

Web System with Gamification to Enhance Reading Comprehension in a Secondary-Level Educational Institution



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ABSTRACT

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In 2021, a decrease in High school students' grades occurred compared to previous years in the Reading comprehension area, according to the MINEDU. To improve their reading comprehension skills, we suggest implementing gamification, a learning technique which helps understanding certain topics by games. To achieve this, we considered working with two groups. The experimental group used gamification strategies and the collaborative annotation tool, while the control group did not have these gamification tools. The results showed that the experimental group took more notes significantly when reading and answered more questions effectively than the control group, having a more immersive experience with teamwork. As there was a 17.46% improvement in scores, this shows that the annotation technique increases the reading comprehension skills in high school students. This demonstrated that the use of the annotation tool helps improve students' reading comprehension.

1. INTRODUCTION

Reading is an essential skill that lays the foundation for individuals' academic and personal success. Through reading, students not only acquire knowledge, but also develop critical and analytical skills that enable them to face the challenges of the modern world. However, in many parts of the world, the low level of reading proficiency among students has become a persistent and worrying problem [1]. This situation is especially alarming in the Peruvian educational context, where statistics reveal a negative trend in the reading performance of young people. In Figure 1 we can see that, according to the Peruvian Ministry of Education (MINEDU), in 2021 the average performance of 2nd grade high school students dropped by 16 points compared to 2019. This decline is considerable, especially considering that the national average year-on-year variation for the same period was only 2 points [2]. This decline in reading skills not only signals a crisis in the educational field, but also puts at risk the academic and professional future of young people, who depend on these skills to advance in their studies and in their working life. This decline in reading skills not only signals a crisis in the educational field, but also puts at risk the academic and professional future of young people, who depend on these skills to advance in their studies and in their working life.

Faced with this problem, it is essential to seek innovative solutions that can address the lack of motivation and low interest in reading that students often face. In this context, the implementation of a web-based system with gamification is presented as a promising alternative to enhance reading

comprehension in secondary education institutions. Gamification, which consists of incorporating game elements into learning environments, has the potential to transform the educational experience into something more attractive and dynamic. Gamification not only makes reading more fun, but also allows students to interact more effectively with texts. By turning reading into a game, active participation is encouraged, which can result in greater engagement and more meaningful learning. This playful approach allows students to engage with different types of texts, from narrative to informative, and develop critical skills such as comprehension, analysis, and synthesis of information.

In addition, a gamified web system can offer instant feedback, which is crucial to the learning process. Students can receive information about their performance in real time, allowing them to identify areas for improvement and work on them proactively. This feature not only promotes autonomous learning, but also helps educators monitor their students' progress and adjust their pedagogical strategies as needed. The implementation of this system not only seeks to improve reading skills, but also to foster a reading habit that lasts over time. By creating an environment where reading is associated with fun and play, students are expected to develop a genuine interest in books and literature, which in turn can contribute to their academic and personal success. In conclusion, the creation of a web-based system with gamification to enhance reading comprehension in secondary education institutions represents an innovative and necessary response to the reading literacy crisis in Peru. Through this approach, it is hoped not only to improve students' reading skills, but also to cultivate a

lasting love of reading that will accompany them throughout their lives.

It was also found, according to a study [2], that the greatest

drop in learning occurred in the percentage of students who reached the expected levels in Reading across all strata, as shown in Figure 2.

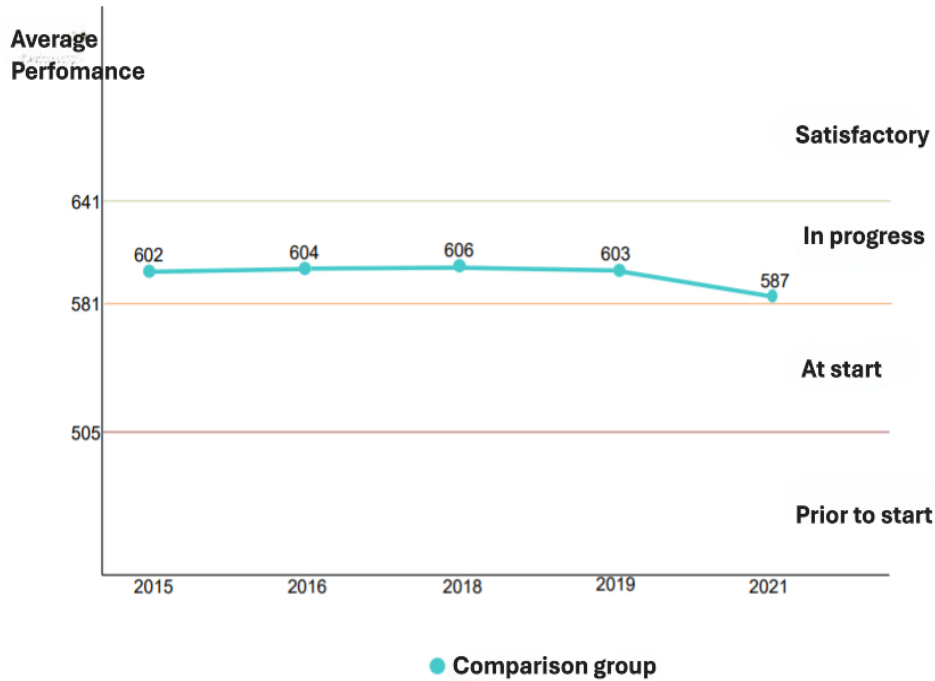


Figure 1. Reading achievement in 2nd grade of secondary school: Comparative results from 2015-2019 to 2019-2021 by average measurement [2]

