
GAMIFICATION FOR ONLINE COURSES TO IMPROVE INQUIRY METHODOLOGY

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Challenges of inquiry learning

One of the biggest issues in courses and learning materials is that they are usually too inductive, too explicative and entirely too transmissive. In order to ensure that students grasp a concept, learning materials tend to use a single logic path from simplicity to complexity that shows, presents or explains things from only one point of view. Usually truths are presented as established dogma, which doesn't do much to encourage deductive and investigative thinking on the students' part, neither helps students understand that science is made using models built on data and presuppositions.

Investigative learning demands several competences essential if we are to overcome this reductive approach and create more critical and engaged citizens.

According to Barrell (2007) there are different types of investigative learning, depending on how problems are presented or elaborated. In a problem-based learning approach, there are situations in which problems are proposed by the teacher and the learning process traces a limited movement of investigating and solving problems, which can be more or less open according to the teacher's proposal. There are also approaches that are actually investigative, in which problems arise from students' observation of their contexts and/or social questions considered relevant; in such cases, the teacher may provoke the emergence of the problems, but the entire group will share impressions and create shared and collective questions to engage with.

According to Okada (2016), to pursue a safe and socially sustainable world it is important to reshape how we teach sciences, considering an approach that favours innovation and social responsibility.

“This process should be inclusive, interactive, anticipatory and transparent. To better align the innovation outcomes it must be based on the societal needs, expectations and ethical values (...) Inquiry based science education is considered the basis for helping learners develop scientific skills, responsible values and lifelong learning. Inquiry based learning is a constructivist approach, which supports students in active experimentation (...) The five E's

is one example, which fosters inquiry based learning through five steps: engage, explore, explain, extend and evaluate” (Okada, 2016; p.12)

But how can we create courses and digital learning material that promote learning with a more investigative methodology? How can gamification favour this more deductive logic?

Experimentation, Instruction and Creation

When we think of games or even learning resources, we usually think of Closed Instructional Design, in which every action and student feedback are pre-programmed, their paths and trails are determined beforehand, are often even reactive, and feature reductive and limited answers.

But it is possible to go beyond the use of closed and pre-programmed games; they can be departure points to other, more authorial and reflexive activities, or gaming language can be incorporated to pedagogical strategies as a form of gamification, which is the use of gaming elements in other contexts.

But how does that investigative construction happen? Which gaming elements can be incorporated to online courses so as to potentialise scientific investigation?

Pappert (1997) proposes three ways in which we relate to knowledge: experimentation, instruction and creation. Experimentation is the first way to learn; it's what we do as babies, when we begin to explore the world with our bodies and our senses. At that stage we decide what to learn and how to learn it, depending on our bodily reach and on the limitations of our senses. We must consider that experimentation learning won't give us quick access to all the knowledge and cultural practices accumulated by humanity over the centuries.

To accomplish cultural transmission, learning must go beyond personal experimentation and for that purpose formal learning institutions were created, as well as non-formal cultural spaces, both with instructional models that select what is culturally relevant and must therefore be taught. This is what Papert terms the Instruction stage, and it has a planned design. In online learning, the planning process is usually entrusted to Instructional Designers.

The biggest issue with instruction stage, according to Papert, is that we stop learning and accept being taught, since the choice of what will be presented is external to the individual doing the learning. These dynamics foster passivity in students, as they get used to being in a receiving role and develop a content-consumer attitude, rather than the active attitude required for Papert's third learning stage, the creation of knowledge.

The creation stage is when we appropriate aesthetic and scientific knowledge constructions and start to build new concepts and technologies to solve personal and social problems.

The three stages are important, and any course or exposition has an instructional basis, since there is a plan of what will be taught or a script to follow. Also, it would be impossible to create anything without access to thousands of years worth of cultural capital. But how can we ditch the transmissive paradigm and improve instruction stage to make it less castrating and creativity-inhibiting? Papert suggests that we use technology to make instruction an extension of experimentation. In other words, that we plan learning materials and instructional processes in which students can experience, experiment and decide their paths, rather than just be receptacles.

It is in light of Papert's ideas that we stress the importance of creating learning materials that enable experimentation rather than demonstration. Games and gamification can be very relevant to this transformation, because games are usually experimentative and players have high agency and are in a position to make decisions.

