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Integrated Gamification Model in a Constructivist Learning Environment for the Promotion of Creative Skills

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ABSTRACT

The Knowledge Society has highlighted the importance of creativity as a goal competence, which should be fostered in higher education institutions; therefore, it is necessary to integrate innovative educational experiences oriented to the development of creativity complementing the professional training of students. Recent research from psychology and pedagogy reports advances associated with the nature, evaluation, composition, and conditions for teaching creativity that have resulted in successful applications in only one facet of the creative process. In this research, we propose an integrated model for making educational interventions through online courses. This model combines contributions to the teaching of creativity from pedagogy in relation to the pedagogical model, instructional design, and conditions of the teaching-learning process required for the promotion of creativity. It also includes the contributions of psychology in relation to the cognitive processes and skills associated with creativity, the techniques and activities for the development of creative skills, as well as the principles associated with intrinsic motivation based on the theory of self-determination through its application in the learning technique called gamification. The advantage of this integrated model is that it incorporates and fosters multiple components of creativity simultaneously, with the objective of generating creative results of greater breadth and quality.

KEYWORDS:

creativity, gamification, constructivist learning environment, elearning, teaching creativity, creative skills

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INTRODUCTION

Creativity is a meta-competency (Saliceti, 2015) that implies the use of high-level abstraction skills. Its development has become an unavoidable need for professionals who currently join the so-called Knowledge Society. Particularly, it is relevant for engineers, whose work involves proposing and implementing solutions to organizational problems through the use of technology (Ghersi & Miralles, 2014). In these professions, the use of Creativity is required, not only for the proposal, but also for the construction of the solutions to be implemented. Therefore, it is necessary to incorporate educational interventions that foster creativity in students of higher education institutions, recovering the advances that have been made in this regard in psychology and pedagogy in such a way that they complement the skills obtained in the course of vocational training.

The idea of fostering students' creativity in the educational process is not new, from the research conducted by Bruner (1965) to the results obtained by Scott et al. in 2004 and subsequent works, it has been confirmed that creative training is beneficial for all types of people regardless of their age or level of skills; in all cases, creativity training works (Scott et al., 2004). In this regard, many educators support the idea that creativity can be developed through educational techniques (Baer, 1987; Christensen, 1988; Doolittle, 1995; Fasko, 2000; Ghosh, 1993; Sternberg & Williams, 1996; Torrance, 1972 cited by Clapham, 2003) and believe that promoting innovative thinking should begin in childhood (Carter, 1984; McCormack, 1984 cited by Clapham, 2003), but that it can also be fostered at an advanced age (Baer, 1987; Kozbelt et al., 2010; López Monroy, 2015; Root-Bernstein & Root-Bernstein, 2017; Valqui, 2009).

In that sense, the promotion of creativity through educational techniques is not linear (Smith & Smith, 2010; Valqui, 2009) and not all educational activities promote its development; that is, there are activities that can enhance, but also block creativity (Elisondo, 2018). Further, the teaching of creativity is a discipline that encompasses a large amount and variety of content, as well as different areas of knowledge and various aspects from reality (Saliceti, 2015), this situation represents a challenge, but also amplifies the possibilities of creative teaching (Elisondo, 2018).

Under these considerations, the approaches for teaching creativity has been studied from different areas of knowledge being more prolific the works developed by psychology and pedagogy. A selective review of these proposals allowed us to identify that despite being branches of knowledge that are naturally linked, their contributions have been oriented to different aspects of creativity teaching. Thus, we found that the contributions of psychology have generally focused on the creation of techniques, mostly oriented to foster ideation and divergent thinking, while the contributions of pedagogy have focused on identifying the type of activities that promote creativity, as well as defining the conditions of the physical, social and educational context around its teaching. A summary of this review is presented in Tables 1 and 2 below.

Table 1. Examples of techniques for the promotion of creativity developed from psychology

Techniques	Description
Brainstorming (Osborn, 1953)	Ideation technique based on the principle that many different ideas increase the likelihood of a high-quality idea.
Creative Problem Solving (CPS) (Treffinger et al., 2003)	Structure problems in five stages: fact-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding.
Synectics (Gordon, 1963)	It employs analogy for the generation of ideas from three approaches: Personal analogy Direct analogy Symbolic analogy.
Lateral thinking (De Bono, 1967)	Oriented to ideation through two processes: Escape: consists of rejecting assumptions and preformed concepts Provocation: consists mainly of suspending.
Hemisphericity (McCarthy, 1981)	Develops through the practice of information-processing activities that are believed to be dominated by the right hemisphere or require a balanced use of both hemispheres.
Khatena Method (Khatena & Torrance, 1976)	Proposes five main strategies for improving ideation Breaking with the obvious and the commonplace Transposing ideas Exploring analogies Restructure Synthesizing ideas.
Packaged educational programs (Covington et al., 1974; Feldhusen et al., 1971)	Purdue's creative thinking program consists of lessons emphasizing divergent thinking through stories of creative people. Productive Thinking Program aimed at developing creative problem-solving skills and improving attitude and self-confidence. It involves solving mysteries or detective problems. Torrance Idea Books are workbooks for practicing perceptual and cognitive skills, the basis of divergent thinking.

Table 2. Contributions to the teaching of creativity from pedagogy

Author	Proposal for teaching creativity
(Davies et al., 2013)	The following are necessary components for creativity: physical environment; availability of resources; external environment; pedagogical environment; roles; use of time; relationship between teachers and students; use of environments beyond the school.
(Susnea et al., 2014)	Conditions required for creativity: the physical environment; availability of resources and materials; the use of the outdoor environment; the pedagogical environment; the use of other environments beyond the school; game-based learning; effective and flexible use of time, and relationships between teachers and students.
(Saliceti, 2015)	Considerations for teaching creativity: conception of the discipline and principles underlying it; analysis of the social and educational context; principles and reasons on the basis of which the contents are selected; teaching strategies to be used.
(Rodrigo et al., 2013)	Recommendations for the development of creativity: include the framework on which the discipline is based with the contribution of different areas of knowledge and/or theoretical bodies; make reference to the social and educational contexts, where teaching will be developed; present the contents and specify a course of action on the different elements involved in teaching (learning models, means, goals, methods, training, etc.).