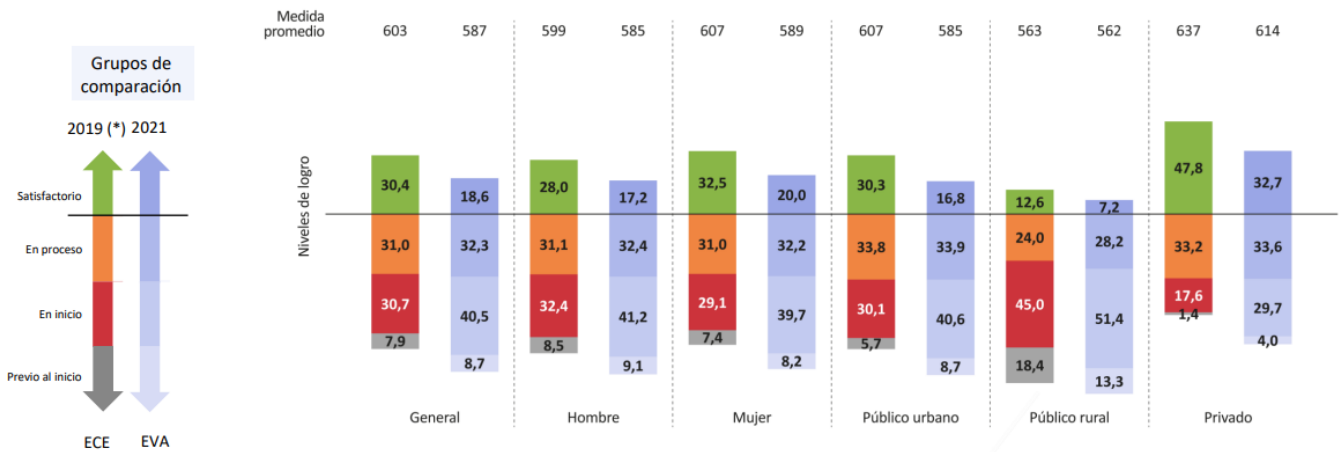


Figure 2. Reading achievement in 2nd grade secondary school: Comparison of 2019 and 2021 Groups by sex, management, and area [2]

2. BACKGROUND

The existing literature on digital platforms and their impact on education underscores the transformative effects these technologies have on the form, meaning, and control of teaching practices [3]. The COVID-19 pandemic has significantly accelerated the adoption of Information and Communication Technology (ICT) across various educational dimensions, particularly in tutoring and evaluations [4]. This shift has led to greater accessibility and cost savings in online learning, eliminating additional expenses related to travel and printed materials that are associated with traditional face-to-face education [5]. Consequently, online learning has emerged

as a valuable alternative for enhancing students' reading comprehension [6, 7].

To fully capitalize on these benefits, it is crucial to develop effective digital strategies. Research highlights that focusing on metacognitive aspects, reading support strategies, and enhancing working memory are essential components of these strategies [8]. Metacognitive activity has been shown to be significantly linked to digital text comprehension in e-Learning environments [9], emphasizing the importance of promoting self-regulation and providing continuous feedback throughout the learning process. Strategies such as instructions, feedback, and suggestions are effective in supporting self-regulated learning [10]. Additionally, integrating collaborative

annotations and gamification has proven to enhance student engagement and participation [10-14]. Effective examples of collaborative digital reading annotations (CDRAS) and general discussion boards (GDB) are illustrated in Figure 3, which demonstrate how these tools can facilitate interaction and support learning.

track student performance, play a crucial role in preventing dropout and supporting timely decision-making [15-17]. Addressing dropout involves considering factors such as economic constraints, internet access limitations, and family issues, which can impact students' academic performance and retention.

This study builds upon these insights by integrating gamification with digital annotations to enhance reading comprehension. While prior research has explored the benefits of gamification [10, 12] and digital annotations [13] separately, our approach combines these elements to create a comprehensive system designed to improve educational outcomes at the secondary level. By leveraging a REST API architecture, our system efficiently manages high traffic volumes and provides scalable solutions, addressing the performance challenges discussed by Di Francesco et al. [18] and Milovanović [19]. This integrated approach not only advances our understanding of the combined impact of gamification and annotations but also offers a robust technical framework to enhance accessibility and effectiveness in digital educational platforms.

On the technological front, the microservices architecture has gained prominence for its advantages in performance and maintainability since 2014 [18-20]. This architecture supports flexibility and reusability, allowing applications to scale rapidly and adapt to changing needs [21]. Hybrid architectures, including serverless microservices, are particularly effective in managing high traffic volumes and reducing costs [22]. Furthermore, deep neural networks have demonstrated significant potential in optimizing planning and solving complex problems, highlighting the importance of efficient data organization for application success [23-26].

In line with this, the works [27, 28] emphasize the crucial role of having key performance indicators (KPIs) and dashboards to support decision-making processes. These tools are vital for managers and decision-makers in sectors such as gastronomy and healthcare, as they enable real-time tracking of critical metrics, facilitating informed decisions. The use of data mart systems further enhances this capacity, ensuring data-driven insights that improve operational efficiency.

Moreover, the research [29, 30] highlight the importance of mobile applications in sectors like neurorehabilitation and education. These technologies, including gamified systems and interactive tools like chatbots, can significantly improve engagement and provide personalized support. In the context of enhancing reading comprehension, mobile applications offer opportunities to create dynamic learning experiences that boost student interaction, motivation, and educational outcomes.