According to Murray (2003) games, as digital media, have three aesthetic components: agency, immersion and transformation. Instead of addressing transformation we prefer to highlight the fun aspect, because it is usually the fun things that transform us. Therefore, we shall consider as fundamental gamification elements agency, immersion and fun.

Agency, Immersion and fun

According to Murray (2003; p.127), agency is "the gratifying ability to make significant actions and see the results of our actions and choices". Murray claims that the interactor can assume the roles of navigator, protagonist, explorer or builder.

Agency is related to the action that the player will make, and consequently to gameability, which is the part of game design that regulates interaction between users and games, meaning that it defines what users will effectively be able to do in the game and what are the feedbacks and rewards.

Gameability includes the matters of competition and collaboration, since those relate to how the player or players will interact with the game and with each other.

Gameability also has to do with the missions and challenges. What sort of challenges are there? What is the sequence? Is there a hierarchy, or are they independent? Are they open or closed?

If the game has educational purposes, it can be of interest to design agency and gameability keeping in mind the competences you want the student/player to develop. This relationship between agency and competences is an important clue to produce good Gamified Instructional Design for a course or learning material.

The greatest challenge often is the lack of cohesion between the expected competences and what the player actually does in the game. There are many reactive and reductionist games that accomplish nothing beyond the memorisation of concepts and don't develop complex

competences such as the ones needed for investigative learning. Reactive actions are quite useless in learning to analyse contexts or to problematise, for instance.

Another important element is immersion, which is the famous “magic circle” that makes a player stay in a game, often for hours. Much more than sensory stimuli or devices that isolate the player from the physical world, immersion is a complex concept that involves more than sensation and thinking (sensorial and cognitive structures), comprehending also feelings and intuition.

Immersion can also be brought on by feelings of belonging and by archetypical structures, such as the ones invoked by narratives. The simple use of virtual environments or technology that intensely stimulates the senses is not enough to ensure immersion. A novel can be more immersive (and even more interactive) than some games. The secret is usually in the narrative, packed with symbols so as to attain subconscious – and therefore deeper – contents. There are several levels of immersion, ranging from a simple visit to the full-on transport of the embodied mind to that magic circle.

In a research on immersive educational practices, Carolei (2012) proposed the following relationship between immersion and the concepts of Jung (2004) and Delors (1999):

Table 1: Immersion dimensions

Immersion dimensions	Psychological Typology (Jung)	Proposal for Contemporary Education (Delors)
Physical	Sensation	Learning to do
Empathic	Feeling	Learning to live together
Cognitive	Thinking	Learning to know
Experiential	Intuition	Learning to be

Carolei (2012) conducted a research with online students analysing the connections between their psychological typologies, instructional activities and the functions they demanded. Data showed that immersion is deeper when more Jungian psychological functions are demanded and more of Delors’ proposals are attained. Therefore, an activity is more immersive if it invites on one to do, to know, to live together and to reflect about oneself.

The study’s main conclusion is that if an experience remains at the sensorial level it is less immersive than the ones with symbolic content that involve the Intuitive function, or emotions that engage the Feeling function, or even experiences with complex investigative proposals that demand the competence to know, especially those experienced in investigative processes.

Another important conclusion from Carolei’s research (2012) involves the results achieved by playing on students’ lesser psychological functions. According to Jung, every person has a lesser psychological function that is less used. When the activity demands that function exclusively, students tend to initially refuse to do the activity, abandon it at the start and report that they didn’t feel immersed. But once they overcome that initial rejection and

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persist, the experience is more transformative than the ones in activities that demand the functions students are more comfortable using.

This information is very relevant for online courses and for the new trends of personalised learning, since if we adapt the materials to match what's more comfortable for each student we might be losing the chance to enlarge their experience and challenge them to develop other psychological functions.

When it comes to educational proposals, especially regarding scientific literacy, immersion via the Thinking function with an investigative format is very desirable.

However, we must be careful of the two sides of the Thinking function: the magic immersion circle can be shattered if the activity is too explicative, but if it's mysterious and deductive, the activity can have a high immersive potential. The difference between knowing in a more or less immersive fashion lies mainly in the activity's logic.

