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RESEARCH ARTICLE

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Gamification tools in the learning of shipbuilding in the undergraduate marine engineering education

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Abstract

This study assesses the implementation of different gamification tools and learning complexity in the of the subject Shipbuilding Principles of the Universitat Politècnica de Catalunya · BarcelonaTech (UPC). This experience has been carried out under a triple new scenario: the virtuality due to the Covid-19 pandemic, added to the gamified training, and the assessment carried out remotely. Both the content and the assessment of the subject have been presented using three gamification web tools (Kahoot!, Mentimeter, and Socrative) and three learning complexity (Lexicon, Comprehension, and Visual & Relationship). The content of the subject has been taught in a dynamic, entertaining, and active way. An important factor that has been taken into account was student diversity when responding to gamified elements, using different gamification tools and different learning complexity. This experience of gamification had a positive impact on student motivation, class attendance, participation, collaborative learning, and classroom climate, which is key in a scenario like the current one, with an adaptation of classes to online learning due to the pandemic. From the results obtained, it can be stated that the gamified experience, even offering a good result compared to previous academic years, did not provide a significant improvement in the overall academic performance of the students. Regarding the gamification tools, the one that presented a slight advantage over the rest was Socrative, which is based on a particular challenge without competition between peers or groups. Regarding the learning complexity, all presented a similar level of success.

KEYWORDS

assessment, gamification, learning complexity, motivation, online learning

1 | INTRODUCTION

The unprecedented situation of the Covid-19 pandemic has caused the closure of universities worldwide and has led to the forced transition to online learning [17,36,37]. The adaptation of classes to online learning has meant higher workloads and stress than face-to-face classes for higher education faculty [30]. Several challenges concerning online education during the Covid-19 lockdown have been identified, such as the quality of online teaching that students received [4], the correct adaptation of teaching to the online format, including the classes, assessment methods, the

contact with other students and teachers [15,33], and students' boredom due to prolonged lockdown [6]. These factors can have an impact on academic performance and student achievement [5]. For this adaptation to online classes, the implementation of new technologies has been a key element in transforming education [14]. This is usually a challenge for teachers, as it requires, in addition to a deep knowledge of the subject, knowledge of the technological tools to be implemented [38]. In addition, another challenge in teaching–learning activities has been conducting assessments remotely, due to the lack of preparation superimposed on the problems inherent in remote assessment [20].

One way of using technology and trying to promote student engagement in online teaching [26] is the implementation of gamification in teaching–learning processes in higher education institutions [9,12,13,32,32,35]. As for technology, the use of this method is not an added problem, as it is based on the idea that the students have smartphones, tablets, or laptops [3,8,39]. In this case, in addition to the aforementioned challenges associated with online education, uncertainties are added, such as the relationship between gamification and the academic development of students. There are previous studies on the use of games in higher education, but their conclusions are still uncertain about the effect on academic performance [1,25]. Regarding student engagement, studies confirm that this type of practice leads to higher student motivation [7,16,18,31], but it is important to pay attention to game design and student diversity when responding to gamified elements [24,29,34]. This is the case of gamification in relation to achievement orientation [21], the use of badges [22,23], although most achievements do benefit motivation and performance [11,19], it must be borne in mind that this is not always the case and that their design must be done properly. This is the case of the response of students to the visibility of badges, studies show that among no badges, badges visible to peers, and badges only visible to students themselves, the badges that could only be viewed by the students themselves were evaluated more positively than the rest [27]. What seems clear is that gamification has a positive impact on student motivation, class attendance, participation, collaborative learning, and classroom climate [10,28,40], which is key in a scenario like the current one. In relation to the gamification tools used, these are very diverse (Kahoot!, Socrative...) and it will be detailed later which ones have been chosen in this study.

1.1 | Context of the study

The subject in which this gamification experience was implemented is called Shipbuiding Principles and is taught at the Barcelona School of Nautical Studies at the Universitat Politècnica de Catalunya · BarcelonaTech (UPC). Its content covers two different degrees: Bachelor of Engineering in Naval Systems and Technology and double degree of Bachelor of Marine Technologies and Bachelor of Naval Systems and Technology. In other words, it is a subject with mixed students from two different courses (both from the second year). Students do not require prior knowledge to carry out the subject. The class group is normally around 60–70 people. In the 2020–2021 academic year, in which gamification was implemented, the group consisted of 70 students. It is worth mentioning that the context in which this academic year is presented is derived from the circumstances of the Covid-19 pandemic: the classes were virtual, conducted through Google Meet.

Within the subject content and at the beginning of the course there are some themes that practically focus on the memorization of words and definitions. This type of content (memorizing a glossary) is tedious and, from the teacher's point of view, unattractive (although necessary). The glossary in question is made up of about 300 words. Furthermore, due to the nature of the subject and the studies, this glossary is in Spanish (SP)—English (EN), so this means 300 + 300 words to memorize. Point out that these themes are initial themes of the course (they represent 30%–40% of the course content), and that attendance at these classes is normal (students do not stop attending class because these themes are less attractive).