Author	Proposal for teaching creativity
(Beghetto & Schreiber, 2016)	Encourage the formation of questions and doubts.
(Beghetto y Kaufman, 2014)	Expand the possibilities for novel thinking and interpretation.
(Ayob et al., 2011; Bakir, 2011; Chiecher et al., 2018; Csikszentmihalyi, 1996; Davies et al., 2013; Elisondo, 2015; Hong et al., 2013)	Proposals outside the classroom and extracurricular activities are opportunities for creativity.
(Alfonso-Benlliure & Valadez Huizar, 2013; Cotter et al., 2016; Paek et al., 2016)	Relationships between learning, academic performance, creativity and out-of-class activities.

Based on this information, a model of online courses to foster creativity was structured. It integrates the contributions of psychology to understanding the structure of creativity, its processes and components, as well as the theories that support these assertions. On the pedagogical side, the model integrates the theories that establish the environmental and instructional conditions necessary for its promotion, under the premise that creative skills are skills of high level of abstraction or reflective abstraction (Villar, 2003).

The model proposed in this document is based on Amabile's (1996) approach (Figure 1) in relation to the components of creativity in individuals. Those components allows to develop a framework that integrates the contributions of psychology in relation to cognitive processes and skills related to creative thinking according to Mumford et al. (2018), cognitive skills according to Ward and Kolomyts (2010), gamification as a techno-educational tool based on the Theory of Self-Determination (Deci et al., 1991) with contributions from the pedagogy of a constructivist approach (Barriga, 2005) that promotes the use of extra-classroom spaces and technological tools that enrich the educational environment (Pecheanu & Tudorie, 2015), oriented to an instructional design aimed at the development of reflective skills (Jonassen et al., 1995) associated with creative problem solving (Treffinger, 1995). These elements are described below.



Figure 1. Components of creativity in individuals

Note: This model is proposed by Amabile (1999).

THE EXPERIENCE

According to Amabile (1996), experience refers to knowledge in some of its forms: technical, procedural, and intellectual. This knowledge can be acquired both theoretically and practically and is constituted according to the specific area of expertise the individual wishes to focus on. In profes-

sional training, the students acquire experience in the educational process by getting involved, interacting and executing actions that enrich his knowledge and skills in the field of his interest.

CREATIVE THINKING SKILLS

Stemming from cognitive theory, creative abilities involve the use of specific processes or combinations of processes, the intensity of the application of those processes, the richness or flexibility of stored data, cognitive structures to which the processes are applied, the capacity of memory systems, and other known and observable fundamental cognitive principles (Ward et al., 1997). Among these cognitive principles and structures, we have abstraction, conceptual combination, analogy, and problem solving, which can operate to produce creative outcomes across a wide range of domains (Ward & Kolomyts, 2010). Conceptual combination is a process by which previously separate ideas, concepts, or other forms are mentally merged. These ideas or concepts can be simple or represent even more abstract or complex levels, such as visual forms, scientific constructs, musical styles, or artistic genres. In any of these variants, combination is considered a stimulant of creativity (Rothenberg, 1976; Smith et al., 2009; Thagard, 1984). Another cognitive process is analogy, the purpose of which is to apply knowledge from one domain as a model for understanding or developing ideas in other domains, to communicate a new idea in a concise and understandable way. Analogy has been the source of several proposals for teaching and fostering creativity in different domains of knowledge (Fernández González et al., 2004; Gentner et al., 2001; Holyoak & Thagard, 1995). Problem formulation is an important component of the creative process, because the way people conceptualize a problem strongly influences their probability of finding an original or creative solution (Basadur, 1994, 1997; Mumford et al., 1991; Runco & Chand, 1995; Sternberg, 1988; Treffinger et al., 2003).

To the principles and cognitive structures presented by Ward and Kolomyts (2010), we integrate the work initially developed by Mumford, Mobley, Uhlman, Reiter-Palmon and Doares (1991), who identified eight core processes involved in most incidents of creative problem solving: problem definition or construction (Mumford, Baughman, Threlfall, et al., 1996), information gathering (Mumford, Baughman, Supinski, et al., 1996), concept selection (Mumford et al., 1998), conceptual combination and reorganization (Baughman & Mumford, 1995), idea generation (Eubanks et al., 2010), idea evaluation (Lonergan et al., 2004), implementation planning (Osburn & Mumford, 2006), and adaptive solution monitoring (Hunter & Mumford, 2005). Execution of each of these processes has been shown to make a unique contribution to creative performance in problem solving (Mumford et al., 1997). Finally, Mumford et al. (2018) integrated the cognitive skills required to enhance creative performance for each of these steps of the creative problem-solving process, as well as related cross-cutting skills. Figure 2. presents the general structure that integrates these processes and skills with the cognitive principles and structures determined by Ward and Kolomyts (2010).



Figure 2. Processes and skills with the cognitive principles and structures proposed

Note: The figure represents integration of processes and skills identified by Mumford et al. (2018) related to problem resolution and the general cognitive abilities described by Ward and Kolomyts (2010). This integration is a reference to the proposed model.

Another aspect to consider regarding creativity is measurement. Assessment of creativity continues to be one of the most debated aspects in the field of creativity research. Most of the proposals generated by researchers are oriented to the use of psychometric techniques for its determination. Those psychometric methods are usually grouped into four different aspects: creative processes, behavioral manifestations of creativity, characteristics of creative products, and attributes of the environment that foster creativity (Rhodes, 1961).

Some proposals have focused specifically on the assessment of divergent thinking, which, although it is not synonymous with creativity, is useful for research on creative potential and creative thinking that occurs in the natural environment. Divergent thinking research has many advantages,

including the fact that it provides information about process and product, and is quite practical (Runco, 2010). Thus, it is possible to use divergent thinking as a way to learn what kind of ability individuals must possess to be creative (Csikszentmihalyi, 1999). Nor is it inappropriate to use divergent thinking scores as indicators of creative ability. In fact, there is some evidence that divergent thinking scores predict real-world creativity (Ward & Kolomyts, 2010).

