

Gamification in Education Through Design Thinking

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Abstract. When thinking of inclusive education, it is necessary to consider that schools and teachers must utilize appropriate didactical materials that suit the students' needs. For some subjects, such as Geometry, the vision is the most utilized sense. However, as much as it is an important sense that helps to understand the concepts better, it can become an obstacle when the student has a visual disability. The same thing occurs with hearing disability when utilizing learning objects that contain multimedia resources. The main purpose of this work is to discuss the creation of a gamified object of accessible learning that presents the principles of design thinking. In order to achieve this goal, a literature review has been made, mainly focused on accessibility, gamification and design thinking, considering the accessibility guidelines for LOs presented by Macedo. As a result, besides the initially proposed objectives, it was also possible to relate the concepts approached by the Theory of Flow.

Keywords: Gamification · Accessibility · Learning objects · Design thinking · Theory of flow

1 Introduction

Gamification, according to [1], is the use of game design elements outside the gaming context.

According to [2], gamification in education increases the students' commitment and, by integrating game elements with the subjects, it makes the activities more attractive and engaging. With the profusion of environments focused on e-learning, there is the need of spreading gamification in education. [3] highlights that the current challenges regarding games are invitations for a knowledge adventure and a dynamic learning experience. In e-learning, articulated by HCI, the immersion process within the LMS is powered by gamification and the experience articulates interactions and knowledge sharing among the students.

The use of gamification in learning processes has been propagated, especially with the use of learning objects (LOs). According to [4], the teaching materials distributed in learning environments should be accessible to all individuals, with or without

disabilities. In this context, this work intends to relate: gamification concepts, design thinking and accessible learning objects, in order to produce educational content.

2 Gamification and the Theory of Flow

The insertion process of Gamification in education can help by providing a different dynamic regarding learning and mobilizing stimuli, sensations, emotions and a immersion mediated at different knowledge instances. In this context, Csikszentmihalyi's Theory of Flow sought to demonstrate how some experiences may lead the participant to a Flow state.

Mihaly has created the autotelic experience model, which is defined as “a self-sufficient activity, carried out without the expectation of some future benefit, simply because executing it is the reward itself” [5]. Figure 1 presents the Flow path.

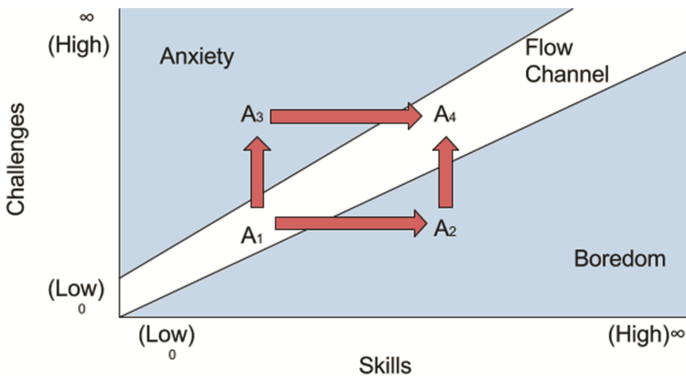


Fig. 1. Diagram showing the path for the Flow state (Source: Adapted from Csikszentmihalyi for authors, p. 74)

By associating this theory with the gamification process, it is stated that a student, when starting his gamified classes, has its challenges occurring accordingly to his ability (A1). At this point, he is probably in Flow state, though it soon turns into boredom (A2), since his skills have already increased and no longer correspond to the initial challenge. However, as soon as a new challenge is proposed, his feeling turns into anxiety (A3), as now he intends to overcome his new challenge and reach again his Flow state (A4).

According to [6], the individual reaches his Flow state in two stages: A1 and A4, both being equally pleasant. What is different in these two moments is the ability level acquired, since while achieving the full Flow state the individual realizes that his ability corresponds to level of the proposed challenge, thus transforming motivation in stimulus.

In the article “Flow in games (and everything else)”, [7] lists a couple of points from the Theory of Flow. He claims that Csikszentmihalyi's research and personal observations have identified eight major components of Flow that can be associated with the gamification process: challenging activity requiring skill; a merging of action and

awareness; clear goals; direct, immediate feedback; concentration on the task at hand; a sense of control; loss of self-consciousness; an altered sense of time.

