achieve objectives, and this is known to be rewarding even when the goals are ephemeral (Gee, 2003). Regardless of the context, putting in place one's self-reliance to understand how to overcome an obstacle that hinders reaching one's objectives, and then understanding how to solve a problem, how to unravel a complex situation, and how to face a controversial question results in intellectual fulfilment.

Thus, the challenge is the cohesive element of motivation and we propose to design learning activities at school that regard acquisition of contents as "objectives to conquer". The first step is therefore trying to prompt in students the desire to understand a specific topic. Consequently, teachers are required to call the content into question; instead of simply presenting it, they are called on to convert it from a declaratory and established form to a hypothetical and conjectural one, and to leave the task of finding a solution to the students. The teacher should throw down a challenge related to everyday life that is as real and meaningful as it can be, yet designed to convey well-defined subject content.

To be effective, the challenge should rely on two main concepts:

- "cognitive dissonance" (Festinger, 1962) or "cognitive conflict" (Piaget, 1974), which is to produce an incoherence between what students know and what the challenge states. This inconsistency should give rise to the need for students to reset;
- the mobilisation of "prior knowledge" (Ausubel, Novak, & Hanessian, 1968), that is, beginning the learning process by asking students to put in place what they already know, an essential condition for meaningful learning (Novak, 2002; Mayer, 2002).

In addition to these guiding principles there are other elements which should drive the design of the challenge:

- *providing a well-defined objective* (students should immediately understand what they need to achieve);
- *adjusting the level of difficulty* (it should be demanding but achievable for students' abilities);
- *allowing for a quick start* (to quickly engage students without asking them to complete preparatory materials, or at least reduce this request to a minimum);
- *setting the time* (so that students can quickly settle into their activities);
- *sharing the assessment criteria* (students should know how they will be evaluated).

Thereafter, students are called on to engage in authentic tasks that are completely different from – if not antithetical to – the exercises and homework usually given to them. With the latter, they must apply knowledge and procedures that they, at least in theory, have already acquired. The target is to reinforce these. Posing challenging problems focuses instead on igniting students' learning by promoting the "uncovering" of new knowledge, which students have to attain with the teacher's support by using essentially inquiry and problem solving approaches.

In practice, this first step of the cycle can be implemented in different ways, such as, for instance, engaging students when the class starts, or even before class, by means of a Learning Management System which offers advanced tools of data-sharing and interaction, and that can monitor student involvement.

2.2. *Driving the challenge*

Activating intellectual curiosity (Berlyne, 1960) and motivation to learn (Ryan & Deci, 2000a, 2000b) can be achieved by throwing down the challenge to students, and here lies the foundations for their engagement. This is where providing a setting oriented to the active learning approach in class becomes productive. Here, students are called on to carry out in different forms and ways, depending on their age and context, the cognitive strategy and the inquiry methods most appropriate to the subject that they are addressing. The teacher's scaffolding should promote a scientific attitude sustaining the value of doubt, and the ability of questioning knowledge rather than its acritical assimilation. What is required is learning to ask appropriate questions so as to choose the most likely hypothesis and finding ways to test it. This can be achieved by information research, deep reflection, peer to peer comparison, and engagement in activities that allow for the experimentation of students' ideas. There are several methodologies a teacher could refer to that draw on the almost century-old tradition of active learning (Dewey, 2007), but also original strategies delivered by new media (Jonassen, 2008). Cooperative learning and peer learning are crucial landmarks here.

In agreement with the cultural development induced by new media (Gee, 2003; Jenkins et al. 2009), this could be achieved by transforming the class into a learning community. This produces significant benefits for behaviour, attitudes towards studying, self-reliance and school performance.

Teachers can refer to the extensive body of scientific literature to implement different cooperative methodologies developed over the last decades in the classroom (Slavin, 1990).