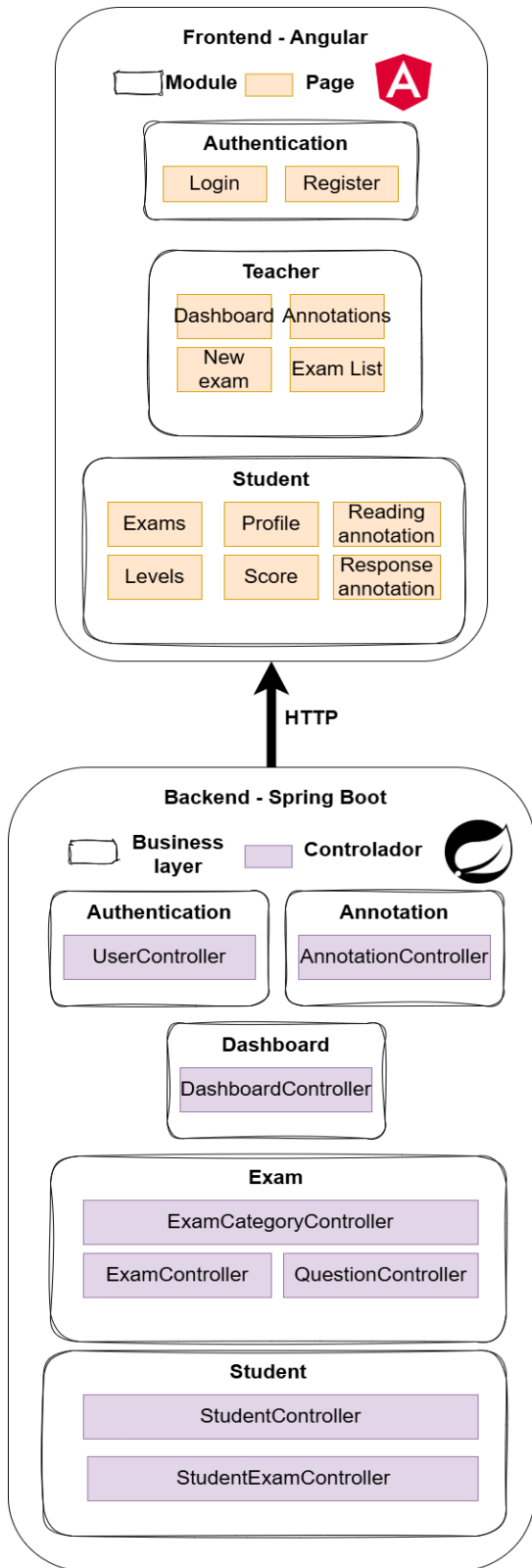


Figure 3. Rest API architecture diagram

In parallel, managing information effectively is critical. Systems like GOAL, which monitor academic progress and

3. PROPOSAL DESIGN

3.1 Methodology

In this study, a sample of 20 first-year high school students was selected from a larger population of 200 students. Participants were randomly chosen to ensure equitable representation and minimize bias, based on criteria such as academic level and availability. They were then randomly assigned to two groups: the experimental group and the control group.

The experimental group used a gamification tool for making annotations while reading online materials, whereas the

control group did not use this tool. The experiment lasted for four weeks, with reading and annotation sessions evenly distributed over this period. To measure student motivation, the total number of annotations and their types were recorded and analyzed.

A pre-assessment and post-assessment of reading comprehension skills were conducted. Statistical analysis was used to identify significant differences between the groups. Ethical considerations, including informed consent and participant confidentiality, were ensured. A pilot study refined the design and validated the assessment tools, allowing for a thorough evaluation of the gamification tool's impact on academic performance and motivation [31].

3.2 Requirements

3.2.1 Functional requirements

- Reading Annotations:** Allow students to highlight, underline, or add notes to specific parts of the text as they read.
- Answering Questions:** Provide students with the ability to answer specific questions related to the text or reading activities.
- Teacher Comments and Feedback:** Allow the teacher to add comments and provide feedback to students on their annotations and responses.
- Organizing and Searching Notes:** Provide students and teachers with the ability to organize and search notes by category, topic, and date.

3.2.2 Non-functional requirements

- Security and privacy:** Ensure the security and privacy of student notes and data, ensuring that only the teacher and authorized students can access the information.
- Usability:** The tool must be intuitive and easy to use for both students and teachers, with a clear and well-designed interface.
- Performance:** The tool must be fast and efficient, with minimal response times when performing annotation actions and viewing annotations.
- Availability:** The tool must be available at all times for students to make notes and for the teacher to access them.
- Scalability:** The tool must be able to handle increasing numbers of students and annotations without degrading its performance.
- Integration:** Enable integration with other tools or platforms used in the educational environment, such as learning management systems or online collaboration platforms.

3.3 Annotation tool

For the annotation tool, an interface was implemented on the web page that will allow students to make reading and response annotations. The reading annotation is what the student will make to the text and the response annotation will be directed towards another student's annotation. Additionally, the option to publish these annotations anonymously or with the student's name will be included. A specific limit will not be established for the number of annotations, but we sought to encourage the generation of a large number of annotations, prioritizing quality. It will be the teacher's responsibility to evaluate whether an annotation meets the requirements to be considered high level. To guide students regarding the notes that the student can make, this is shown in Table 1.

