The Role of Gamification and the New Technologies in the Construction of Mathematical Thinking

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Abstract
The game has always represented a role of fundamental importance in the activation of learning processes. The development of videogames have given a distinctive mark to the introduction of innovative technologies in education. With the advent of Generation Z, the theme of the game has become very important for human life. The effect of these factors has led to the birth of the phenomenon of gamification both in school environments (Biró, 2014) and in work contexts, becoming a management practice (Mollik and Rothbard, 2015; Kapp, 2012). In summary, attention will be focused on three different points of view: the contribution of gamification in motivational processes, the type of skills developed and the effectiveness of the learning process activated. Surely, the development of human skills is successful where investments are correctly managed and oriented. The effectiveness of an educational process is subject to three conditions: the involvement of the student, the accurate analysis of his training needs and the adoption of effective tools for the desired purpose. In this regard, the Theory of Intentional Change formulated by Richard Boyatzis suggests that without the drive for personal improvement, any activity would be useless.

Keywords: Gamification, New Tecnologies, Mathematical Thinking

Introduction

The primary objective of this work is to consider the aspects of gamification from an educational point of view and to highlight its ability to stimulate learning processes and the structuring of human skills, especially when considered in the context of mathematical thinking. Gamification is based on the consideration that playful elements play a fundamental role in the approach to knowledge, especially when referring to school-age children.

Gamification bases its assumptions on the application of the mechanics of games in various contexts: learning, productive work, and marketing. The main purpose of gamification is to make an action more enjoyable and engaging which, alternatively, would be boring, banal and repetitive. Surely, implementing game mechanics is one of the most efficient ways to involve people in activities (study, work) and to facilitate the behavior of a gamified system.

The objective of this reflection is to analyze gamification on the basis of the psychological aspects and experience of each individual and to evaluate, then, its effectiveness in the learning processes of mathematics, even when it refers to complex processes and is considered to internship of higher-order school situations (high school mathematics).

Gamification seeks to structure learning through the motivation to learn through game, a psychological construct of great interest and educational relevance. In fact, the use of gamification stimulates the user's interest and both intrinsic and extrinsic motivation. Intrinsic motivation arises from the inner awareness of the subject, who decides whether to perform a specific action guided by principles such as: altruism, competition, cooperation and a sense of belonging. On the contrary, extrinsic motivation occurs on the basis of external stimulations (classification, levels, points, badges, trophies, missions).

Therefore, motivation leverages people's desires and needs, pushing them to achieve goals (learning, work, etc.) in a stimulating and productive way. In fact, the human being tends by nature to have an intrinsic motivation that pushes him to seek novelty and challenges to extend his abilities, to explore and to learn.

The spontaneous interest that grows in every person from the first years of life helps develop their cognitive and social skills. Such conditions occur only if certain psychological and social needs are met. They are: autonomy, understood as the player's willingness to perform a task; competence, understood as the player's need to participate in challenges feeling competent and efficient (positive feedback stimulates competition and the perception of competence); relatedness, which consists in the experience lived by the player who feels in relationship with others; the purpose, that is, the need to make sense of one's actions. For Marczewski the purpose represents the need to perform an action only in the presence of a reason and a deeper meaning (Marczewski, 2015).

It is understood, then, how much in Education, each course of study calibrated on the principles of motivation and active stimulation of all perceptual and sensory channels is significant, effective and efficient for the structuring of cognitive processes and for the optimization of learning. It is, also, good to consider that gamification allows players to achieve their goals by choosing the methods that best suit their needs, but considering their performance and the related feedback almost always collectively (Birò, 2014, pp. 148-151).

Taking a cue from the numerous research areas that investigate the educational potential of the game and the emotional involvement of the subject who uses gamification, we intend, in these notes, to investigate its educational potential and, in this specific case, its contribution to learning mathematics.

Gamification in Action

Due to the material and structural characteristics that characterize them, Gamification systems are capable of generating profound implications in teaching and school processes. Both the extraordinary diffusion of numerous game consoles and the great success of mobile tools such as tablets and smartphones contributed massively to achieving this goal. Their spread has fueled the use of video games, making them increasingly usable in school settings.

One of the features most considered in the use of educational software dedicated to gamification is the ability to affect the habits and behavioral performance of the recipients. The implementation of playful mechanics is one of the most effective methods for involving pupils in activities capable of facilitating and developing significant behaviors and attitudes within the context considered.