For greater substance, we provide an example of a teaching activity in a physics class inspired by this approach. It was designed for learning the phenomenon of buoyancy and to comprehend the resulting formula of the Archimedes principle. The activity begins by presenting a video of the dissonant behaviour of a helium balloon inside a car turning to the left (Figure 2) and asking students to provide their spontaneous interpretations of the cause.

Figure 2. Video of a helium balloon inside a car turning to the left[2].

[2] https://youtu.be/FjuMvUbT8gA

At this stage, every student should be encouraged to speak and freely propose their ideas with the aim of promoting widespread participation of the class, and not only the participation of more confident students, as is generally the case. Responses can usually be very creative, but far from the right one. At this stage, the teacher should lead the activity with the help of an interactive classroom tool such as Nearpod[3] (McClean & Crowe, 2017). With this digital tool teachers can collect and compare the answers of many students in a syncronous way.
The teacher should then ask students to draw air and helium particles to try to justify the behaviour of the balloon. Initially, the drawings could be like those shown in the first column of Figure 3.

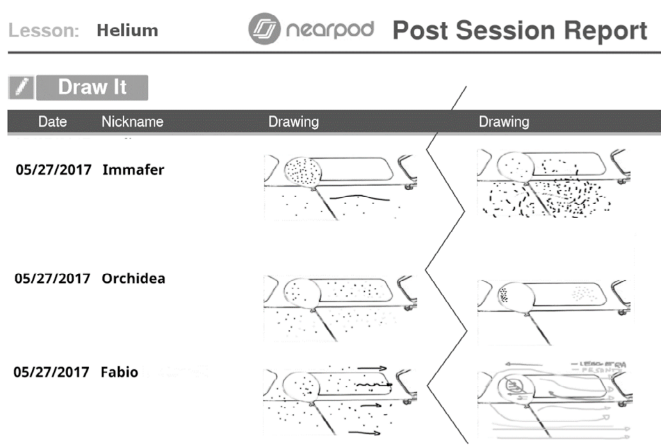

Figure 3. Nearpod Post Session Report.

After a quick overview, the teacher could share ideas with the class and comment upon the drawings of a few students, selecting not only those who have arrived at or close to the correct answer (e.g. Fabio, third row in Figure 3), but also other interesting ones to bring out misconceptions and ideas. The interactive tool makes this process both simple and fun, evoking the feeling of classroom time flying by. At this early stage, the teacher should not give the correct answer but should provide the students with a model from an analogous phenomenon to ensure that there is a proper framing of the topic (Figure 4).

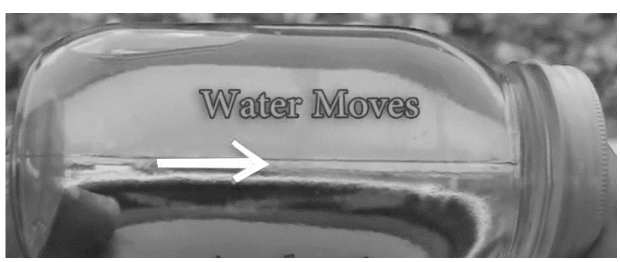

Figure 4. Air bubble in a moving glass filled with water[4].

After having seen the model, students can produce drawings much closer to the correct answer (second

[3] https://nearpod.com/

[4] https://youtu.be/y8mzDvpKzfY?t=1m52s

column of Figure 3) and even those students who had already perceived the phenomenon will manage to formalize it better. Only at this point should the teacher show the corresponding model for the behaviour of the helium balloon in the car, and thus provide immediate feedback to the students' answers. With such activities, students receive instant feedback that enables them to enter the challenge more deeply and to attempt to formalize the phenomenon of buoyancy with a mathematical formula. Indeed, the teacher could ask them to identify how many helium balloons are needed to lift a small wooden house.

This challenge is also conceived as an authentic task. It is, in fact, an open-ended problem that requires not the application of a known procedure but, first and foremost, some reflection to define the problem (mathematical modeling) (Meyer, 2015).