Table 1. Descriptions of read and response annotation types [10]

Annotation Type	Reading Annotation	Response Annotation
HE	Provide understanding or known facts from a text	Answer questions posed in other students' notes
New Knowledge	Identify new knowledge learned	Identify new knowledge learned from other students' notes
I don't understand	Indicate an annotated text that I do not understand	Indicate notes from other students that I do not understand
Different ideas	Indicate the text that is different from what I think, and give reasons.	Indicate notes from other students that are different from what I think, and give reasons
Additional Information	Provide supplementary information for an annotated text using an online search tool in WCRAS	Provide supplemental information for other students' annotations by using an online search tool in WCRAS
I mean	Give comments to an annotated text and invite other students to discuss their ideas	Respond to other students' comments or discussions about an annotated text
Correction	-	Reminds other students to correct problematic annotations or inappropriate use of annotation types or wording

3.4 Gamification strategy

A range will be established based on the number of high-level annotations made by the student or the identification of relevant keywords. To establish the ranges and permissions, the article [10] was taken as a reference, where a 5-level system is proposed. Level 1 will correspond to the rank of "Soldier", level 2 to the rank of "Knight", level 3 to the rank of "Bishop", level 4 to the rank of "Castilian" and level 5 to the rank of "King". For each of these ranks, specific permissions and requirements will be established to advance levels, as shown in Table 2.

In addition, there will be a forum where students can share ideas related to reading. Both the information on the content and the number of annotations made, as well as the messages published in the forum, were stored to be able to periodically evaluate the student's progress and monitor their progress throughout the course.

The teacher will have access to an interface from which they can view the progress of each student. This information was presented through graphs and tables that allowed the performance of each student to be observed.

3.5 Web service design

As shown in Figure 3, the system is based on a REST API service for communication, with the frontend developed using Angular and the backend using Spring Boot. The frontend includes authentication, teacher, and student modules. The authentication module determines whether a user meets the requirements to access a specific profile based on their username and password. The teacher module features pages for the dashboard, annotations, exams, and exam list, making

HTTP requests to the controllers for annotations, user, dashboard, exams, and student. The student module can only access the exams and annotations endpoints and does not have access to the dashboard endpoint. All controllers will handle POST, DELETE, GET, and PUT requests.

Table 2. Annotation function achievement and permission tasks of each level [10]

Level	Annotation Permission	The Task of Leveling Up
1. Soldier	reading notes	Annotations on the text using different types of annotations for each annotation
2. Knight	reading notes, response notes	Annotations on the text including "I know" and "I don't understand"
3. Bishop	Read classmates' reading notes, personal reading notes	Respond other students' entries, Annotations on the text, for "New knowledge" and for "Additional information"
4. Spanish	response notes, Read classmates' reading notes,	Respond other students' entries Annotations on the text, for "New knowledge" and for "Additional information"
	Read classmates' response notes, personal reading notes	Respond other students' entries Get response from students
5. King	response notes, Read classmates' reading notes, Use "heart" icon	Number of scores contributed remains in the top three in the class

3.6 Conceptual model

This model covers all the tables necessary for the system to function, including exams, categories, teachers, levels, among others. The visual representation, as shown in Figure 4, provides a complete view of the database structure. This model will be used in conjunction with Spring Data JPA, allowing the efficient mapping of each class for the automated creation of tables in the database.

3.7 Views

3.7.1 Login

This page will allow the user to access the main interface, the content shown will depend on the role assigned to their account, as shown in Figure 5. When the user registers, a token will be generated that will be stored in the Local Storage, which will allow the user to continue accessing the page without having to register again. This will stop working if the user closes their session or if the token expires.

3.7.2 Description of the levels

This section describes the permissions that each user has according to their level, as shown in Figures 6 and 7. In addition, the activities they must carry out to advance to the next level are detailed.

3.7.3 Student level

Through this interface, users can understand their position within the level hierarchy, the privileges associated with their current status, and the key activities that will take them to the next educational milestone. This information can be seen in Figure 8.