Through gamification, a type of active participation is implemented through which dynamic behaviors are encouraged in which the message to be communicated can be connected to the action itself and be contained in the context of the experience. From this point of view, another fundamental advantage that can be obtained through Gamification should not be underestimated, i.e. user behavior is measurable, by collecting data based on the actions performed within the game and this stimulates users to intentionally improve the their attitudes towards the task addressed.

The "Theory of Intentional Change", formulated by Richard Boyatzsis, suggests that without a deep-seated drive for self-improvement, any training activity would be in vain. For the development of soft skills, a phase of awareness of the importance of these skills for individual performance is necessary, which prepares the subjects to implement a change (self-assessment, self-awareness, self-confidence, self-control, adaptability, etc.). In this sense, the supports that information and communication technologies make available can prove to be effective and efficient tools, which however require careful analysis. Many think that Gamification is a part of the world of gaming and the game industry (Petruzzi, 2015).

This is a big misunderstanding, because in reality the purpose of Gamification is not to create a game tout court but to apply some typical dynamics of game design to other contexts to achieve specific objectives. We have often talked about good design, but: "What do we mean by this term?" Analyzing the psychology of Gamification, we realize that all the guidelines for defining a project that works converge towards a common idea: the good design of a gamified experience always places the user, his needs and requirements (also educational) personal at the center.

Through "user-centered design", a term referring both to a broader design philosophy and to certain application methodologies, the goal becomes to ensure that the needs and wishes of the people involved in Gamification are fully considered and satisfied, throughout the game experience life cycle (Abras, C. Maloney-Krichmar, D. Preece J., 2014). If "user-centered design" is used appropriately, it allows to achieve relevant results in: better understanding psychological, organizational, social and ergonomic factors; manage the expectations and

motivations of users; increase acceptance of the gamified experience; increase the effectiveness and efficiency of the project (Abras, C. Maloney-Krichmar, D. Preece J., 2014).

Without "human-focused design" it is impossible to create effective Gamification systems. On the contrary, a design centered on the needs of the players allows to design Meaningful Gamification consisting in the integration of elements of "user-centered design" within non-playful contexts (Nicholson S., 2012). Even if the risks are always present and lead to Meaningless Gamification phenomena, often the positivity of the experience lived by the people involved stimulates them to involve and take action towards the activities required by the gamification project and this allows a perfect realignment in the long term. between personal and organizational goals.

According to Jane McGonigal, all games, when stripped of all gender differences and technological complexities, have four defining traits in common: a goal, a set of rules, a feedback system and the voluntariness of participation (McGonigal J., Reality Is Broken, 2011). What makes gamification so effective is the strong motivational component that stimulates people to carry out certain activities (Maestri A., Polsinelli P., Sassoon J., 2015). It becomes important to understand the psychology of motivation by trying to understand what it consists of, what the different types are and how to be able to repeat it over time, enriching the experience lived by the user.

Motivational research done by university researcher Michael Sailer, together with other colleagues (Sailer M., Hense J., Mandl H., Klevers M., 2013) have identified six main study perspectives on motivation which are: *traits, behavioral, cognitive, self-motivation, interest, emotions.* These six perspectives are not to be seen as contradicting or potentially competing with each other. They simply focus on different sides of the same coin and can be used to better investigate the persuasive and motivational potential of playful elements that can be used within an educational Gamification project. Finally, the motivational dimension offers a strong importance to emotions, which can also be influenced by specific strategies. In fact, Gamification increases one's attraction towards players if it facilitates a decrease in negative feelings such as fear, anxiety and anger, while increasing the positive dimensions such as joy and personal happiness (Maestri A., Polsinelli P ., Sassoon J., 2015).

Regardless of the study dimension with which the theme of Gamification is approached, the main classification of motivation provides for its differentiation into two types: intrinsic and extrinsic (Werbach K. and Hunter D., 2012).

Intrinsic motivation originates within the individual, rather than being generated in the surrounding world. This derives from a situation of curiosity, genuine involvement and the desire to increase one's skills. People engage in a specific activity as they find it stimulating, rewarding and fully satisfying. Users are motivated by different and subjective intrinsic motivations (Havercamp S.M. and Reiss S., 2003). On the contrary, extrinsic motivation is generated most of the time by factors external to the user such as the desire to receive recognition or the desire to avoid unpleasant situations.

The basic concept is not so much wanting to do something as the perception of having to do it (Pink D., 2009). In conclusion, it is emphasized that there is no better type of motivation than the other, while experiences in the educational field show that Gamification works best

when it is designed to align and integrate intrinsic motivations and extrinsic variables (Zichermann G. and Cunningham C., 2011).