In general, divergent thinking tests ask for multiple responses to verbal or figural prompts, and responses are scored for fluency, flexibility, originality, and elaboration of ideas. The fluency is defined as the number of responses to a given stimulus. Originality is operationalized as the uniqueness of responses to a given stimulus. Flexibility is operationalized as the number and/or uniqueness of categories of responses to a given stimulus. Elaboration is operationalized as the extent of ideas within a specific category of responses to a given stimulus (Plucker & Makel, 2010).

Although other approaches have been developed to measure creativity in the individual based on the criteria described above or proposing new constructs, researchers have begun to use psychometric methods to assess product creativity (Horn & Salvendy, 2006), investigate environmental characteristics associated with creativity and innovation (Amabile et al., 2004; Amabile & Conti, 1999), and develop new personality measures (Kelly, 2004) which allows to explore another proposals to address the study of creativity.

TEACHING AND LEARNING CONDITIONS

In relation to the teaching and learning conditions, we chose the pedagogical approach whose strategies and methods are related to the needs detected for the development of creativity. In this regard, we consider that the constructivist approach is the appropriate pedagogical model because it shares many of the conditions identified by creativity theorists for its development (Chadwick, 2001; Pozo, 2008). In this regard, Brown, Collins and Duguid (1989) argue that situations co-produce knowledge (along with cognition) through activity. And this activity must be developed in environments where it is linked to the students' lived experiences. In agreement, Saliceti (2015) states that the development of creativity is adapted to the knowledge domains in which it interacts and its promotion is related to the promotion of activities outside the classroom that stimulate active and experiential learning (Ayob et al., 2011). Like constructivism, these activities favor collaborative and exploratory processes for the resolution of complex tasks (Elisondo, 2015, 2018).

On the other hand, in constructivism, the goal of instruction is not to ensure that the student knows particular facts, but they can elaborate and interpret information (Ertmer & Newby, 1993), in line with the objective sought for the development of creativity, which consists of elaborating and interpreting information to generate new and different ideas. Also, diverse environments outside the classroom, availability of resources, interaction between teachers and students and the pedagogical environment are necessary to develop creativity (Saliceti, 2015). Similarly, constructivism

argues that active learning in the student develops from the interaction between the student with the environment and collaboration with peers and the teacher (Pozo, 2008).

Finally, Torrance (cited by Chaplam, 2003) concluded that the most successful programs that improve ideation emphasize cognitive and emotional components. These cognitive components of constructivism are built through interaction with the environment and learning processes, i.e., the ways of organizing information (Chadwick, 2001). Consequently, they make it the appropriate pedagogical model for the promotion of creativity. An example is problem-based learning, which is a constructivist didactic technique of inquiry in which students collaboratively and independently develop critical thinking to create proposals for solving a given problem.

After choosing the pedagogical approach, we selected the instructional design for online courses considering the limited face-to-face interaction due to the SARS-CoV-2 coronavirus pandemic, together with the need to have an active learning design that prioritizes collaborative work, the acquisition of reflective abstraction skills and creative problem solving to develop the cognitive processes and skills necessary for the promotion of creativity. As a consequence, an instructional design focused on active, virtual learning was chosen, in which problem solving is the guide for learning and collaborative work is prioritized. This design is called Constructivist Learning Environment.

This instructional design proposal by Jonassen (1994), called Constructivist Learning Environment (CLE), is made up of five components: problems, complementary information sources and analogies, cognitive tools, conversational or collaborative tools, and social/contextual support systems. Problems are the starting point of the design and must be associated with the students' future professional practice. Problems or projects, according to Jonassen (1995), need to include three components: context, representation, and manipulation of the workspace (Esteban, 2002; Jonassen et al., 1995).

MOTIVATION

Psychology has studied the factors that influence and promote motivation in human beings from many perspectives. One of these theories is known as the Self-Determination Theory (SDT). It was proposed by Ryan and Deci (2000) and emphasizes the importance of the evolution of internal human resources for the development of personality and the self-regulation of behavior (Ryan et al., 1997).

This theory characterizes the types of motivation according to the factors that provoke people's interest and intention to act, classifying motivation as intrinsic and extrinsic. Extrinsic motivation is based on external factors such as rewards, fear, coercion or others. Intrinsic motivation, is attributed to internal factors related to the interest, excitement, and confidence with which a person undertakes an activity, which manifests an increase in performance, persistence, and creativity (Deci et al., 1991; Sheldon et al., 1997), an increase in vitality (Nix et al., 1999), self-esteem (Deci & Ryan, 1995), and general well-being (Ryan et al., 1995).

In this sense, the theory of intrinsic motivation focuses on the study of the factors that stimulate, sustain, or avoid and diminish this quality in people. To this end, Deci and Ryan (1985) propose a theory, called cognitive evaluation theory (CET), which identifies three psychological needs that are the basis of self-motivation and personal development. These needs are the need to be competent (Harter, 1978), the need to be autonomous (Deci, 1975), and the need to relate (Baumeister & Leary, 1995). They are essential to promote growth and integration, as well as the constructive functioning and well-being of individuals.

However, as adult life develops, many of the activities that people perform do not involve an intrinsic interest, so there are external factors that guide their performance. Extrinsic motivation comes into play in these activities, to achieve the action of people. In this regard, CET states that extrinsic motivation varies according to the conditions of the social and organizational environment and is variable in its relative autonomy (Ryan & Deci, 2000). For example, a student who participates in a school event because their grade depends on it has a different level of motivational autonomy than the one who participates because they believe that their job opportunities will benefit from it.

This relative autonomy manifests itself concretely in extrinsic motivation in four regulatory styles that form a spectrum between demotivation and self-motivation. Each one presents different regulatory styles and processes. Demotivation results from not attaching value to an activity (Ryan, 1995), not feeling competent to do it (Bandura cited by Deci & Ryan, 1995), or not expecting it to produce a desired result (Seligman cited by Deci & Ryan, 1995).