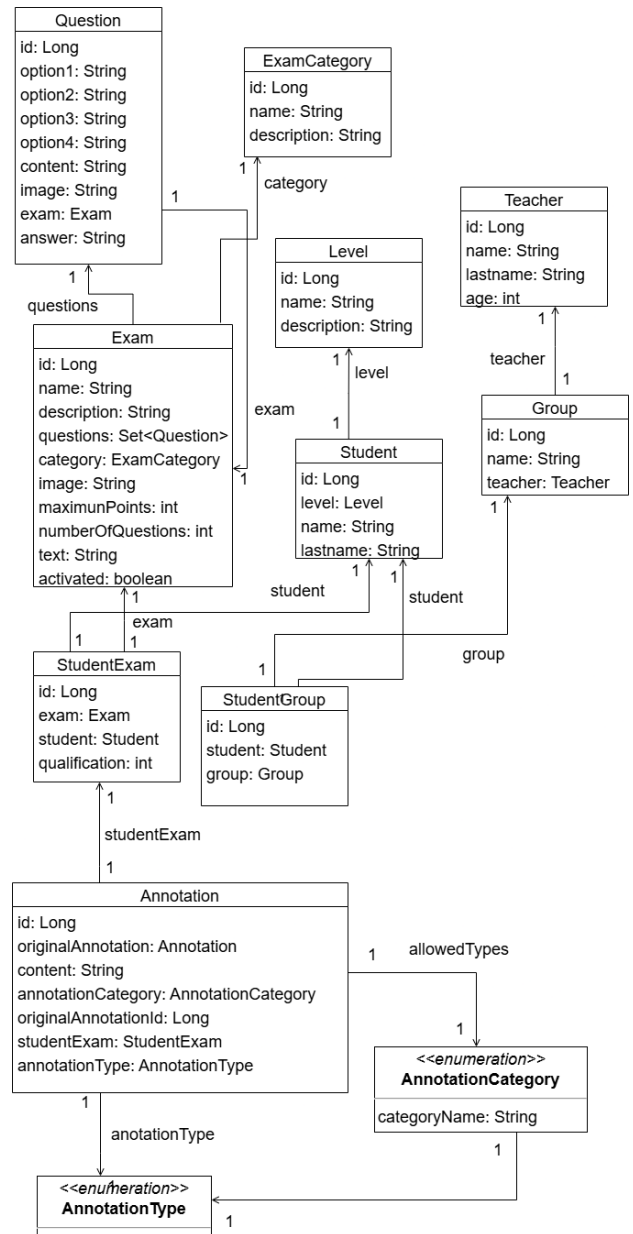


Figure 4. Conceptual model of the project

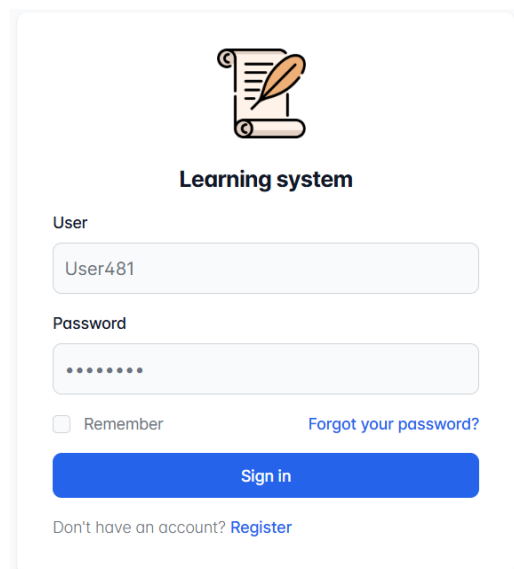


Figure 5. System login




LEVEL	PERMISSIONS	TASKS TO LEVEL UP
 Soldier	<ul style="list-style-type: none"> Make personal reading notes 	<ul style="list-style-type: none"> Make 6 annotations in the text (different types of annotations for each annotation)
 Gentleman	<ul style="list-style-type: none"> Make personal reading notes Make response notes 	<ul style="list-style-type: none"> Make 7 annotations in the text (including 4 "I know" annotations and 3 "I don't understand" annotations)
 Obispo	<ul style="list-style-type: none"> Read peer reading notes Respond to 3 other students' notes Make personal reading notes 	<ul style="list-style-type: none"> Make 8 annotations in the text (4 "New Knowledge" notes and 4 "Additional Information" notes)

Figure 6. Description of levels - part 1


 Rey	<ul style="list-style-type: none"> Make response notes Read peer reading notes Using the "heart" icon Make personal reading notes Make response notes Read classmates' response notes Using the "heart" icon 	<ul style="list-style-type: none"> Maintain the total number of contributed annotations in the top three of the class
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Figure 7. Description of levels - part 2

3.7.4 Exam-notes

The exam interface clearly and orderly presents the five questions, each designed to assess different aspects of the student's knowledge, as shown in Figure 9. Users have the ability to select and provide answers, allowing them to demonstrate their understanding of the exam. study material. In addition to solving questions, the exam view allows students to make personalized annotations. These notes can range from personal reflections to the identification of key concepts.

Figure 10 also shows that, depending on the student's level, they will be able to make annotations of responses to their classmates' annotations.

My level



45%

Castellain

INDICATORS	DESCRIPTIONS
Permissions	<ul style="list-style-type: none"> Make response notes Respond to 3 other students' notes Read reading notes from colleagues Read response notes from colleagues Make personal reading notes Get response from 3 other students

Figure 8. User level

Reading: Free Will - Are We Architects of Our Own Lives?

Free will is a fundamental concept that has been the subject of intense debate in philosophy, psychology, and neuroscience. This term refers to the ability of human beings to make decisions autonomously, without being completely determined by external factors such as genetics, social environment, or personal circumstances.



The central question of free will is whether we are truly capable of choosing our actions or whether, in reality, our decisions are predestined by a series of preconditions that we cannot control. In philosophy, free will is pitted against the theory of determinism, which holds that all events, including our decisions, are caused by previous events and therefore could not have occurred otherwise. This perspective raises the question of whether our choices are truly free or whether they are determined by a chain of causality that limits us to acting in only one way. Psychology, on the other hand, explores how our decisions are influenced by internal factors such as personality, emotions, and past experiences. Psychological studies have shown that our decisions are often conditioned by cognitive and emotional biases, which can limit our ability to make completely autonomous decisions.

Notes

See

Add

▼ The dilemma of morality and free will

The text raises the question of free will and whether human beings have the ability to make autonomous decisions or are predestined by external forces. Some defend the idea that we are architects of our own lives, while others argue that free will is an illusion and our decisions are influenced by various factors.

> Determinism

> The complexity of human nature

Figure 9. Read annotations

Reading: Free Will - Are We Architects of Our Own Lives?

I DON'T UNDERSTAND

01 **Dilemma of morality and free will**

I can't understand what the dilemma would be between the two.

Jean Paul

DIFFERENT IDEAS

02 **Circumstances**

Some advocate individual free will, while others believe that circumstances may limit the ability to choose.

Thiago

Notes

Answer

What is the dilemma of morality and free will? - Commentary on Jean Paul's annotation

The text raises the question of free will and whether human beings have the ability to make autonomous decisions or are predestined by external forces. Some defend the idea that we are architects of our own lives, while others argue that free will is an illusion, and our decisions are influenced by various factors.