The situation before the experience presented here is understood to be problematic based on the following aspects:

- As a teacher, the content is difficult to present without falling into boredom.
- The students get bored in class (or at least that is how the teaching staff of the subject perceive it) in the first themes of the subject, the same does not happen in the rest of the themes of the subject.
- From the point of view of the students, learning based on simple memorization causes them deficiencies in future themes and subjects.
- The methodology required in these initial themes is not the same as that of the rest of the themes of the subject. Therefore, a change in methodology on these themes would not pose a problem.
- The evaluation of this glossary is likely to be easily copied by the students. New approaches to the type of evaluation would also be interesting to assess.

1.2 | Objectives and research questions

Given the previous situation, by gamification of the initial themes of the subject, the following objectives are intended to be achieved:

- In the space of a virtual classroom, the presentation of content is as efficient as possible.
- The proposed content is delivered in a more dynamic way.
- The students enter into this dynamism and find better ways of studying, beyond the simple memorization of words.
- Practice the presentation of content with more online tools.
- Quantify the effectiveness of the different tools used.

The research questions posed in this study were the following:

- Does the use of gamification tools compared to the classic content presentation offer better academic results?
- In the use of gamification tools, there is a differentiation; being able to determine, in general, the effectiveness of one over another?
- In the introduction of content using different learning complexity in a controlled way, classification is also produced, implying that one learning complexity is more effective over another?
- In the interaction of gamification tools and learning complexity, can an optimization pattern be obtained?

2 | METHODOLOGY

This experience assesses the academic results of the Shipbuilding Principles through the use of different gamification tools and learning complexity. The entire class group was presented with the same teaching content, although different gamification tools and different learning complexity were used in the presentation of said content. Specifically, three gamification tools and three learning complexity were used, combining each of them.

For better control of the study variables, the content presentation was always done using the multiple-choice modality: correct response plus three distractors (in total four options to choose from). It is important to clarify that the use of the tools in the classroom did not register the level of success–errors of the students. This assessment was only analyzed in the final evaluation of the contents.

The final assessment of the knowledge acquired was carried out through an exam using the online tool Google Forms, the gamification tools and the learning complexity used were the same as those shown in the classroom. The evaluation with respect to the different questions yielded three possible results: correct (positive score), incorrect (negative score), or blank (no score).

2.1 | Gamification tools

This study has considered three gamification tools, which are summarized below.

2.1.1 | Tool 1: Kahoot!

Kahoot! (https://kahoot.com) is based on a direct, individual, and real-time competition, where the different students compete with each other to obtain the highest possible score. The pressure of the game is obtained by the limited time in the answers and is based on beating your own companions. The results are displayed as the different responses are produced. The tool allows the teacher to create competitive strategies in the classroom to learn or reinforce learning and where students take the role of contestants.

The following table (Table 1) details the main advantages and disadvantages of this tool.

2.1.2 | Tool 2: Mentimeter

Mentimeter (https://www.mentimeter.com) features the same game strategy as Kahoot!. The teacher poses a question in class and the students respond with a live poll, that is, by sending a response that only the teacher can see. This system in its open version can also be done with a Google Drive document. This modality introduces the following characteristics: it is individual, it does not generate competition between the different students, and the final assessment (solution) is offered directly by the teacher.

The following table (Table 2) details the main advantages and disadvantages of this tool.

2.1.3 | Tool 3: Socrative

Socrative (https://www.socrative.com) is a teacher evaluation tool in digital environments that allows teaching staff to know the answers of their students in real time, through mobile devices and computers. Socrative allows you to engage and connect with students directly, offering immediate feedback. This tool is not so competitive ("Space Race" option) as the level of results obtained is not verified until the end. The tool was used in groups of four to five students. The groups were managed directly with Google Meet.

The following table (Table 3) details the main advantages and disadvantages of this tool.

TABLE 1 Advantages and disadvantages of Kahoot!

Advantages	Disadvantages
The tool is widely used in the education sector (many users)	Payment tool, although functional in its free version 7 days
There are more and more accessories. The tool allows many options	Extensive use of the tool has led some students to loathe it
Very playable, implying a challenge from the students	The cheapest version only allows access to 50 students, so you have to hire the Premium version
Students compete with each other while the teacher simply presents the content	The "question" and "answer" fields have severe limitations regarding the number of characters
It allows multiple selection options, as well as the combinations that the different learning complexity demands	
Allows you to enter the application with a Gmail account (such as the [University] account)	
Allows the use of different devices and OS (PC, Windows, Tablets, phones, etc.)	