For this activity, students could be divided into groups to reflect upon factors that determine whether a greater or lower force is capable of lifting a wooden house and to think about the relationships among those factors. During this step, the teacher listens in to the different positions, noting the processes that result in correct or incorrect findings, and gives interpretative suggestions, but never solutions.

With the teacher's scaffolding, students are expected to be able to identify whether factors are important, to relate them to one another, and possibily within classroom time, reach a reconstruction of the mathematical equation from scratch. The activity will be completed in the third phase, where groups present their ideas so that reflections and results are shared with the whole class.

2.3. *Closing the challenge*

A phase of re-elaboration and evaluation of what the students have done in response to the challenge completes the cycle. It is at this stage that more complex assessment activities take place, even though they permeate all phases as formative practice (Sadler, 1989, Nicol, & Macfarlane-Dick, 2006). This could be achieved through observation and annotation of student activity within the context, individual and group examination of their products, student auto- and self-evaluation (Topping, 1998), as well as through more traditional assessment activities.

The first goal is to ensure whether the knowledge to be gained through the activity has been achieved, and how so. This is a collective process of reflection and comparison led by the teacher with the involvement of the whole class. It involves sharing what has been worked out, and concerns emphasising the most productive paths. This can involve asking individual students or groups to present their findings to the class. Such an activity can also lead to individual evaluations, which form meaningful assessment practice as they require students to present their own reflections to their peers. These evaluations create a much more valuable activity than traditional written and oral tests, which consider the teacher as an antagonist, and have the goal of reproducing the knowledge.

We are aware that it is not easy for teachers to design teaching activities with these features, and, at present, traditional teaching materials - such as manuals and textbooks - are not suitable resources for these ends. Assistance comes from the Web, where there are sites that offer useful scientific questions as challenging starter questions for a lesson plan in all STEM subjects. Key problems and unsolved questions from history, literature, art and almost any other subject are also offered[5], but there is still a lack of resources helping teachers that want to adopt innovative teaching approaches like the suggested one.

Nevertheless, we believe that proposing challenge-based school activities can provide an appropriate solution to the widespread lack of motivation. The outlined methodological approach, could, in fact, satisfy basic psychological needs (Deci & Ryan, 2000). It meets the need for competence by involving students in

[5] Here are some examples: in Mathematics - whenmathhappens.com/3-act-math; in Physics - veritasium.com; in Science - www.nquire-it.org, in History - www.umbc.edu/che/historylabs/questions.php

tackling and solving challenges with their own skills, the need for autonomy by promoting active learning practices in which students have a higher degree of self-determination, and the need for relatedness between students by drawing on collaborative classroom activities and the need for relatedness between student and teacher by assuming the role of teacher as "guide on the side" (King, 1993).

3. RESEARCH

In order to operationalize and analyse the motivational implications of the above methodology, Self-Determination Theory (SDT) (Ryan & Deci, 2000a) was used as theoretical framework in a quasi-experimental setting. In the following, we describe the variables considered, the method adopted and discuss the results obtained.

3.1. *Variables*

According to SDT, there is a self-determination continuum from "amotivation" to "intrinsic motivation". Along this there are four levels of "extrinsic motivation" varying to the extent to which their regulation is autonomous: external regulation, introjected regulation, identified regulation, and integrated regulation (Ryan & Deci, 2000a, 2000b, 2002). The differences between the continuum's levels are not about motivational quantity (i.e., high levels of motivation), but about the quality of motivation (i.e., the presence or absence of self-determined forms of motivation) (Vallerand, Koestner & Pelletier, 2008; Guay, Ratelle, & Chanal, 2008). SDT allows distinctions between more controlled types of motivation (i.e., introjected and external regulation) and more self-determined forms of motivation (i.e., intrinsic motivation, integrated and identified regulation) (Deci & Ryan, 2008, 2000; Ryan & Deci, 2000a, 2000b).