Figure 10. Response annotations

3.7.5 Dashboard

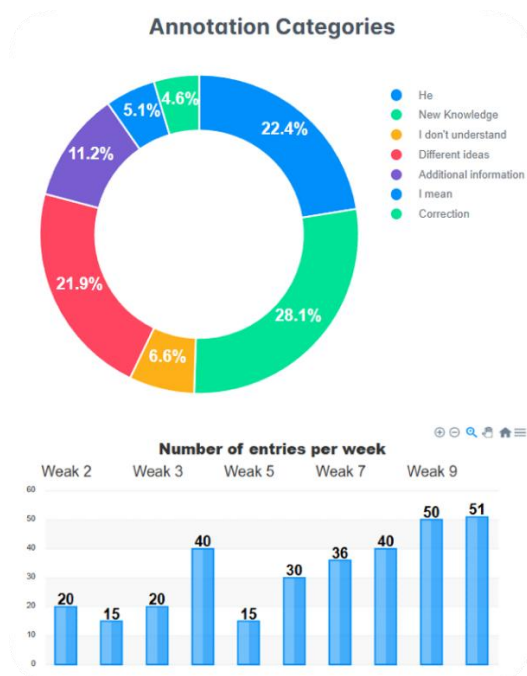


Figure 11. Teacher dashboard

In this section, various graphs will be displayed that will allow the teacher to observe the most used annotation categories, using a donut graph. Also, you can monitor the total number of notes made per week through a progress bar. Additionally, a table will be presented that will show the individual progress of each student, making it easier to identify those who may need help, as shown in Figure 11.

4. RESULTS

4.1 Normality tests

To evaluate the distributions of scores of the experimental groups (Group B, with the gamification tool) and control groups (Group A, without the gamification tool), the Shapiro-Wilk normality test was applied. This test is used to determine if a sample comes from a population with a normal distribution. A significance level (alpha) of 0.05 was established. In this context, the null hypothesis (H0) states that the data come from a population with a normal distribution.

Table 3 shows that the p values obtained for both groups are greater than 0.05. Therefore, there was insufficient evidence to reject the null hypothesis of normality in either group. This suggests that, according to the Shapiro-Wilk test, the data in both groups can be assumed to come from a normal distribution.

Table 3. Normality test

	Pre B	Pos B	Pre A	Pos A
N	20	20	20	20
Lost	0	0	0	0
Half	12.2	17.4	11.9	12.7
Median	12.0	18.0	12.0	13.0
Standard deviation	2.04	1.19	1.93	1.66
Minimum	10	15	8	10
Maximum	16	19	16	17
Shapiro-Wilk W	0.880	0.869	0.952	0.939
Shapiro-Wilk p-value	0.118	0.211	0.404	0.227

Since the normality of the data is assumed according to the results of the Shapiro-Wilk test, the student test will be used to compare the means of the experimental and control groups. The t test is appropriate when the assumptions of normality and homogeneity of variance are met. The choice of this test is based on its sensitivity to detect significant differences between the means of two groups when these assumptions are met.

4.2 T-test for paired samples

Given that the Shapiro-Wilk test confirmed the normality of the data for both the experimental and control groups, and the assumptions of homogeneity of variance are met, the student's t-test is the appropriate statistical method for comparing the means of the two groups. The t-test is particularly suitable for this scenario as it is designed to detect significant differences between the means of two normally distributed groups when these assumptions are fulfilled.

The null hypothesis (H0) for this analysis posits that the results obtained in the pretest are equal to or superior to those obtained in the post-test. Conversely, the alternative hypothesis (H1) suggests that the results in the post-test are greater than those in the pre-test, indicating an improvement.

Table 4 reveals a p-value < 0.0001. With a confidence level of 95%, this p-value is well below the threshold for statistical significance, leading us to reject the null hypothesis. This result provides strong statistical evidence that there is a significant improvement in students' reading comprehension following the use of the web system with gamification.

Table 4. T-test for paired samples

			Statistical	GL	p
Pre B	Pos B	Student's T	-15.5	19.0	<.001
Note. H _a μ Measurement 1 - Measurement 2 < 0					

4.3 Comparison of both groups for dysgraphia

Table 5 highlights that Group B experienced a significant increase of 47.46% in the mean score between the pretest and the posttest regarding their reading comprehension. In contrast, Group A showed a more modest improvement of approximately 0.84%, which is considerably smaller compared to Group B. These results suggest that the intervention or change implemented, possibly related to the gamification system, had a more substantial impact on Group B's scores compared to Group A.

Additionally, Table 6 shows that Group B experienced an impressive 60% increase in the average word structuring between the pretest and the posttest. Similarly, Table 7 indicates a 65% increase for the correct use of words. The difference in improvement percentages suggests that the gamification system was particularly effective for Group B in enhancing text comprehension and related skills.

Table 5. Comparison of groups regarding the reading comprehension score

Groups	Half		Median	
	Pretest	Posttest	Pretest	Posttest
Group B	11.8	17.4	12.0	18.0
Group A	11.9	12.0	12.0	13.0

Table 6. Comparison of groups regarding the qualification in word structuring

Groups	Half		Median	
	Pretest	Posttest	Pretest	Posttest
Group B	11.8	19.5	12.0	18.0
Group A	11.9	11.97	12.0	13.0

Table 7. Comparison of groups regarding the rating of correct use of words

Groups	Half		Median	
	Pretest	Posttest	Pretest	Posttest
Group B	11.8	19.47	12.0	18.0
Group A	12.0	11.97	13.0	14.0

Importantly, these findings support the idea that implementing specific strategies, such as gamification, can positively impact academic performance. In addition to the improvement in scores observed in the experimental group, it was identified that the gamification elements, such as the scoreboard, icons for each level, and the evolving permissions granted at each level, contributed to continued learning and engagement. This was evident from the comparison of the number and types of annotations made by students. The

availability of extra materials and interactive features also played a role in sustaining student motivation and enhancing overall learning outcomes.

