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Design of a Serious Game for the Improvement of Reading Comprehension Through the iPlus Methodology

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ABSTRACT

Reading understanding is an indispensable ability for the educational training of every citizen. Designates a higher level than the mere fact of reading (decoding linguistic signs). While reading already implies a great cognitive advance for anyone, reading comprehension requires more skills. In Ecuador, reading comprehension levels are still low. The standardized tests that the Ecuadorian State has applied to students for admission to public universities for 10 years are evidence of the serious delay in this skill. This situation would also explain the low levels of performance in other subjects, as well as the little cultural and educational development of the general population. This research set out to build a gamified application for the development of students reading students from 12 to 16 years of age. For the creation of this application, the iPlus methodology and Roblox Studio Development tool were used. This video game allows to train students reading skills, through the use of exercises resolution in multiple choice questions and the Cloze test. The application works very well with short texts such as those required by the Cloze test. This application can expand its scope by using its playability dynamics to other areas of knowledge such as mathematics, natural sciences, and social sciences.

Keywords: Serious games, Reading comprehension, iPlus, Gamification, Education

INTRODUCTION

Reading comprehension can be defined as a competence for life, indispensable for learning and thinking. It is considered one of the generic competencies for education, which is why it is appreciated as an area of evaluation in the admission processes of educational institutions at all levels (Andrade and Utria, 2020).

The level of reading comprehension is the degree of development reached by the reader in obtaining, processing, evaluating, and applying the information contained in the text. It includes the independence, originality, and creativity with which the reader evaluates the information (Cervantes et al. 2017).

For some authors (Cervantes et al. 2017), reading is a fundamental tool in the development of personality, but it is also a tool for socialization as an essential element for living together in democracy and developing in society. Reading not only provides information (instruction), but also forms (educates), creating habits of reflection, analysis, effort, and concentration.

On the other hand, the process of reading comprehension can be understood as an operation in which two types of activities are involved: some basic and others at a higher level. Basic activities comprise the decoding of the text that, at a higher level of reading development, a person executes automatically (Araujo et al. 2022). In this sense, from the initial processes of reading and writing acquisition, teachers work to ensure that a student understands what he or she reads and therefore can internalize what is learned through reading. However, this achievement of understanding what we read is not an acquired process in all people. And in high percentages, it is the triggering fact of diagnoses related to a learning difficulty at all educational levels. In addition, it can be the cause of poor performance in the workplace.

It is important to analyze what happens with reading comprehension levels in university students. Let us remember that, at the higher level, reading constitutes an unavoidable requirement for access to autonomous learning knowledge (Araujo et al. 2022). However, reading processes are not unique: they are based on other skills that must be appropriately developed. These skills include attention, knowledge of the language, and knowledge of the world (Bruning et al. 2005). Training before higher education should ensure that these skills are sufficiently developed in young people so that they can learn the levels and genres of reading that the professional environment demands.

In Latin America, several studies have found that 70% of students entering higher education have reading comprehension failures. Likewise, these studies have shown, in addition to low performance, inadequate use of strategies to facilitate comprehension (Andrade and Utria, 2020). These researchers, after conducting research related to the level of reading comprehension, where 1,125 students of the first level of a Colombian university were evaluated, define that the results obtained are consistent with other studies that affirm that in general university students present low levels of literacy, which does not contribute in a positive way to their formative process or gradual incorporation into the scientific and professional community of their discipline of study.

In another research conducted by (Cervantes et al. 2017), in a Mexican educational institution of the Upper Middle level that is part of the National System of Technological Education, researchers state that students present serious difficulties concerning reading comprehension. One of them consists of insufficient lexical and semantic knowledge, which must be remedied for students to perceive and decode the text in its entirety.

In Ecuador, the research "Evaluation of reading comprehension in recent university students in Ecuador" by (Araujo et al. 2022) concludes that 61.17% of the students evaluated in reading comprehension present problems in inferring the structure of a written text. The inference process depends to a large extent on the subject having the necessary prior knowledge

related to what he/she is reading. Presenting difficulties in inferring the structure of the text will cause an inefficient comprehension of what is read and, therefore, meaningful learning will not take place.