Extrinsically motivated behaviors that are less autonomous are described as externally regulated. Of the different categories of extrinsic motivation, external regulation is the type of motivation that operant conditioning theorists focus on. In the so-called introjected regulation, behaviors are performed to avoid guilt, anxiety, or to obtain gains for ego gains, such as pride. Another, more autonomous, form of extrinsic motivation is regulation through identification, which reflects attaching conscious value to a behavioral goal or regulation, such that the action is accepted or made one's own as personally important. Finally, the most autonomous form of extrinsic motivation is integrated motivation. The actions that characterize integrated motivation share many qualities with intrinsic motivation, although those are still considered extrinsic because they are done for separable outcomes rather than for their inherent enjoyment (Ryan & Deci, 2000).

Thus, to promote both integrated extrinsic motivation and intrinsic motivation, we must construct contexts that support autonomy, competence, and relatedness, which have been shown to foster greater internalization and integration than have the contexts that frustrate the satisfaction of these needs. In this regard, CET states that such actions as positive feedback, communications, and rewards can enhance intrinsic motivation, while negative feedback and tangible rewards reduce it, and competition does not increase intrinsic motivation unless accompanied by a sense of autonomy. On the other hand, excessive control, non-optimal challenges, and lack of connectivity disrupt the actualizing and organizing tendencies with which nature has endowed individuals. It is also important to note that these conditions are maintained in intrinsically motivated individuals in tasks with intrinsic interest that have the appeal of novelty, challenge, or aesthetic value (Ryan & Deci, 2000).

These results have also been reported by other researchers interested in the relationship between intrinsic motivation and the development of creativity. Amabile (1993), for example, pointed out that rewards enhance intrinsic motivation when they confirm competence or provide useful supporting information or allow a person to do something that they were already intrinsically motivated to do, especially when their levels of intrinsic motivation are high. In later work, the author reports that incentive systems indicate, in the case of adults, that the value of their contribution has an impact on improving their level of motivation and even creativity (Hennessey & Amabile, 1998). Years later, these results are reiterated when researchers recognize that extrinsic rewards can have a positive effect on creativity; a result that improves when intrinsic motivation is already high (Hennessey & Amabile, 2010). Additionally, Harackiewicz et al. (1984) argued that rewards associated with performance provide a tangible symbol of achievement that can intensify the affective meaning and importance of achievement, making competence information more salient and thus strengthening motivation.

On the other hand, a meta-analysis by Eisenberg and Byron (2011) reports that rewards given for creativity increase creativity, while rewards for high performance, not specifically for creative performance, increase creativity to a lesser extent. In contrast, rewards not earned for performance generally reduce creativity. More generally and confirming the value of reward in extrinsic and intrinsic motivation, Jovanovic and Matejevic (2014) corroborate that rewards have an interrelationship between external motivators and task-oriented motivation that is confirmed by Sternberg's cognitive approach (Sternberg & Lubart, 1991, 1993). In that sense, rewards are considered to promote rather than limit freedom and independence in individuals. And they reiterate that although students find pleasure in an activity at the beginning, their level of satisfaction and enjoyment in the activity with time and long analysis may decrease. In that situation, some level of extrinsic motivation over time may become necessary to restore and continue the activity, even if at the beginning there was no need for external motivators.

These findings are of great significance for people who wish to motivate others in a way that engenders commitment, effort, and high quality performance. They also represent the basis under which gamification is proposed as a techno-educational tool that employs various game elements to promote intrinsic motivation through integrated extrinsic motivation. The latter is associated with the development of creativity in the individual.

GAMIFICATION

Appealing to established theories of intrinsic motivation, gamified systems commonly employ motivational features such as immediate success feedback, continuous progress feedback. They rely on goal setting through interface elements such as scores, badges, levels or challenges and competitions; social feedback, teams or communication features. Additionally they support autonomy through avatars and customizable environments, user choice in goals and activities, or narratives that provide emotional and value-based foundations for an activity (Johnson et al., 2016).

In that sense, gamification proposes the use of motivational components identified in the game to promote contexts that provide motivational elements that favor internalization and improve people's performance in the development of activities. Gamified systems that demonstrate a clear understanding of the psychological needs of their participants can be used to generate a sense of intrinsic motivation in these participants (Buckley et al., 2018). Gamification is an application of its dynamism and system to real-life problem solving (Zichermann & Cunningham, 2011) and offers an alternative for the development of applications or activities that use gamification as a strategy that influences and motivates people's behavior (Matsumoto, 2016). Among the techniques it employs are included rewards, obtaining badges, accumulation of points, development of levels, among others, that lead students towards the achievement of objectives and becoming autonomous agents of learning (Matsumoto, 2016).

On the other hand, in addition to learning, gamification has also been related to various applications of creative ideation, such as divergent thinking and crowdsourcing. Feng et al. (cited by Nivedhitha & Manzoor, 2019) demonstrated that game elements, such as providing feedback and points, influence participation in crowdsourcing websites. Using an experimental study, Zimmerling et al. (2019) demonstrated that game elements improved the quantity of ideation, but questioned the effect of game elements on the quality of ideation. Other common gamification applications during the search/ideation phase are those that aim to facilitate the idea-gathering process, for example, by giving participants a reward for an idea (Shpakova et al., 2019).

Other initiatives have taken a more holistic approach by giving participants the tools to interact with ideas and each other. Mechanics of "investing" points or time in a proposed idea, with subsequent dividends in points if the idea is selected at the end, allow for participation by all, encourages curiosity and exploration of others' ideas, as well as expression of one's own ideas, which could give participants impetus to generate new ideas. When ideas are shared and actively processed within a group, group members can build on them and allow more creative ideas to emerge (Shpakova et al., 2019).

Other proposals, such as placing participants in an imaginary world defined by the rules of the gamified system (Salen et al., 2004), with a narrative and a theme, can facilitate thinking in metaphors and imagining the unimaginable. The game becomes a space where objects and behavior obtain special meaning and participants can explore new ideas, scenarios, and mindsets (Gudiksen & Inlove, 2018). Designed in a collaborative environment outside the participants' comfort zone, such initiatives stimulate unconventional thinking and provide conditions for co-creation of ideas (Prahalad & Ramaswamy, 2004).