Often used in demonstrations to highlight more direct relations and general rules, inductive logic is not very immersive. That is clearly visible in some educational games in which the narrative or action context is interrupted for the explanation of concepts, formulae or rules. That's a nuisance for players, because it breaks the charm.

Description and abstracting processes are part of knowledge, but often they need to be made "palpable" by imagination.

Deductive logic has an inverse process: as in a detective story, one must identify the rules in context through evidences and clues. One makes connections, and that eases projecting, mental building and imagination. The descriptive and inductive process presents students with the relationships as given, whereas the deductive process attempts to use clues to establish, find and/or imagine relations and often create new mental schemes and models.

Many educational games are boring because they are too inductive. Is it possible to change the logic? Instead of providing information and proposing very simple relations, it would be more interesting to propose clues and give students the opportunity to investigate, imagine, build hypothesis and make lots of mistakes.

The deductive process is less certain when it comes to transmitting information, which is the biggest fear of those who want to control student interactions, but the trade-off is the development of exploratory and contemplative competences.

The cognitive imbalance caused by problematization can also be very immersive. There are people who love challenges and problem-solving.

However, some problematizations are more contextualised than others. When a problematization is part of the narrative or of gameability it is more immersive than when it's something artificial or abstract.

Another interesting immersion element is Intuition. Immersion via Intuition can attain high symbolic levels. In order to achieve that, we must go beyond representation (signs) and into that which significantly moves us (symbols), that which transforms us and cannot be fully explained. The symbolic movements touch on archetypical structures and in doing so move the players intensely, even though they rarely have a clear understanding of why that happens.

In order to broaden awareness, it is important to acknowledge that game production can be influenced by image regimens.

Myths, tales and other narrative forms move us because they touch on subconscious symbolic regimens. The hero, wizard or storyteller are part of us and of our way of interacting with the world, and consequently with information and learning.

One way to experience intuitive immersion, to represent those “internal aspects”, is to make use of dramatization. That’s why RPG (Role Playing Games) are so interesting from a learning standpoint.

A RPG situation always has rules, but when the proposal is open to interaction and intuition it is possible to experience different ways of dealing with those rules, proposing new paths and resolutions in a rule-breaking attitude. Laurel (1993) proposes theatre, or dramatization, as a promising activity to conceive or design interactivity relationships, because in theatre one learns to work with multiple agents, to observe and reproduce, trying to recreate human behaviour models.

Theatre as well as games need rules and roles. There are “mechanical” models involved, since one of the essential steps in learning how to interpret is to acknowledge one’s own mechanisms, bodily automations and how they inscribe history and sensation in the bodies, so that later one can consciously manipulate those sensations. In games there is always programming and procedure, and our process is to create despite such programming.

That sort of interaction situation can be used for learning purposes. Dramatized situations can work as an experience laboratory, reproducing certain behaviour environments and helping face the conflicts that emerge in those environments. Those settings allow for investigative learning, with the elaboration of hypothesis that are tested on the dramatized situations.

One way to do that is to build awareness of those mechanisms by experience and experimenting. In today’s world, with technology that enables us to create universes and powerful illusory situations, it’s possible to increase both alienation and the levels of experimentation.

That is why being aware of the reasons we made choices in a game, of our trajectories, of the paths we experienced is very revealing of how we think and learn. Cartography is essential to all processes.

Schlemmer and Lopes (2016) stress the importance of the cartographic method to make sense of the gamification experience and highlight some limits, such as the design of phases, which may not afford the gaming experience the open and rhizomatic nature it requires to be more transformative. “Gamificação em espaços de convivência híbridos e multimodais: uma experiência no ensino superior, financiada pela CAPES, CNPq e FAPERG.” This results are directly related with analyses of academic activities about cognition in digital games with students in the graduate course Technology of Digital Games-Unisinos.

“The stage design of a game can not always guarantee this opening, because it is a limited context and whose control does not develop fully in the reconfiguration of the field of knowledge of the learner. The possible reconfigurations occur in circular or linear dimension of its own success by completing missions. Accordingly, a goal post priori always appears limited from the viewpoint of mapping, but not limiting the viewpoint of learning. What is learned opens possibilities but, on the dynamics of the game, not necessarily unpredictable, since it is provided to advance phase. In this case, it seems important to consider that you need to invest in game dynamics to strengthen and enhance the narratives of the players (as in the case of the RPGs)” (Schlemmer & Lopes, 2016; p.202)

Those limits can often be overcome by narrative logic and imagination. When one describes processes, one reflects deeply about their choices, affections, and the impact is more powerful and transformative than performing tasks with pre-defined goals. Process descriptions as a narrative can be more powerful evidence than results, scores and other indicators obtained by reductive and reactive answers without any metacognition or reflexion involved.