In this context, gamification might be a way to make someone reach the Flow state. For such, it must be intended to provoke greater focus and concentration, stimulate the sensation of ecstasy, allow clarity and provide feedback, encourage the use of skills, provide growth, cause the loss of time sense and generate intrinsic motivation.

3 Gamification and Education

The process of inserting gamified activities into a learning object should follow the principles of game design and gamification.

The authors [8, 9] use a taxonomy of metrics of satisfaction for users and intend to extend their studies to the area of Distance Education and the studies on ‘Gamification’. Thereafter, [10], from [11], brings a couple of features and recommendations to the use of gamification in learning objects. Based on the categorization made by [9], associated to what was proposed by [10, 11], it is possible to list similarities between these two approaches, through the keywords proposed by [9]. Table 1 shows how the concepts may be related to these categories.

Table 1. Relation between the concepts of Petrovic and Ivetic (2012) and Alves (2012)

	[9]	[10, 11]
Feedback	Time that the user takes to dominate the game or perform a certain task	Pleasant productivity, the players see applied efforts and energies achieving the desired results
Social	Socialization- interaction between the system and users; and duty - the system’s and the generated social relations’ capacity of creating and accepting the user’s emotional investment	Generation of the possibility of working cooperatively, in teams and groups in order to solve problems/Construction of stronger social relationships through emotional bonds
Competition	Self-competition and effort to overcome the results	Pursuit of self-motivation to remain in the activity (intrinsic motivation)
Progression	The system’s capacity of providing persistence to the user	Activities created with challenges that can be overcome
Mechanics	Pleasure that the user finds in the game	Epic meaning of achieving something expected
Context	Context of the system’s actions	

Through this categorization, it is possible to use the principles above in order to produce gamified and accessible LOs. Therefore, the gamification concepts can also be inserted in the conceptual basis of a LO.

4 Gamification, Design Thinking and Learning Objects with Accessibility

According to [12], the evolution of design to design thinking is the evolutionary history of creating products for the analysis of the relationship between people and products, and finally, between people and people. Therefore, based on design concepts and “thinking through design”, it was listed a few relations for the construction of several processes and activities through design theories and processes.

To [13], design thinking is an innovation process focused on the human being that emphasizes observation, collaboration, fast learning, visualization of ideas, prototyping concepts and innovation, and is also applicable in different areas.

The design thinking process is essentially human-centered and emphasizes observation, collaboration, fast learning, visualization of ideas, quick prototype building, learning from failures, and allows a project to be validated more effectively and with feedback from the public. The fact that gamification and design thinking are human-centered and respond to the students’ needs meets the urge for accessibility from people with disabilities. To the development of design thinking, [14] points out that the prototype is not only a way to validate final ideas, but is also a creative process. By analyzing the design thinking approach on education and gamification process, it is noticeable the possibility of applying some of the concepts proposed by [12] as empathy, prototyping and experience design.

Another method of applying Design Thinking is the one from Bootcamp Bootleg by [15]. The approach proposed by [15] is divided into five phases: **empathy** (process centered on the user, to immerse, engage and observe the problem); **definition** (makes a synthesis, presents a focus problem or point of view); **ideation** (idea generation, exploration of solutions); **prototyping** (producing ideas in a more realistic context, bringing out the material nature); **tests** (to reset solutions and put the prototype in contact with people).

The presented phases may be related to the processes for building accessible and gamified LOs. As brought by [16], this kind of development must be collaborative and integrated, with actions oriented by the group, collective participation in making decisions, self-regulating coordination, systemically organized thoughts and building relationships through empathy. In this perspective, the gamification steps based on design thinking from their correlations can be used in the process of building accessible and gamified LOs, using steps such as discovery, interpretation, ideation, experimentation and evolution.

During the development of a gamified LO, under the principles of design thinking, it is necessary to conduct an intensive investigation on how the learning object responds to the students’ needs, and also how to create added value for those who use it. Thus, it is noticeable a potential in creating gamified learning objects from design thinking, for teaching and learning processes involving disabled people.