In particular, SDT highlights the role of the relationship between the individual and the environment in promoting self-determination (Deci & Ryan, 2000; Ryan & Deci, 2002). Indeed, the environment promotes the latter when it satisfies the three posited basic psychological needs: autonomy, competence and relatedness (Deci & Ryan, 2000, 2008; Ryan & Deci, 2000a, 2002). In particular, the individual's motivation will reach more optimal levels (i.e., characterized by more autonomous configurations) the more their environment fosters them to feel autonomous, competent and related (Ryan & Deci, 2000a, 2000b): in other words, an environment in which one can experience a sense of volition (autonomy); express and exercise their capacities (competence); and feel connected, respected and cared for (relatedness) (Ryan & Deci, 2002, 2000b). Moreover, according to SDT there are controlling environments distinct from others that are autonomy-supportive (Deci & Ryan, 1987; Vansteenkiste, Lens, & Deci, 2006; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). In the former environment type, one feels constrained or guided (by directives, deadlines and/or rewards) to assume certain behaviors and to reach particular outcomes. By contrast, the latter is characterized by free choice and encourages the assumption of responsibility, personal initiative and the search for interesting activities (Deci & Ryan, 1987; Vansteenkiste, Lens, & Deci, 2006; Vansteenkiste et al., 2004; Vansteenkiste et al., 2012). The elements that distinguish these two environments are based on on the satisfaction or dissatisfaction of the three basic psychological needs (Ryan & Deci, 2000a; Vansteenkiste, Lens, & Deci, 2006).

3.2. *Aims and research questions*

The outlined teaching methodology was introduced in 30 primary and secondary schools in different regions of Italy by an in-service teacher blended training course. It lasted about 6 months and focused on designing and conducting lesson plans consistent with the proposed approach. In one of these schools, the "Bosso - Monti" Institute in Torino, a study (Foschi & Cecchinato, 2018) evaluating the actual results of the proposed teaching methodology was carried out with two classes: an experimental class where the new teaching-learning cycle was used, and a control class where it was not. Our specific aims were to investigate the impact on motivation of the proposed methodology and, specifically, to address the following research questions:

- Q1. Do students in the experimental class, compared to those in the control class, present more self-determination towards studying?
- Q2. Do students in the experimental class, compared to those in the control class, perceive greater satisfaction of the basic psychological needs for autonomy, competence and relatedness?
- Q3. Do students in the experimental class, compared to those in the control class, perceive their teachers as more autonomy-supportive?

3.3. *Method*

A quasi-experimental research design was set up to study the differences in student motivation between the two classes. As previously mentioned, in one class teachers adopted the new learning cycle (experimental class), while in the other they did not (control class). The experimental and control classes consisted of students from the same grade level (grade 11), studying the same curriculum subject (Social-Health Education); the classes had a comparable number of students (19 in the experimental class, 21 in the control class) and same number of teachers (9, who differed for the control and experimental class).

The research analyzed the previously mentioned variables as detailed. The students' motivation was tested through the Italian version of the *Academic Motivation Scale* (AMS; Alivernini & Lucidi, 2008). AMS consists of five subscales assessing Amotivation (Cronbach's alpha: $\alpha = .86$), External Regulation ($\alpha = .83$), Introjected Regulation ($\alpha = .85$), Identified Regulation ($\alpha = .81$) and Intrinsic Motivation ($\alpha = .87$). Each subscale consists of four items (for a total of 20 items) and each item can be rated on a 4-point Likert-type scale from 1 (does not correspond at all) to 4 (corresponds exactly). In this study, as a global measure of students' self-determination towards studying, we considered the Relative Autonomy Index (RAI; Vallerand & Ratelle, 2002), which consists of a summation of weighted scores and serves to incorporate the information from the different motivational subscales into one overall score (Vallerand, Fortier, & Guay, 1997). The computation led to an index for the students' self-determined motivation, so the final RAI measure, which ranges between -9 and +9, served as an indicator of each student's overall motivational orientation.