For the gamification design of this research, the methodology developed by Werbach and Hunter (2014) was used it consists of 6 steps:

1. Define the objectives of the gamification 2.
2. Delineate the desired behaviors.
3. Describe the players.

4. Develop activity loops.
5. Don't forget the fun.
6. Develop appropriate tools.

According to Werbach and Hunter (2014), there are three categories of game elements that are relevant to gamify: dynamics, mechanics, and components. These elements are organized in decreasing order of abstraction and are set out as follows:

Dynamics: these are the most general aspects that have to be considered in a gamified system; however, they are never introduced in the game, the most important ones are:

1. Constraints: these are limitations or forced commitments 2.
2. Emotions: such as curiosity, happiness, anger, frustration, competitiveness.
3. Narrative: the story that surrounds the system. It must be coherent and continuous.
4. Progression: Defines the player's progress and growth.
5. Relationships: are the interactions that occur and that generate companionship, rivalry, status, altruism.

Mechanics: these are the processes that make action progress and help the player to become involved. Werbach and Hunter (2014) identify ten that they consider to be the most important ones:

1. Challenges: puzzles or challenges that require a certain level of effort to be solved.
2. Luck: These are random elements, which help the player.
3. Competition: Where there are players who win and lose.
4. Cooperation: Players are expected to work together to achieve a shared goal.
5. Feedback: players receive information about how they are performing in the activities.
6. Acquisition of resources: Players obtain items that are useful or collectible.
7. Rewards: benefits that are obtained by reaching a goal or performing an action.
8. Transactions: these are exchanges between players, trade through intermediaries or directly.
9. Turns: sequential participation of the players.
10. Victory states: (objectives that define a player as a winner, loser or that there was a draw.

Components: Game components are the nouns of a game. They are, generally, specific manifestations of the mechanics, which in turn are manifestations of the Dynamics.

Gamification is a techno-educational tool that can be pointed out as a derivation of behaviorism given that its foundations are oriented to behavioral change through game elements. However, the game is an activity recognized in constructivism as indispensable for the affective and intellectual balance of the subject. It allows them to have a sector of activity whose motivation is

not the adaptation to the real, but, on the contrary, the assimilation of the real to the self, without coercion or sanctions (Piaget, 1961).

On the other hand, Vygotsky (2009) points out that the imaginary situations generated by play are a means to develop abstract thinking. This is relevant in the Constructivist Learning Environment model proposed by Jonassen et al. (1995), because although when posing the base problems of the instructional design, the real conditions in which they arise should be represented, these elements continue to be integrated artificially, since they cannot be completely emulated in virtual environments for various reasons. It is developed in a distant physical space, in an organization which is not related to education, among others, so its use is relevant as a strategy for placing the problem in an educational space away from the real environment of the problem. In this sense, introducing game elements in a constructivist instructional design represents a possible complement, particularly rule games. The rule games from Piaget's perspective (1961) are the only ones that not only persist in adults, but develop with age and in which respect for the rules and their compliance is a factor which determines the internalization of the social and the enjoyment of it.

Additionally, in the game of rules (Piaget, 1961), guidelines and forms in which the game is developed are established, just as gamification proposes. The implementation of rewards, levels, badges, narratives and other components of gamification establish the rules under which teaching-learning activities are developed. Their integration into the constructivist learning environment, based on the self-determination theory, describes the ways in which these elements should be integrated to promote intrinsic motivation, which is a necessary element for creativity in the individual according to the model used in this research work.

MODEL FOR EDUCATIONAL INTERVENTIONS ORIENTED TO PROMOTE CREATIVITY

The educational intervention model presented in this paper integrates the processes and skills associated with creative problem solving [based on the contributions of the theories of creativity with a cognitive approach by Mumford et al. (2018) and Ward and Kolomyts (2010)]; the characteristics of the environment for fostering creativity (Pecheanu & Tudorie, 2015); the constructivist pedagogical approach, which constitutes the relevant model for the level of reflective abstraction associated with creative activities; the Constructivist Learning Environment as an instructional design generated from the constructivist view of problem-oriented learning in an online modality (Jonassen, 1994); and the principles of fostering motivation from the Self-Determination Theory (Deci et al., 1991), which are promoted in practice through the implementation of gamification based on the methodology of Werbach and Hunter (2014). This is graphically represented in Figure 3. This very model of educational intervention is oriented to students of higher education in professions where creative problem solving is an objective, including the skills to create or implement the proposed solutions to the problems posed, as is the case of engineering education.