Low reading skills may be due to multiple personal factors (attention problems, lack of previous knowledge, low lexical acquisition) and social factors (difficult access to books, non-reading family environment, unstimulating educational level, etc.). In the scope of our research, we propose a technological resource that helps to remedy the personal causes of low reading levels, i.e., attention, knowledge of the world, and lexical acquisition.

Therefore, this research group worked on the creation of a serious game to improve reading comprehension levels using the iPlus methodology. This product is a collaborative work between professionals in the areas of Educational Psychology, Linguistics, and Computer Engineering.

Through Serious Games, students- and the general public- can exercise, strengthen, and improve their reading skills in the three areas noted (Carrion et al. 2019). The playful nature of the resource ensures user motivation, a fact directly related to attention. The challenging activities that users must overcome contribute to the gradual acquisition of lexical and general knowledge that will subsequently improve performance in written texts of different levels.

The serious game is designed for young students between the ages of 12 and 17 years old who are studying at the basic higher education and high school levels in schools in Ecuador. We intend the game to be, in addition, a preparation for university entrance exams since all of them include the evaluation of reading comprehension and areas related to reading and writing.

METODOLOGY

Reading is one of the most critical components of any language and it is an essential tool for lifelong learning. For many reading-disabled students, reading comprehension is a significant problem, someone can read fluently and still have poor comprehension. It happens when a child's decoding skills are more developed than their ability to understand a text. Here we propose a game that aims at strengthening underlying cognitive skills, including processing speed, short-term memory, working memory, and logical thinking.

iPLUS Methodology

iPlus (Carrión-Toro et al. 2020) is a user-centered methodology for SG design that presents a participatory approach. The iPlus design approach is flexible, can be used to design any serious educational game, and offers a design approach integrated with other agile methods. The design process begins by defining the problem according to its specific needs and defining the expected learning outcomes. The story design and the pedagogical objectives are essential, together with the conception of a delightful and playful setting. iPlus aims to take advantage of motivational factors designed through game mechanics to offer interactive learning.

iPlus comprises a series of ordered steps organized into five phases.

Phase 1. Identification: Here, the general problem is defined by the interested party, and, depending on the situation, participants in the methodology are identified.

Result of this phase: A serious game is required to strengthen underlying cognitive skills, including processing speed, short-term memory, working memory, and logical thinking. The specification of the stakeholder needs phase involves a subject matter expert, a subject matter expert, and a game designer. In addition, the methodology facilitator and the software developers and end-users are involved (see Figure 1).

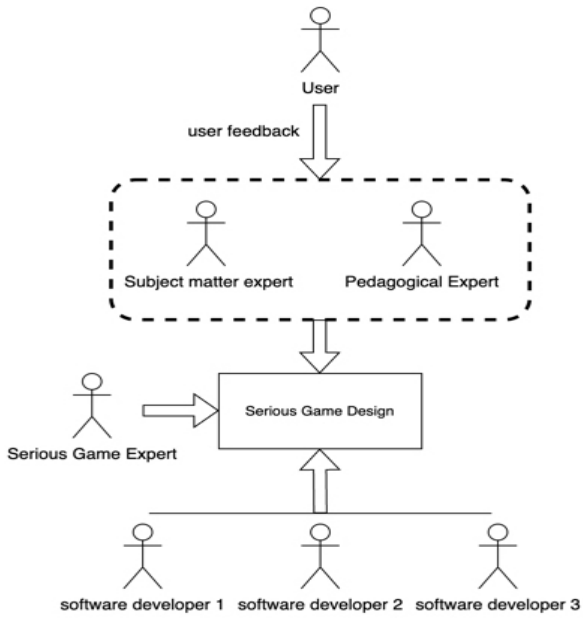

Figure 1: Identification phase: experts and users.

Phase 2. Pedagogical Objectives: In this phase, the general and specific objectives are defined as participatory and agreed upon under the pedagogical expert's guidance.