The satisfaction of the basic psychological needs was tested through the *Adolescent Students' Basic Psychological Needs at School Scale* (ASBPNSS)[6] (Tian, Han, & Huebner, 2014). ASBPNSS consists of three subscales assessing Autonomy (α calculated = .70), Competence (α calculated = .69) and Relatedness (α calculated = .69). Each subscale consists of five items (for a total of 15 items) and each item can be rated on a 6-point Likert-type scale from 1 (strongly disagree) to 6 (strongly agree). Once the two items that are worded in a negative way are reversed score, the scores are calculated by averaging the individual item scores, and range between 1 and 6.

Finally, the teachers' support for autonomy was tested through the *Learning Climate Questionnaire* (LCQ) (Hardre & Reeve, 2003). LCQ consists of 8 items (α calculated = .93) and each item can be rated on a 7-point Likert-type scale from 1 (not at all true) to 7 (extremely true). Scores are calculated by averaging the individual item scores, and range between 1 and 7.

Between-subjects t-tests were used to analyze the differences between the two classes among the variables.

[6] Validated Italian versions of ASBPNSS and LCQ are not available, therefore we have translated and adapted the original versions into Italian, and calculated the respective Cronbach's alphas (α) as an estimate of reliability.

3.4. *Results*

The results highlight how students in the experimental class differ from those in the control class, as reported in Table 1.

	Experimental class		Control class			
Variables	*M*	*SD*	*M*	*SD*	T-test results	Cohen's d
Overall motivational orientation (RAI)	2.97	2.68	1.42	1.72	$t(38) = 2.199$, $p < .05$	.69
Basic psychological needs						
– Autonomy	4.15	.69	3.28	1.13	$t(38) = 2.901$, $p < .01$	.93
– Competence	3.91	.71	3.34	.87	$t(38) = 2.237$, $p < .05$	.72
– Relatedness	4.63	.94	3.96	.67	$t(38) = 2.609$, $p < .05$	.82
Autonomy support	5.45	.75	3.82	1.32	$t(32.297) = 4.879$, $p < .001$	1.52

Table 1. Mean (M), Standard deviation (SD),T-test results and Cohen's d.[7]

Notably, as compared students in the control class, those in the experimental class:

- Q1. Present more self-determination towards studying.
- Q2. Perceive greater satisfaction of the basic psychological needs for autonomy, competence and relatedness.
- Q3. Perceive their teachers as more autonomy-supportive.

The results appear encouraging for affirming that the proposed methodology could be effective in determining the above positive changes in motivational dynamics.

4. CONCLUSIONS

Young generations are immersed in a multimedia ecosystem in which strategies and ways of learning are different from those practised in the classroom.

The new digital contexts, from web-based to highly immersive, prompt active participation and the involvement of people. The pursuit of personal paths of knowledge, the development of new modes of socialization and the multi-sensorial involvement in synaesthetic environments promote experiential learning very differently from the symbolic approach promoted by reading-writing processes (Antinucci, 2001).

[7] Given the small sample sizes, we also calculated and reported effect sizes (Cohen's d) to interpret the results. The interpretation of the effect sizes was based on the values of Cohen (1988): small effect size (from d = .20), medium effect size (from d = .50) and large effect size (from d = .80).

Videogames, in particular, are characterized by a high degree of engagement due to their leveraging of the motivational elements of challenge. In videogames, players are constantly challenged to overcome hurdles so as to improve their own performance and win in competion.
We believe that it is possible to innovate the learning-teaching processes implemented at school by transforming the traditional learning cycle into one based on cognitive challenge.
However, the necessary innovations of educational processes do not lie in the use of digital media in schools, rather they are prompted by the adoption of a different cognitive paradigm.
The present methodological approach fits into this perspective as it proposes the use of a challenging problem-solving activity as a means to motivate students and the use of technology in a way that supports the development of creativity, critical thinking, and problem-solving skills.

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