5. CONCLUSIONS

The gamification design implemented in this annotation tool proved to be effective in improving students' performance in the annotation activity during reading. Through gamification, it was possible to increase the reading comprehension grade by 47.46% compared to the pretest.

With the assistance of the system, a notable 60% increase in word structuring score was achieved compared to the group that did not use the system with gamification. This result highlights the effectiveness of the implemented approach in improving participants' ability to structure words in a meaningful way.

In the context of correct word use, an even more notable increase of 65% in scores was observed, compared to the control group. These findings highlight the positive and differential influence of system implementation, particularly in precision and appropriateness of word use.

Based on the results of this research, as a future work, it is proposed to use different types of gamification strategies linked to personalized profiles of students, different courses and the different levels of study in primary education.

REFERENCES

- [1] Wong, J., Baars, M., Davis, D., Van Der Zee, T., Houben, G.J., Paas, F. (2019). Supporting self-regulated learning in online learning environments and MOOCs: A systematic review. *International Journal of Human-Computer Interaction*, 35(4-5): 356-373. <https://doi.org/10.1080/10447318.2018.1543084>
- [2] MINEDU. (2021). Estudio Virtual de Aprendizajes (EVA) 2021. <https://umc.minedu.gob.pe/wp-content/uploads/2023/02/PPT-WEB-EVA.pdf>.
- [3] UNESCO. (2021). La plataformización de la educación: Un marco para definir las nuevas orientaciones de los sistemas educativos híbridos. https://unesdoc.unesco.org/ark:/48223/pf0000377733_spa.
- [4] Melgarejo-Solis, R., Antón-Sancho, Á., Vega-Huerta, H., Vergara-Rodríguez, D. (2023). Impact of COVID-19 on the use of ICT resources among university professors in Peru. *LACCEI*, 1(8). <https://doi.org/10.18687/LACCEI2023.1.1.795>
- [5] Caroline. (2021). Aprendizaje online vs aprendizaje tradicional: y el ganador es...! *EasyLMS*. <https://www.easy-lms.com/es/centro-de-conocimiento/e-learning/aprendizaje-online-vs-aprendizaje-tradicional/item12530>.
- [6] Patra, I., Hashim Alghazali, T.A., Sokolova, E.G., Prasad, K.D.V., Pallathadka, H., Hussein, R.A., Shanan, A.J., Ghaneiarani, S. (2022). Scrutinizing the effects of e-learning on enhancing EFL learners' reading comprehension and reading motivation. *Education Research International*, 2022(1): 4481453. <https://doi.org/10.1155/2022/4481453>
- [7] Tarchi, C., Brante, E.W., Jokar, M., Manzari, E. (2022). Pre-service teachers' conceptions of online learning in