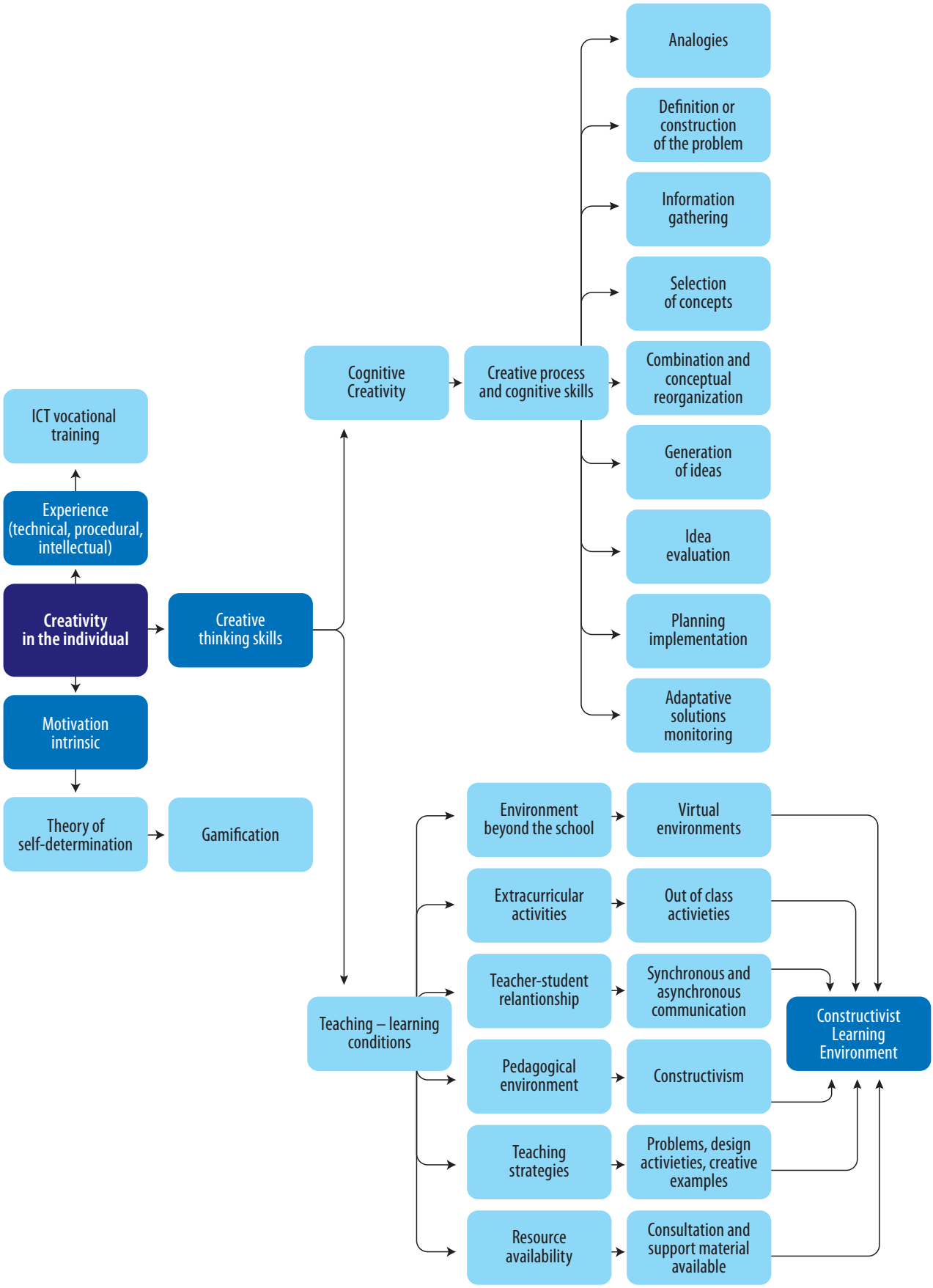


Figure 3. Scheme of the components integrated into the proposed model

STRUCTURE OF THE MODEL

Choice of skills

The first stage of the process is the choice of the creative skills to be developed, as shown in Figure 2. In order to choose those that should be incorporated into the intervention, it is convenient to identify the skills developed in the professional training process in order to discard them and choose those that are lacking or need to be reinforced. This is also bound by the characteristics of the students, as well as the time available for the intervention. Once the processes and skills have been chosen, they are placed in a table used as a base structure to organize the rest of the components of the intervention (Figure 4).



Figure 4. Model table to organize the chosen processes and skills

The Constructivist Learning Environment (CLE) Design

The instructional design of the constructivist learning environment involves problem generation, information sources, cognitive tools, collaboration tools and contextual support systems. In this model, once the processes and skills have been chosen, the starting point is the definition of the set of problems to be solved, related to the students' current context, designed for each creative skill. This involves identifying how the creative skill is used in the student's professional environment.

The structure of a problem depends mostly on the professional area. It is necessary to consider the context in which the graduate develops professionally and the professional skills obtained by the student up to the moment, as well as the type of challenges they will face in their work as a professional. When defining the problems, it is recommended to propose those that involve the use of one or more cognitive skills associated with creativity, and increase their level of complexity as the student develops the activities. Likewise, the variety of ways in which a certain skill is used in a specific domain of application of creativity should be considered. Both considerations will allow, from the constructivist perspective, to develop different levels of mastery. Another variant would be to include more than one activity in the development of the skill, which can also increase the level of complexity or pose different problems with the same level of complexity in different professional contexts in such a way they contribute to improving understanding of the uses of the skill under different scenarios. They can be, for example, the design of a product or service, a strategy, or a process. It implies that the problems proposed at first will be reviewed, modified, and adapted

as the other components of the CLE are generated. A variant of the proposed problems are the psychological tests developed to measure a specific skill, which generally present situations of general scope that can be applied to different professions.

In this proposal, an explicit evaluation of the activities is not considered necessary, since the evaluation of products can discourage experimentation and the exploitation of errors. Instead, positive feedback is proposed, as indicated by the self-determination theory, to guide the student to divergent thinking and originality of ideas. However, if it is of interest to apply an evaluation criterion, it is recommended to use an evaluation tool for creative products, such as Creative Solution Diagnosis Scale (Cropley, 2015). This scale was developed to facilitate the assessment (or diagnosis) both of the *amount* of creativity and the *kind* of creativity of products, including, but not limited to artifacts, systems, processes and services. The scale expands on the four basic criteria of creativity with indicators representing observable characteristics of a creative product. Another way to assess the level of development of creative skills through the online course can be done by applying a test before and after the course measuring creative skills such as the Torrance Test (Torrance, 2018), the Multifactorial Assessment of Creativity (Sanchez Escobedo, 2006), the Creative Imagination Test for Adults (Barraca et al., 2011) or other psychometric tests created for this purpose. These tests can measure the progress in the development of creative skills of those taking the course. Once the problems have been defined, they are incorporated into Figure 5 to organize and assess their coherence with the skills sought.

Process	Ability to develop	Name of the activity	Activity description
Creative resolution process	Ability to develop according to the process	A name related to the skill or to the subject of the skill can be used	In a first description of the activity, it is proposed to describe in detail as many elements, ideas and even examples of the activity that is being planned. It can also be instructions. Subsequently, this information will be refined to obtain a clear and precise description.

Figure 5. Model table to organize and describe the problems of the CLE

Learning sources consist of didactic materials that contain the principles, procedures, methods or examples necessary for students to solve the problems. It is recommended that the examples refer to the first activity in such a way that they support the scaffolding to advance in the skills. Since the contents are presented online, there is a wide diversity of technological tools providing support to diverse learning styles of the students and with additional activities to allow verify the contents were reviewed by the students.

Cognitive tools are integrated by different applications, whose purpose is to support the resolution of the designed problems. For the use of any technological tool, it is necessary to consider the characteristics of the students, their skills in the use of technologies, and the characteristics of the technological equipment they have. For the choice of cognitive tools, analysis of the proposed problems is considered as a starting point in order to identify which moments of the resolution process may require the use of tools and what type of tools would be feasible to use. Based on

this identification, the next step is to identify available options and choose those that adapt to the context and communication needs.