The gamified LOs should seek the immersion and happiness present in the Theory of Flow, with the simple reward of performing the activity itself. Considering this premise, Fig. 2 presents, from the Theory of Flow, how the process of design thinking is directed in order to produce gamified LOs. However, when taking in consideration

the Universal Design and people with disabilities, the only possibility of achieving a Flow stage is by including accessibility guidelines in the project. Figure 2 explains how the elements operate interdependently.

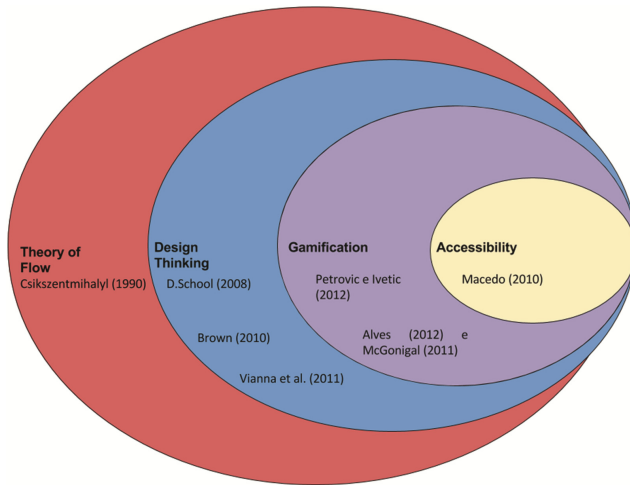


Fig. 2. Interdependence of the elements (Source: Authors)

Based on the premise that the user is the central element of the process and stages of Flow [5] - which allow an immersion state in the process- substantiate this immersion, the first steps of the design thinking process were made [15]. As shown in the model, during all stages of the DT process it was also aimed to integrate gamification theories from [9–11], and to prioritize the last layer of the diagram, from accessibility guidelines for LOs, of [4], outlined by Universal Design and the IMS GLC and W3C-WCAG 1.0 and 2.0 recommendations.

5 Gamified and Accessible LO to People with Visual and Hearing Impairment “Triangle Perimeter”

With the objective of building the LO based on the Design Thinking process, a multi-disciplinary team was organized in order to provide the contribution from different areas to the project. As part of the team, there were researchers from the design areas; programming; mathematics; communication and audiovisual, and expert consultants in LO and accessibility. Unfortunately during the first 3 steps it was not possible to include the participation of people with visual and hearing impairment, although in the process of feedback, based on UX, the tests with users will also be held with this public.

Starting from the Theory of Flow, the assumptions that could be followed in the steps of Empath, Definition and Ideation were listed, correlating to these processes the gamification concepts and accessibility guidelines in LOs.

Figure 3 shows the concepts correlation in these 3 steps. From this piece, the creative processes present in design thinking were utilized during the conception of the project, the correlations between the theories concepts were presented, as well as and their complementarities.

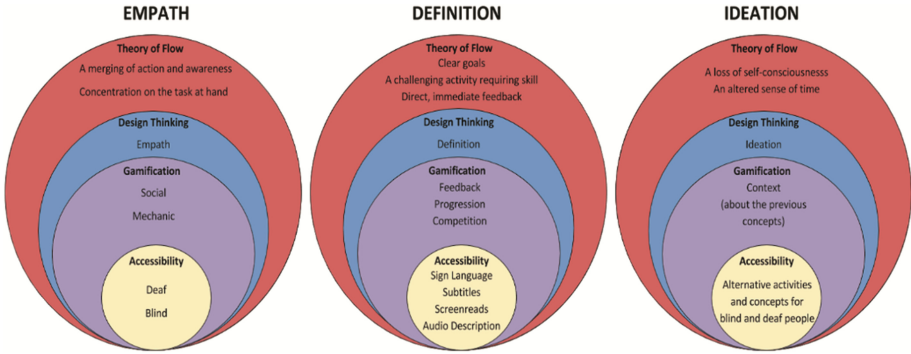


Fig. 3. Correlation of concepts (Source: Authors)

In the subsequent steps (which are not included in this study, considering that the prototype is still in construction), in Prototype, there are all the involved concepts presented, for the construction of the LO, and in Tests, the focus is on the feedback and accessibility, including all the concepts from the preceding stages.

5.1 Empath

At this stage, the process is focused on the user, in order to immerse, engage and observe. At this stage the teams utilized the bibliographic research, the mapping of gamified LOs focused in mathematical concepts and gamified and accessible LOs.