- emergency distance education: How is it defined and what self-regulated learning skills are associated with it? *Teaching and Teacher Education*, 113: 103669. <https://doi.org/10.1016/j.tate.2022.103669>
- [8] Martínez, M., Marrujo, J., Perillo, M., González, F.M., Burin, D. (2019). Reading comprehension in e-learning: Support strategies and working memory *Comprensión de texto en e-Learning: Estrategias de soporte y memoria de trabajo*. *Ocnos*, 18(2): 31-43. https://doi.org/10.18239/ocnos_2019.18.2.1988
- [9] Burin, D.I., Gonzalez, F.M., Barreyro, J.P., Injoque-Ricle, I. (2020). Metacognitive regulation contributes to digital text comprehension in e-learning. *Metacognition and Learning*, 15(3): 391-410. <https://doi.org/10.1007/s11409-020-09226-8>
- [10] Chen, C.M., Li, M.C., Chen, Y.T. (2022). The effects of web-based inquiry learning mode with the support of collaborative digital reading annotation system on information literacy instruction. *Computers & Education*, 179: 104428. <https://doi.org/10.1016/j.compedu.2021.104428>
- [11] Chen, C.M., Li, M.C., Chen, T.C. (2020). A web-based collaborative reading annotation system with gamification mechanisms to improve reading performance. *Computers & Education*, 144: 103697. <https://doi.org/10.1016/j.compedu.2019.103697>
- [12] Li, H., Majumdar, R., Chen, M.R.A., Ogata, H. (2021). Goal-oriented active learning (GOAL) system to promote reading engagement, self-directed learning behavior, and motivation in extensive reading. *Computers & Education*, 171: 104239. <https://doi.org/10.1016/j.compedu.2021.104239>
- [13] Carrocera, M. (2023). Gamificación 2023, desafíos, riesgos y su futuro en las organizaciones. *EXPANSION*. <https://expansion.mx/opinion/2023/01/09/gamificacion-2023-desafios-riesgos-y-su-futuro-en-las-organizaciones>.
- [14] Romero-Rodriguez, L.M., Ramirez-Montoya, M.S., González, J.R.V. (2019). Gamification in MOOCs: Engagement application test in energy sustainability courses. *IEEE Access*, 7: 32093-32101. <https://doi.org/10.1109/ACCESS.2019.2903230>
- [15] da Silva, L.M., Dias, L.P., Barbosa, J.L., Rigo, S.J., dos Anjos, J., Geyer, C.F., Leithardt, V.R. (2022). Learning analytics and collaborative groups of learners in distance education: A systematic mapping study. *Informatics in Education*, 21(1): 113-146. <https://doi.org/10.15388/infedu.2022.05>
- [16] De-La-Cruz, P., Rojas-Coaquira, R., Vega-Huerta, H., Lagos-Barzola, M., Pérez-Quintanilla, J. (2022). A systematic review regarding the prediction of academic performance. *Journal of Computer Science*, 18(12): 1219-1231. <https://doi.org/10.3844/jcssp.2022.1219.1231>
- [17] Vega, H., Sanz, E., De La Cruz, P., Moquillaza, S., Pretell, J. (2022). Intelligent system to predict university students dropout. *International Journal of Online and Biomedical Engineering*, 18(07): pp. 27-43. <https://doi.org/10.3991/ijoe.v18i07.30195>
- [18] Di Francesco, P., Lago, P., Malavolta, I. (2019). Architecting with microservices: A systematic mapping study. *Journal of Systems and Software*, 150: 77-97. <https://doi.org/10.1016/j.jss.2019.01.001>
- [19] Milovanović, A. (2021). Microservice architecture in e-learning. *E-Business Technologies Conference Proceedings*, 1(1): 105-108. <https://ebt.rs/journals/index.php/conf-proc/article/view/81>.
- [20] Services, A.W. (2023). Microservicios. Amazon Web Services. <https://aws.amazon.com/es/microservices/>.
- [21] Guzman, Y., Tavera, A., Zevallos, R., Vega, H. (2021). Implementation of a bilingual participative argumentation web platform for collection of Spanish text and Quechua speech. In 2021 International Conference on Electrical, Communication, and Computer Engineering (ICECCE), Kuala Lumpur, Malaysia, pp. 1-6. <https://doi.org/10.1109/ICECCE52056.2021.9514251>
- [22] Nday, B.A., Kusuma, G.P., Fredyan, R. (2023). Serverless utilization in microservice e-learning platform. *Procedia Computer Science*, 216: 204-212. <https://doi.org/10.1016/j.procs.2022.12.128>
- [23] Elena Maquen-Niño, G.L., Ayelen Sandoval-Juarez, A., Rosa, V.L., Andres, R., Carrión-Barco, G., Adrianzén-Olano, I., Vega-Huerta, H., De-La-Cruz-VdV, P. (2023). Brain tumor classification deep learning model using neural networks. *International Journal of Online & Biomedical Engineering*, 19(9): 81-92. <https://doi.org/10.3991/ijoe.v19i09.38819>
- [24] Maquen-Niño, G.L.E., Bravo, J., Alarcón, R., Adrianzén-Olano, I., Vega-Huerta, H. (2023). Una revisión sistemática de Modelos de clasificación de dengue utilizando machine learning. *RISTI-Revista Ibérica de Sistemas e Tecnologias de Informação*, (50): 5-27. <https://doi.org/10.17013/risti.50.5-27>
- [25] DelaCruz-VdV, P., Cadenillas-Rivera, D., Vega-Huerta, H., Cancho-Rodriguez, E., Bulnes, M.E.P., Maquen-Niño, G.L.E., Pantoja-Collantes, J. (2023). Diagnosis of brain tumors using a convolutional neural network. *International Conference in Information Technology and Education*, Singapore, pp. 45-56. https://doi.org/10.1007/978-981-99-5414-8_6
- [26] Yauri, J., Lagos, M., Vega-Huerta, H., De-La-Cruz-VdV, P., Maquen-Ni, G.L.E., Condor-Tinoco, E. (2023). Detection of epileptic seizures based-on channel fusion and transformer network in EEG recordings. *International Journal of Advanced Computer Science and Applications*, 14(5): 1067-1074. <https://doi.org/10.14569/IJACSA.2023.01405110>
- [27] Arrieta-Espinoza, E., Moquillaza-Henríquez, S., Vega-Huerta, H., Cámara-Figueroa, A., De-La-Cruz-Vdv, P., Grados, L.G. (2023). Improvement to the Papeat software of the gastronomy sector based on Intelligence using Tableau. In 2023 18th Iberian Conference on Information Systems and Technologies (CISTI), Aveiro, Portugal, pp. 1-7. <https://doi.org/10.23919/CISTI58278.2023.10211723>
- [28] De-La-Cruz-Vdv, P., Moquillaza-Henríquez, S., Valeriano-Peña, M., Maquen-Niño, G.L.E., Vega-Huerta, H., Adrianzén-Olano, I. (2023). Data Mart and key performance indicators to optimize decisions in a medical service clinic. In 2023 18th Iberian Conference on Information Systems and Technologies (CISTI), Aveiro, Portugal, pp. 1-6. <https://doi.org/10.23919/CISTI58278.2023.10211492>
- [29] Velez-Villanueva, R., Vega-Huerta, H., De-La-Cruz, P., Gamboa-Cruzado, J., Cancho-Rodriguez, E., Cámara-Figueroa, A. (2022). Support in the neurorehabilitation

- for older people using a mobile application. International Conference on Intelligent Technologies, Jakarta, Indonesia, pp. 85-96. https://doi.org/10.1007/978-981-99-1912-3_8
- [30] Sánchez-Tello, J., Vega-Huerta, H., De-La-Cruz-VdeV, P., Maquen-Niño, G., Melgarejo-Solis, R., Cámara-Figueroa, A., Cancho-Rodriguez, E. (2023). Implementation of a chatbot for virtual attention of queries case: Postgraduate School of the UNMSM. LACCEI, 1(8). <https://doi.org/10.18687/LACCEI2023.1.1.787>
- [31] Parada, I. (2021). Diferencias entre grupo de control y grupo experimental. YuBrain. <https://www.yubrain.com/ciencia/diferencias-entre-grupo-de-control-y-grupo-experimental/#gsc.tab=0>.