Collaboration tools are all the means that can be used for students to interact with each other and with teachers. Among the proposed communication alternatives are virtual sessions, forums, chat groups or others. The choice of the appropriate tool depends on the technological tools available and the platforms chosen for implementation. A relevant aspect is that collaboration is fundamental in the promotion of creativity, so it is also necessary to promote rules in communication that do not inhibit the generation of ideas, such as encouraging questions, avoiding criticism and qualifications to the proposed ideas, rewarding the creative effort with new ideas. In this sense, the teacher's participation should encourage interventions stimulating divergent thinking, originality, and discussion, where different points of view come into play in search of increasingly creative ideas.

Finally, the support systems should consider alternatives of contact with the teacher to develop tutoring, tutorials of the technological tools that require it, as well as additional activities, games or review activities. This section also considers other complements to the instructional design such as opinion surveys, among others. All the defined elements of the CLE are integrated with the description of the problems. This generates an information matrix on which gamification can be implemented. Another alternative is to divide the matrix into two parts to facilitate its handling. Both proposals are illustrated in Figure 6.

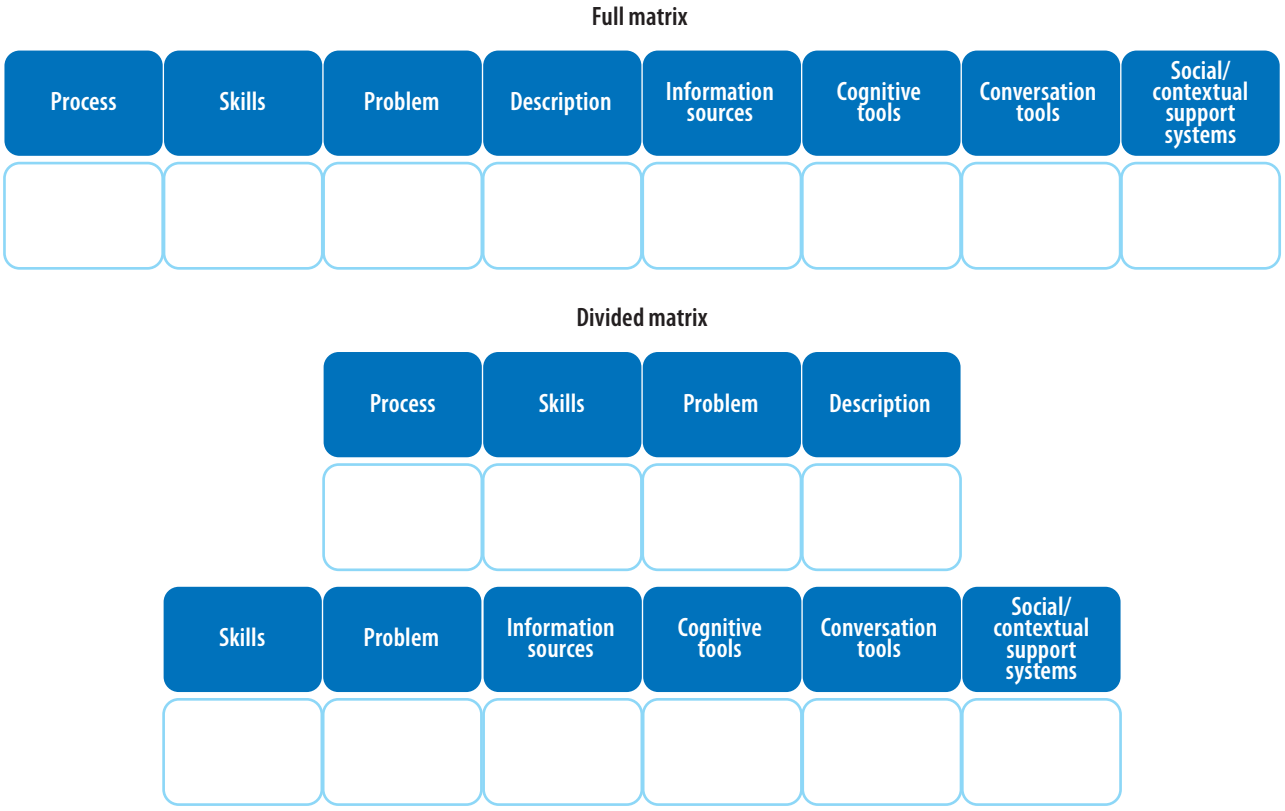


Figure 6. Matrix to organize the implementation of CLE instructional design

Note: Matrix of processes, skills, and components of the CLE defined for the educational intervention.

With this structure, the model maintains the four components pointed out by Jonassen (1995) regarding the design of the constructivist learning environment:

Context: Which is considered in the problems proposed based on the profession and level of professional skills achieved by the students.

Construction: The construction consists of the problem statement, the design of the information sources, the cognitive tools and the supporting material that provide resources to be used in solving the problems.

Cooperation: developed through group problem solving or participation in posing and answering questions, as well as participation in social communication networks.

Communication: associated with cooperation through the exchange of questions and answers through forums or in the follow-up of the teacher through online tutoring.

Implementation of gamification

The gamification design was created based on the methodology proposed by Werbach and Hunter (2014), over the structure of the CLE matrix designed (Figure 7). In this proposal, all the components integrated to the intervention start from the definition of the narrative. The entire intervention must be wrapped in a narrative associated with the development of skills organized in levels. The narrative defines the characteristics of the levels, forms of progression, the type of rewards, transactions, objects, acquisition of resources, challenges and even the style of feedback used. Thus, the components that make up gamification are organized as follows.

Students' advancement is organized in levels, each creative process identified corresponds to a level of advancement. Additionally, there is an initial level, where the organization of the intervention is explained, the narrative is presented to immerse the student in the environment, and the components of the CLE are presented according to the defined rules. This initial level will also show how the level will be advanced, how the platform and its elements are manipulated, as well as how it will be used to introduce the students to their colleagues or to promote a collaborative exercise.