We always expect a game to be fun. The Latin version of the word “fun”, besides being associated with difference, has in its etymology “a second version”. In other words, it’s as though we tried to experience another reality, another time, another place, another life. To evade our daily routines and allow ourselves to be something else, live another life, in different places. That’s the powerful magic of games: allowing for other versions, including other explanations of reality itself.

Realist games with detailed simulations are frequently more successful in demographics for whom the portrayed reality is very far from what they experience every day.

Games with fantastical plots delight a great many people (we have only to look at the success of characters such as Harry Potter), even though many adults have a certain resistance to that sort of plot, feeling that fantastical elements infantilise games.

The biggest challenge in the use of games with fantastical plots, besides students’ possible resistance, is discussing the process. In more fantastical games people project more and reveal more than would be expected, or politically correct. Sometimes issues arise, every bit as interesting as they are complicated. But that open aspect is highly transformative.

A common problem in games with fictitious and fantastical plots is that metaphors and characters aren't designed properly. The symbolic elements are often poor, for lack of game design knowledge.

Symbolic elements are very powerful and must be well-chosen to be effective. We must go beyond entertaining – which can dissolve into alienation. In an educational context, we must do more than just distract the students so that they don't realise they're learning; we must make learning more fun by offering different options, challenges, investigation rather than having the student simply consume information or be amused.

There is no learning if we keep to the politically correct, with everything under control, following instructions and with a guaranteed result. It is better to offer experiences and diversity so that students can make mistakes, try again, propose new paths, live many lives and, in doing so, create.

Fun doesn't lie in evading and denying the world we live in, but rather in experimenting new ways of learning how to better deal with this world.

Immersion is related to fun as well as agency, since the player's action isn't a mere command but “an experience to be savoured” and that causes an “affect” on the player.

As we said before, agency can happen through navigation, which allows the player to face the “unknown” as a labyrinth that must at once provoke and control the user's trepidation. Educational proposals as well as their narrative lines can be plainly delimited, but there must be room for the navigator to create their own stories and project themselves in the game.

There are many possible solutions in a labyrinth. There can also be games with rhizomatic structures and no solution; in that case, the user must act as a detective: experiment hypothesis and create their own answers in more open and pervasive games without pre-programmed conclusions.

Final considerations: linking gamification to inquiry methodology

As we have seen, there are several important competences to be developed for a more investigative attitude. Gamification of online courses can help enhance many of them:

- Observation: Gamification can propose narratives, work with characters, exploratory actions, including of physical environments using augmented reality, media locative or many sorts of log that can help the online student be more observant of his/her own territory, question and problematise his/her own actions and experiences;
- Questioning: the sorts of challenges proposed and even actions in which students have to prepare challenges themselves, with clues for the other students – that always helps with proposing good questions;
- Engaging: Most studies on gamification present student engagement as a result, noting that students increase participation and mobilisation. However, that's not something

inherent to any gamification effort, but rather dependent on a good challenge, narrative etc.

- Exploring: Exploring is a deductive action and must be proposed with clues, questioning, course log and pattern-seeking. In a game, usually the player collects items in exploratory actions so in gamefied activities we must think of ways to keep score, logs, possible access to information as “mysteries” or simply the attitude of exploring spaces and sharing records and patterns;
- Explain: in investigative logic, the explaining isn’t done by the teacher or the material, but by the person that is learning. The student must have ways of communicating and sharing their experiences, describing and recovering them.
- Evaluate: understanding processes and trajectories is essential for learning. Much more than scores and rankings, gamification is interesting to evaluate our ways of interacting with certain themes, contexts and environments. Badges, markers and interaction data visualisation strategies can be interesting to help chart the process, but it must involve awareness and display something relevant – for instance, a visualisation can be interesting if it shows the social impact of an action, but if it’s just a number or illustrative icon, it will not aid the evaluation process.

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