Result of this phase: The objective defines what the game wants to achieve "To train reading comprehension skills for the development of academic activities and a better performance in the college entrance exam" (see Table 1).

Phase 3. Ludic Game Script: This phase aims to create the "Game Design Document" (GDD) based on the Product Owner's needs or requirements. Then, with the selected ideas, the participants and the subject expert create the game script that contains the narrative, characters, and gamification elements such as badges, points, and prizes, among others, which can be implemented in the SG.

Table 1. Pedagogical objectives description.

General objectives	Specific objectives
"To train reading comprehension skills for the development of academic activities and a better performance in the college entrance exam"	Number: 5 Priority: High Role: Pedagogical expert Role in the game: Player Objective title: Strengthening player reading comprehension Description: The player will be able to navigate through different scenarios by activating different gameplay mechanics that will capture his attention and generate the enjoyment of activities to stimulate his memory and allow him to reflect and inspect the meaning of what he reads.
Atmosphere (temperature, pressure, humidity, quality, etc.)	Related ideas (orange post it notes): ID: 5 The player will be able to navigate through different scenarios by activating different gameplay mechanics that will capture his attention and generate the enjoyment of activities to stimulate his memory. ID: 5.1 Multiple choice questions ID: 5.2 Cloze test questions ID: 5.3 Attention and memory activation ID: 5.4 Exercises for students between 16 and 18 years of age

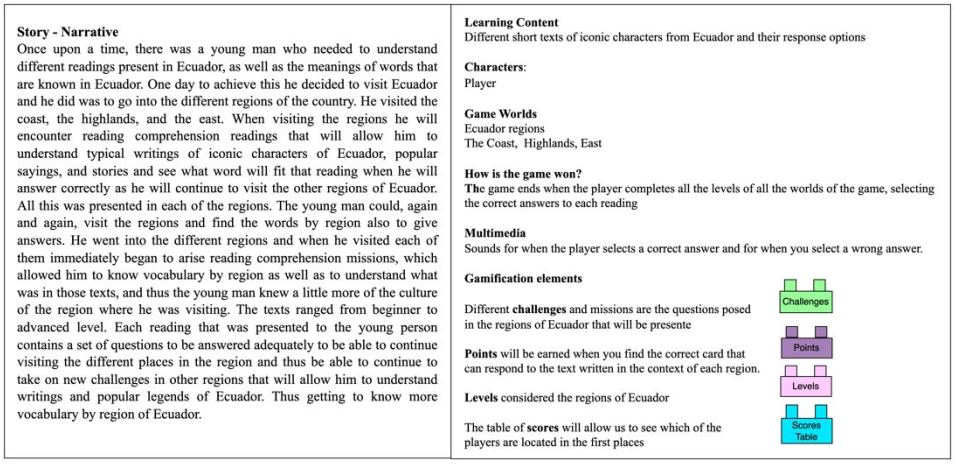

Figure 2: Consensual game script.

Result of this phase: The result of this phase is the game script format or consensual story. The game consists of touring Ecuador, exploring its regions, and appreciating its diversity, such as the "Reventador" volcano, the "Amazonas" river, alpacas, and shrimp boats. The player must understand a text and select the correct answer from a set of multiple-choice questions. Also, we implemented the Cloze test (Sukarni, 2021), where players must locate the omitted words systematically in a written text containing gaps. Figure 2 summarizes the aspects that allow the reader to have a complete idea of the serious game.

Phase 4. GamePlay: Here, experts define the GamePlay blocks. They are used to describe the functionalities that are part of the game. Additionally, the genre of the game is identified.

Result of this phase: The Gameplay blocks are related to holding, moving, position, and points such as "The player will be able to select among the different regions of Ecuador: Coast, Highlands, East, and Galapagos to perform reading exercises based on the context of that region (see Figure 3). In each of the regions, the scenario will change with the theme of the region". Additionally, stakeholders define the game genre as reasoning and adventure because the player assumes the role of a protagonist and the game involves problem-solving skills.