Gamification in Education

To design an educational learning experience through the use of Gamification, it is necessary, first of all, to balance the challenges offered by the environment with the skills and competences of the person. Any imbalance of intrinsic or extrinsic motivational factors would generate conditions of boredom or anxiety. Thanks to the state of flow, the subject instead experiences a strong sense of self-awareness and effectiveness.

Thus, a virtuous cycle is generated capable of increasing personal satisfaction and performance towards the final goal, the effects of which are expanded by Gamification itself (Hamari J and Koivisto J., 2014). The flow experience is characterized by intense involvement, the loss of the sense of time and high concentration. It represents a situation of perfect balance between the perceived level of a challenge and our perceived ability to overcome it, for this reason it does not generate anxiety (understood as the fear of not succeeding), nor boredom (understood as the certainty of succeeding easily) (Petruzzi V., 2019).

This sensation of flow, which we rarely experience in everyday reality, is instead generated by those activities that are able to seriously and totally involve and that have their own motivation and reward within themselves. An effective and functioning Gamification is able to amplify the overall scope of this state of flow, enriching its perceived value in relation to daily experience (Hamari J and Koivisto J., 2014).

Study and fun are often seen as contradictory. Even if at times the study can be competitive, it is not easy to create situations where it can become a pleasure. But this perspective perhaps remains a little dated and does not take into account the fact that a lot depends on how you study and play. Teenage play has become a field of interest in developmental psychology, which has associated it with building their intelligence. The genesis and development of the game of young people have been thoroughly analyzed and it is now an established fact, children learn while they play, and it is on this basis that we find the union between play and learning, whatever form the game may have. Often, in fact, we accept the idea that children learn by playing, not paying enough attention to the learning methods contained in the different situations.

The transition from the gaming experience to a learning content is in some cases very mysterious (Maestri A., Polsinelli P., Sassoon J., 2015). That play can have a much more fruitful relationship with study than one might think is a concept at the basis of the new school, where the meaning of knowledge today has shifted from being able to remember and repeat information to being able. to find, evaluate and use them convincingly in the right context. Education in the early part of the twentieth century tended to focus on the acquisition of basic skills and knowledge of content such as reading, writing and arithmetic.

Many experts, on the other hand, believe that success in the twenty-first century depends on an education that develops higher-level skills such as the ability to think, solve complex problems and interact critically through language and media. To cope well with the challenges of the contemporary world, the skills acquired with the game seem to be fundamental.

This statement links many of the normal teaching and learning practices and all this has al-

ready become part of that area of Gamification that deals with e-learning. In general, it is very important that a gamified project is able to identify the user's level of competence and give him immediate feedback.

The tests must be of slightly higher difficulty than the user's starting level to give him satisfaction when he succeeds in passing them, and without mortifying him when he fails. As the level of competence increases, even the stages of learning can and must increase the degree of difficulty (Kapp K.M., p.336). Currently, it is observed that a generation of digital natives is increasingly expanding within contemporary society. Some call it "Generation Y", also called Millenials, a term coined in relation to the previous "Generation X" which represents those born in the sixties and seventies (Prensky M., pp.1-6). Millennials are people born between 1980 and 2000 who have lived with digital technologies since birth and who therefore recognize the language and codes of the web, gaming and social networks as their mother tongue. Papert talks about the “Generation gap”, understood as the distance and diversity between those who grew up in a digital environment and those who instead learned the language of new media as a second “digital immigrants” language (Papert S, 1996). Digital natives have learned from an early age to manipulate technologies to satisfy their needs, while digital immigrants find themselves in a situation of cognitive disadvantage, which often gives rise to prejudices such as those that have always characterized the relationship between adults and video games.

Digital natives are used to receiving information quickly, they love to manage processes in a parallel and multi-task manner, they prefer graphics to text, and random access, as happens in hypertext. They are more productive when they log on to the net, make progress through instant gratification and frequent rewards, and enjoy reflective work games more. After dealing with Generation Y also called Millenials (digital natives), it is also important to reflect on the new next cluster provisionally called Generation Z.

We are talking about about 1/4 of the world population characterized by being currently of school age, not yet included in the working world and, therefore, without one's spending power. In fact, it is essential to start looking at their distinctive features, their ways of behaving, relating and consequently acting in the world of learning (Viola F. 2011).

Designing a learning experience, even gamified, follows a very specific procedural flow. Among the points to be taken into consideration, the target audience is fundamental. As indicated in the previous chapter, each of us is motivated to interact with a product or service on the basis of different dynamics. Without careful analysis, every motivational design and every attempt to create involvement through the use of Gamification mechanics becomes random (Viola F. 2011). Generation Z is the first to be always connected with technology, especially touch, to represent a real body extension.