Level advancement depends on the problems/activities; solving all of them will allow students to advance to the next level. This will be through points, which they will get for each activity performed. The points can take the form that interests teachers in accordance with the narrative (stones, minerals, bitcoins, others). Each activity can be fed back by the teacher, but not evaluated, with comments that highlight the original aspects and guide with comments or questions the use of a skill in the process. It is also possible to determine some type of additional reward in the case of very original ideas.

The review of information sources and associated activities awards the participant with badges related to the increase of their body of knowledge. The names of the badges should also be related to the narrative. The sources of information are very important as support for problem solving. Feedback is also important in the sources of understanding because its assimilation by the student will contribute positively in the solution of the problems and with the understanding of the impor-

tance of the cognitive skills they are developing, their influence on creativity, and their application in problem solving.

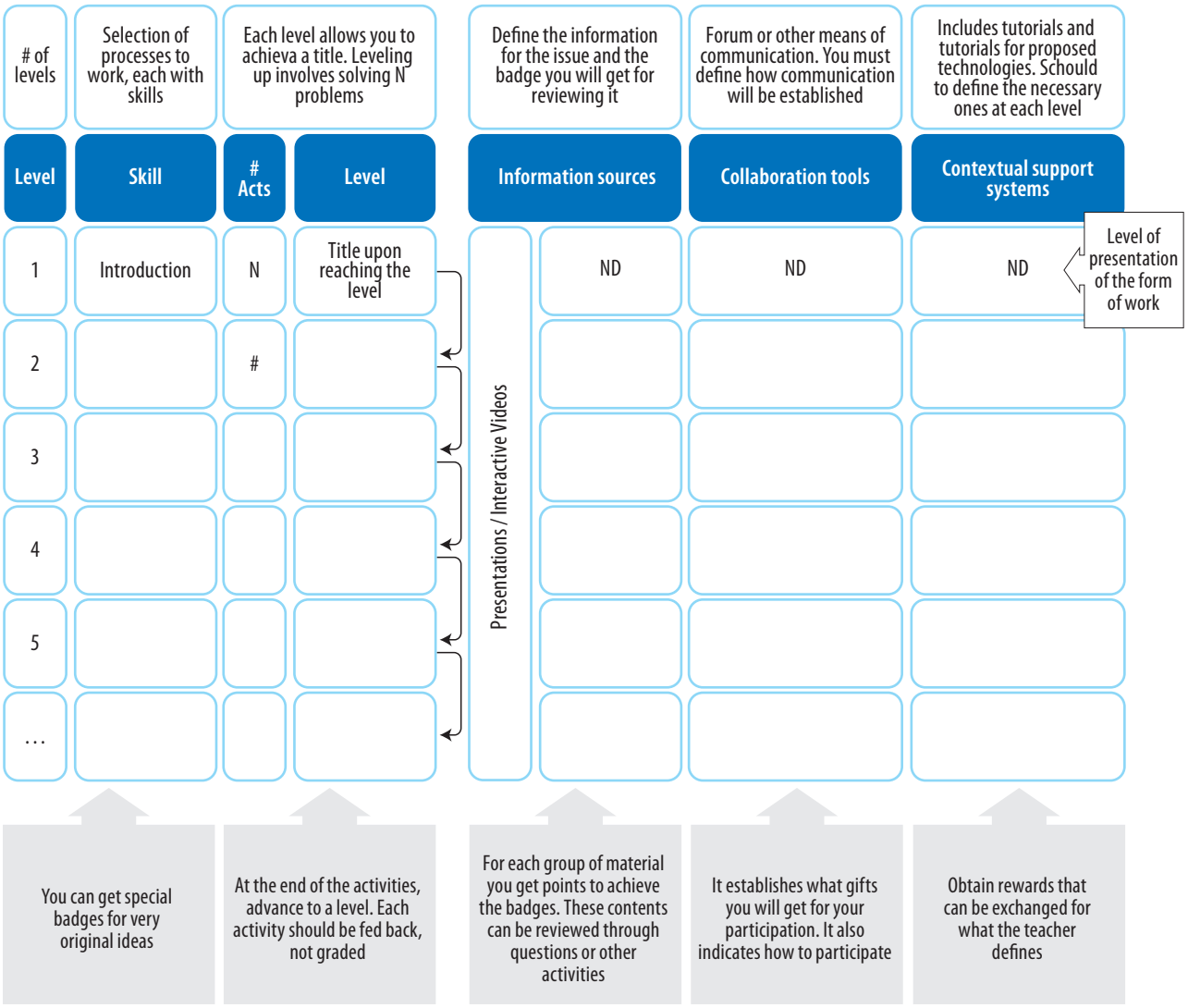


Figure 7. Model of the gamification over the CLE matrix

Note: The figure graphically describes the elements that should be included in the integrated model. It explains the elements included and the recommendations related to each component of the CLE matrix.

Support in the resolution of doubts, questions, feedback among students through the established means of communication are also rewarded with collectible virtual objects. The teacher can choose to exchange them for some incentive outside the platform. Some of them can be used as "keys" to unlock additional activities. The use of support systems is also rewarded with objects that can be exchanged between players. Since these activities are optional and accessible if additional help is required, their review is not mandatory.

CONCLUSIONS

Creativity is a fundamental goal and competence for new professionals to face the challenges imposed by the Knowledge Society. This forces higher education institutions to look for alternatives to complement the professional training curriculum and take advantage of the benefits offered by technology to generate educational interventions that promote creativity. In this way, the present model integrates contributions from psychology and pedagogy in relation to processes, cognitive skills, characteristics of the work and pedagogical environment, instructional design, didactic materials, and proven recommendations that have shown to have an effective impact on the creativity of individuals.

The integrated model for educational interventions oriented to the promotion of creativity is aimed at the developing online courses that integrate gamification in a constructivist learning environment. It and also can be applied to different disciplines of knowledge where the solution to organizational problems, as well as the creation or implementation of those solutions require the ingenuity and originality that creativity brings. Additionally, the proposed model presents an alternative integration of constructivist structures with a techno-educational tool based on theories associated with behaviorism, recovering the strengths of both approaches in the promotion of creativity.

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