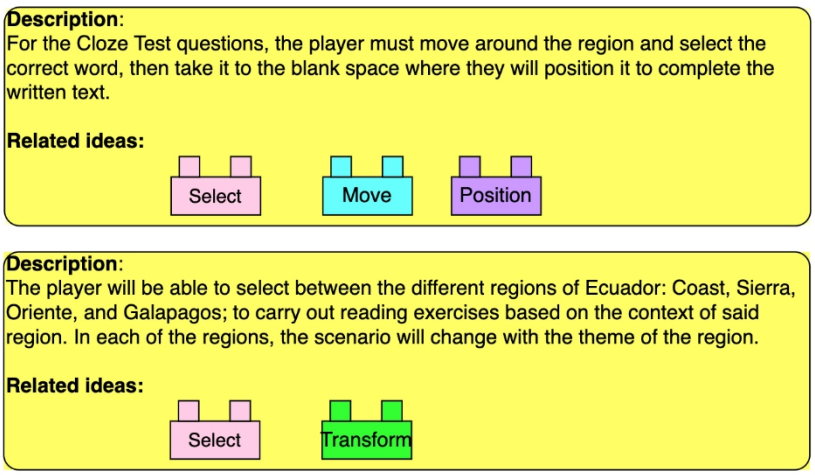

Figure 3: GamePlay cards.

Phase 5. Refine Resultant artifacts: After going through the ideation process, GamePlays need to be filtered to eliminate repetitive or impossible aspects to create from the pool of ideas. The requirements ideas are filtered by means of a refinement matrix, which evaluates a list of criteria (Clear and unambiguous, Feasible, Correct, Appropriate, Verifiable, Completeness, Necessary, Unique, conforms to these standards, Consistent, Modifiable, Traceable) that define whether a requirement is a good or not.

Result of this phase: User stories that represent a short description of characteristics of the game expressed as user needs. Table 2 shows the result of the evaluation of the purposes or ideas obtained in the phase of pedagogical objectives and the evaluation of the GamePlay cards, obtained in the GamePlay phase. These are evaluated according to the required properties and are considered by those who pass the evaluation with the mandatory properties. In other words, if your calculation is greater than seven, that need is considered for the design of the game. Figure 4 shows a resultant User Story.

User Story

Id: CL005 **Role**: Player
Title Story: Presentation of multiple choice questions
Priority: High (H)
Description: The player requires to observe fragments of text that show multiple-choice questions about reading to strengthen your
Acceptance criteria:
- The multiple-choice questions are accompanied by a short text and four answer options.
- The player will click on the answer he considers relevant to record an answer for that question and earn points.
- The player will be able to retry until the next time he accesses that level.

Figure 4: Resultant user story.

Table 2. Evaluation of the purposes and GamePlay obtained.

Ideas	Qualification	Ideas	Qualification
H1 01	8	H5 01	12
H1 02	5	H5 02	12
H1 03	10	H5 03	8
H2 01	4	H5 04	11
H2 02	4	H5 05	12
H3 01	10	H5 06	12
H3 02	2	H5 07	6
H4 01	10	H5 08	10
H4 02	11	H5 09	11
H4 03	11	H5 10	8
GamePlay	**Qualification**	**GamePlay**	**Qualification**
R1 01	8	R3 02	10
R2 01	10	R3 03	10
R3 01	9	R3 04	11

THE SERIOUS GAME IMPLEMENTATION

As mentioned above, our case study deals with reading comprehension, stimulating reading skills through a game that consists of going through the regions of Ecuador while facing some reading comprehension challenges from beginner to advanced level. Each reading will contain a set of questions related to it, which the player will have to answer. Once the player succeeds, he/she will be able to take on new challenges in the other regions that will allow him/her to understand typical writings of iconic Ecuadorian characters, popular sayings, stories, and legends. and legends.

What is valuable about the serious game presented in this publication is that it has been designed in an interdisciplinary manner and is based on the needs and interests of students who need to improve their reading comprehension levels to gain admission to universities and achieve an adequate student trajectory with a view to their inclusion in the labor market.