From this early stage, the experiences of each one of the professionals were taken in consideration regarding projects that have already been developed and the target audience feedback, also emphasizing the need for reflexions regarding LOs developed for people with visual and hearing impairment. The similarities between the theories were:

Theory of Flow. *Emphasized points: a merging of action and awareness; concentration on the task at hand.*

The possibility of promoting the Flow state in a gamified LO was directed to the LOs analyzes that could promote educational concepts that would lead the student to the action of starting gamified activities, through the awareness of how pleasant that activity could be. In the reflexions, it was found that many gamified LOs bring obligatory tasks and do not address the possibility of choice, which consequently removes the student from the decision-making (he is obliged to enter in the environment). Then, it was decided to go for the LO direction, in which the processes are focused on decision-making. This context lead us to the following point, the concentration on the task at

hand, in which the decision-making of the tasks must be made by the student. When deciding on entering the gamified universe, he is already aware of the possibility of immersion and achieving the Flow state.

Gamification. *Emphasized points: social and mechanic.*

Social: With the work of the multidisciplinary team being done through the DT concepts, there was a direct relationship with the empathy matter, considering a product that is closely related to a social matter, in which through the system the users can promote socialization and interaction relations, and trigger phases such as competition and progression. There is also the possibility of working cooperatively in teams and groups, in order to solve problems and build stronger relationships through affective bonds.

Mechanics: From the pleasurable situations generated, it was sought the gamified LO's development, with the narrative construction from a character and his search for goals and challenges, also bringing what [10 and 11] have presented regarding the epic significance of achieving something expected.

Accessibility. *Emphasized points: Accessibility for people with visual or hearing disability.*

In order to allow the steps above to bring accessibility tools, the empathy process begins with studies directed to dynamics utilized in gamified LOs from the stages of merging of action and awareness and concentration on the task at hand; Social and Mechanics, and accessibility and Universal Design strategies.

5.2 Definition

From the studies on empathy presented above, it was sought a first definition regarding the project, mainly summarizing the collected concepts and presenting the focus of the problem. Again, this step begins by looking for settings that can converge into solutions to the points presented by the Theory of Flow.

Theory of Flow. *Emphasized points: clear goals; A challenging activity requiring skill; direct, immediate feedback.*

Here emerges again the user's immersion process, which directs him to challenging activities that explore his different skills, always by utilizing clear goals and immediate feedback. Exploring these possibilities allows the student, after having access to the concepts, to direct his actions towards exploring the gamified LO through the presented narrative. However, for this to occur he must be able to achieve the settled goals and, in case of failure, to be able to optimize his actions in order to continue in the immersion process. Therefore, the gamification strategies bring the directions for this.

Gamification. *Emphasized points: feedback, progression and Competition.*

Feedback: When searching for immersion, the users have different skills, and previous collected knowledge. Thus, the feedback regarding the time in which the user performs a certain task is essential, as well as the feedback regarding mistakes and successes. In the validation stage, this process should be mapped in order to provide continuity and the satisfaction of overcoming challenges. Consequently, the progression process occurs.

Progression: In order to remain in the environment, his goals and actions must be clarified as well as the key points yet to be achieved. Regarding a gamified and accessible LO (under the principles of Universal Design), all users must have a path to overcome challenges. For this to occur, the team searched for references of gamified LO with possibilities of customization according to the users profiles, in which goals are set accordingly with the presented profile. Another possibility would be the user himself setting his own tracks and challenges, by directing actions and goals according to his abilities and skills.

Competition: It was chosen to search in a VLE, besides the self-competition, also the possibility of bringing collective challenges. This feature should be explored very reflexively in learning environments. Promoting competition in gamification is one of the resources that provides the immersion and recovery process. In order to define the execution of these challenges, the team found in interactivity the possibility of the students being stimulated to stimulate, with rewards and new challenges from stimulating other colleagues.

Accessibility. *Emphasized points: Sign language, subtitle, environmental architecture for screen readers and audio description.*

The concepts presented in this work should be articulated so that people with visual or hearing disabilities can explore them. Thus, it is defined the importance of using what [4] defines as alternative media that, in the case of the gamified LO “Triangle’s Perimeter” should contain the sign language resources and subtitles for people with hearing disability, and the organization of the Virtual Environment architecture in accordance with the guidelines of IMS GLC and W3C -WCAG 1.0 and 2.0, in order to be accessed by screen readers, besides the audio description resource for videos and pictures.