It is enough to observe two or three year old children and the naturalness with which they move between the screens of a smartphone rather than a tablet, their ability to "swipe" and click and their expectation of similar interactions with any object in the environment. domestic. This, as far as learning is concerned, opens the door to a more conscious use of new technologies.

About 90% of this generation habitually use video games, making this medium the most important in terms of time and money spent, overwhelming entertainment products such as books, films and But, what are we talking about, when we pronounce the term Gamification

in reference to school education? According to Deterding (Deterding S., 2012) the term is currently used in reference to multiple related concepts, such as the increasing prevalence and omnipresence of games and video games in daily life, and the use of game-specific elements to capture the attention of students in contexts traditionally far from entertainment such as, for example, training and learning.

In general, the purpose is to involve users, encouraging them to achieve certain objectives by following pre-established rules and possibly having fun. Gamification has applications in many areas of daily life, such as those characterized by repetitive, boring or aversive actions, such as, sometimes, learning. The game has always been used as a tool for didactic purposes, since the youngest age groups, and there are many examples of "educational" games, capable of developing skills and abilities such as concentration, memory and manual skills from time to time.

Educational Math Games

The discourse becomes more complex and articulated if it refers to the study of mathematics and the use of gamification. Some research on affectivity related to mathematics has shown that the range of emotions that often accompanies the traditional study of mathematics ranges from negative feelings (anger, fear, inadequacy, frustration, anxiety, boredom) in percentage more frequent to positive feelings (happiness, excitement , fun, trust, relief) in less frequent percentages.

Surely the psychological tension that creates the study of mathematics is related to its conceptual structure and to the type of language through which the teaching is proposed. It would be desirable that even in mathematical high schools an interdisciplinary interaction could be considered capable of synergistically intersecting the scientific language of mathematics with the humanistic one. This approach together with the use of gamification could allow students to tackle topics related to the study of mathematics with less tension.

Dealing with something that you find interesting and fun can facilitate learning processes and make studying more enjoyable. If you manage to transform what you "must" do into something you "want" to do, the results obtained can only be better. In this regard, the use of the Moodle platform (Moodle for Education - M4Edu) by some Italian high schools was very interesting.

All Moodle Activities and Resources provide for the establishment of certain conditions that allow access only to students who meet them. The requirements to be met may be based on various elements, such as the assessment obtained in other activities or membership in certain Groups. This made it possible to reconsider learning mathematics on the basis of a different approach. The possible Moodle activities, in this sense, were: the task, the quiz, the crossword puzzle, the glossary and GeoGebra. To make the path more interactive, it is possible to install various plug-ins and, in particular, to stimulate competition more, the "Level up" plug-in can be installed, through which students can monitor their progress in the assigned path and their position in the class ranking.

The plug-in allows you to establish rules according to which scores are assigned. To encourage the pupils, unsuccessful attempts were also rewarded, albeit in a reduced way. The experience has presented numerous positive results: active participation of pupils, assimilation of content with greater ease, engagement and loyalty and immediate feedback on objectives.

To evaluate the users' perception of the path, an evaluation questionnaire was administered which provided substantially positive and encouraging results. The use of gamification techniques has made it possible to attract the attention of students by transforming passive participation in the learning process into active participation capable of making learning more personalized and therefore more effective.

Conclusion

The integration of cognitive theories into mathematical teaching research marked a turning point in the study of affectivity, because they highlighted that emotion is not intrinsically linked to a specific experience, but depends on how it is perceived and interpreted. This means that the feelings expressed by students depend on both their view of mathematics and their relationship to it.

The above may explain the results of some studies according to which mathematics is, in general, the favorite subject of elementary school children, but becomes the most detested by adolescents. The emotions aroused by matter change over the years and this is due to the fact that, continuing their studies, the students change their way of interpreting it.

Gamification is a complex issue, which will still require time and a lot of research, both theoretical and applied, to be explored in all its forms. What is certain is that the growing application of gamified logic and gaming elements to non-playful contexts is also deeply and substantially changing the world of school education.

Gamification can help overcome obsolete and ineffective training models, generating interactive, engaging learning environments in which the student is not just a passive receiver of notions. By exploiting the close relationship that exists between play and learning, Gamification can become a powerful ally in stimulating continuous improvement of pupils, in school learning, especially in those areas of more difficult cognitive access such as mathematics and physics.

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