The serious game contains challenges to strengthen the player's reading comprehension in different themes or missions: "The coast", "The highlands", and "the east". Each of the scenarios contains instruction signs, a start button, a board to enter the correct answer, and answer option cards.

Figure 5 shows the coast and Amazonia scenarios of Ecuador. Ecuadorian coast where elements such as houses and wooden huts in the style of the coastal communities are detailed. Additionally, animals common to the region such as the shrimps are placed on the stage along with fishing boats in an aquatic setting. The East of Ecuador or Amazonia where part of the Amazon River and an emblematic volcano such as the "Reventador" can be seen. Ecuadorian Sierra is represented by mountains and green areas with typical animals of the region such as Alpacas.

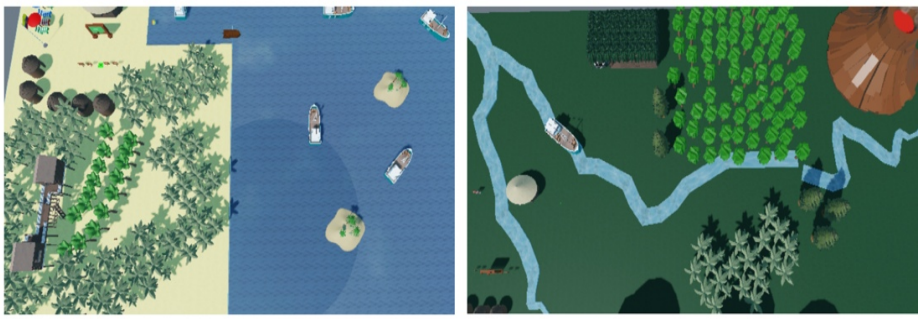

Figure 5: Game screens.

When running the game, the player must choose one of the worlds or scenarios. The player must click on the Start button, which will start the quiz game with a maximum response time of five minutes for the player to find the cards with the correct answer. To win the challenge, the player places the correct answer card on a blackboard in the scenario and it will display the message "Correct answer", otherwise the message "Wrong answer" is displayed. Figure 6 shows the game scenario.

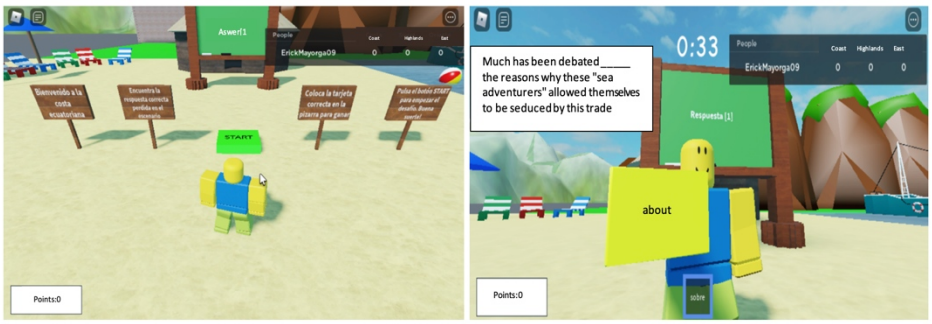

Figure 6: Cloze test questions game.

When all questions are answered correctly, the leaderboard is updated, showing on the right side of the screen the highest scores as a function of time. This illustrates the inclusion of Gamification game mechanics.

CONCLUSION

Games for improving reading comprehension can be valuable tools to help people refine their reading comprehension. Instead of taking a traditional approach to teaching, games can engage learners more interactively. Our serious game helps to remedy the personal causes of low reading levels, i.e., attention, knowledge of the world, and lexical acquisition.

The construction of the Serious Game to improve reading comprehension skills with iPlus offers a phase for determining consensual requirements through the participation of several experts. iPlus methodology allows generating more accessible software products so that software development experts can obtain and use user stories as input to any software methodology. We suggest applying the iPlus methodology, a user-centered methodology for designing Serious Games. It incorporates a participatory, flexible, and user-centered approach, adaptable to users with non-standard knowledge.

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