5.3 Ideation

It may seem that the ideation phase is present in the preceding step, however the previously articulated ideas and the presented solutions served to bring out possibilities of solutions, based on the focus of the problem. However, it was in the ideation phase that the evaluation and criticism regarding the initial solutions were applied. This option was due to the Flow state characteristics related in this stage.

Theory of Flow. *Emphasized points: A loss of self-consciousness; an altered sense of time.*

In this context, the objective of developing an accessible and gamified LO is to actually take the user into a Flow state where the full immersion occurs. By accessing

the contents and starting the gamified path, the Flow experience can be associated with an immersion in which the attention level is high and the gamified process puts the user off from what is around him. For those who have lived this experience, it is known that at this moment the perception of time becomes elastic, and sometimes several hours go by during one activity, without noticing its actual passage.

Gamification. *Emphasized points: Context of system actions.*

In the ideation phase, after mapping the application possibilities, it is tried to verify the possibility of using the resources proposed in the architecture of a VLE, and how the initially planned actions may be performed. Since it is a proposal for a VLE, it is important in this process, besides the action plan of the system used in the laboratory, to settle which are the software resources and minimum hardware required to run the system, and the availability of internet connection.

Accessibility. *Emphasized points: Alternative activities and concepts for blind and deaf people.*

After bringing resources such as subtitles, sign language, screen readers and audio description, at this stage it is also aimed to develop alternative activities, based on the mapping of geometry learning process for people with visual or hearing disability. An example is the printing of Braille materials for children with visual disability, or the proposal of producing a tactile geometric board so they can handle and understand the concepts outside the computer screen. It was not presented in this topic the description of the gamified and accessible LO development, since the focus of this work is to bring directions for utilizing the presented theories towards the advancement of researches focused on the production of resources that are accessible to people with disabilities.

6 Conclusion

The ideation stage brought the direction of a gamified and accessible LO, which still has to go through stages of prototyping and feedback tests accordingly with the prescripts of UX. The target audience is geometry students with visual or hearing disability. The learning dynamic occurs from presenting educational materials accessible on the MOOBI¹ accessible platform. After accessing the accessible teaching materials regarding the triangle's perimeter, the student chooses to enter the gamified activities.

After entering the gamified LO, the student is introduced to the character Elvis (who appears in the story as an animated character; a comic character and in videos (which will be performed by an actor with similar characteristics to the character). He is the one who leads the search for the student's immersion into the Flow state, along with the accessibility guidelines (subtitles activation, sign language, audio description, presentation of challenges, activities (within the environment and at home - such as the construction of a tactile geometric board - in order to explore the perimeter concept, made with egg packagings and strings); the print of Braille materials; among other

¹ MOOBI is an accessible VLE (Virtual Learning Environment) that has been being developed by the group WebGD PPEGC/UFSC, and is available in <http://webgd.egc.ufsc.br/>.

possibilities of exploring accessibility resources, in order to bring the plane geometry's learning process closer to the universe of these children.

Besides enabling the immersion through an accessible environment, the LO stimulates through challenges, scores and awards, the search for "A loss of self-consciousness"; and "An altered sense of time". A technological tool that directs this search is the accessible environment MOOBI, which allows students to upload videos (a very useful resource for the person with hearing disability who communicates through sign language) or audio (for the person with hearing disability) and explore the interaction process along with other colleagues within the environment. With these resources, they can also interact with students without disabilities (as they are able to understand the messages), which enables the development of integrated activities.

The Flow state's main purpose in this work is directed to people with visual and hearing disabilities. The reason for this choice is due to the particularities of disabled people's learning processes, of their historical social exclusion and the limited resources available that promote learning and knowledge sharing. Lastly, it is aimed to bring this reflection to researchers, educators, developers and instructional designers, regarding the necessity of advancing in researches that seek alternatives to foster the inclusion process and the disabled people's active participation in society.

7 Future Steps

Future steps of this research should be directed to the Prototyping stages, with accessibility validation tests made with the public.

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