TABLE 2 Advantages and disadvantages of Mentimeter

Advantages	Disadvantages
Quick and guided access	Not very attractive visually
The free version has no restriction on the number of students	Subscriptions are slightly more expensive than other applications
Very easy to configure and start	Allows more characters (150) in question creation
Many options in content creation through predefined templates	Limitation on the number of slides in the free version
Allows use of different devices	

TABLE 3 Advantages and disadvantages of Socrative

Advantages	Disadvantages
Oriented to more spontaneous situations	Tedious registration. It does not allow to enter with other accounts such as Gmail
Very easy to configure and start up (few options and all very clear)	Not many options to present content
Highly effective	In the free version, limitation of up to 50 users, as well as the impossibility of creating subgroups–classes
Allows use of different devices	Payment/subscription tool
	Not very playable

2.2 | Content structure

The initial glossary can be structured in a general way in a structure: Topic → Element → Variables

The topics are adjusted to the general contents of the subject. Different topics are:

1. Elements of the ship
2. Hull subdivision
3. Hull structure
4. Efforts and materials
5. Covers and hatches
6. Blocks and struts
7. Anchors and chains

Each of the topics has various elements that make up the glossaries themselves. The number of elements varies, depending on the topic, between 50 and 100 elements. The reference of each of the elements is its own name.

The variables considered in each element are not always the same. That is, not all the elements have to have

all the variables listed here. On the contrary, what is intended is that the student knows all the variables of each of the elements. The different variables are:

1. Reference (internal value for content control)
2. Element name (SP—Spanish). It is the one that serves as an index since its existence is necessary.
3. Element definition (SP—Spanish)
4. Typology
5. Illustration (graphic, photo, diagram, etc... showing the element)
6. Relationship by context (direct relationship with other elements)
7. Element name (EN—English)
8. Element definition (EN—English)
9. Figurative pronunciation (EN—English)

Some examples of content structure are shown in Figures 1–3.

2.3 | Learning complexity

The different variables and their relationships are, in short, the contents that the students have to learn. That said, the tools presented offer us the possibility of organizing the information of said contents. The presentation options are limitless. That is why it is essential to order the options that we think will be more successful when presenting the information (in its game format).

It is logical to assume that at different presentations the mental schemes that we activate in the students are different. Using different methods leads us to model the variables according to their categories of knowledge: Lexicon, Comprehension, Relationship, Visual, and Hearing.

Specifically applied to our structure, the different variables correspond to the following categories:

1. Element name (SP): Lexicon
2. Element definition (SP): Comprehension
3. Typology: Relationship
4. Illustration: Visual
5. Relationship by context: Relationship
6. Name of the item (EN): Lexicon
7. Element definition (EN): Comprehension
8. Figurative pronunciation (EN): Hearing

The idea is, the design has a categorization that includes all the possible dimensions, which, in turn, uses all the variables to later assign the corresponding gamified tool. The following table (Table 4) serves as a summary of all the strategies that can be considered.

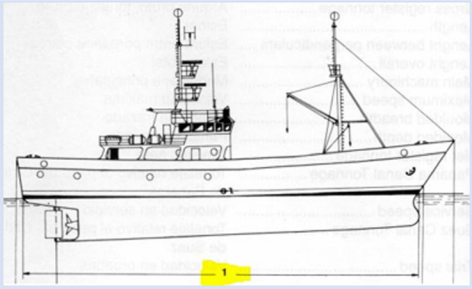
Reference	0101
Topic	Elements of the ship
Element name (SP)	EEP (eslora entre perpendiculares)
Element definition (SP)	Es la distancia longitudinal entre la perpendicular de proa (Ppr) y la perpendicular de popa (Ppp).
Typology	Measures
Illustration	
Relationship by context	Bow perpendicular; Stern perpendicular
Element name (EN)	LBP (Length Between Perpendiculars)
Element definition (EN)	It is the distance between two perpendiculars to the summer water line, drawn between the fore side of the stem and the after side of stern post.
Figurative pronunciation (EN)	/leŋkθ/ /bɪˈtwiːn/ /ˌpɜːpənˈdɪkjələ(r)/

FIGURE 1 Content structure Example 1

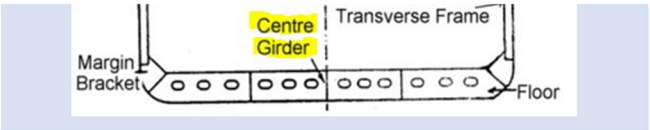
Reference	0301
Topic	Hull structure
Element name (SP)	Sobrequilla
Element definition (SP)	Viga formada de piezas, colocado de popa a proa por encima de la trabazón de las varengas, y fuertemente empernado a la quilla, que sirve para consolidar la unión de esta con las cuadernas.
Typology	Longitudinal reinforcement
Illustration	
Relationship by context	Side Length; Plan top; Keel
Element name (EN)	Centre Girder
Element definition (EN)	They are longitudinal running in a fore-and-aft direction under the top bottom tank beams.
Figurative pronunciation (EN)	/ˈsentə(r)//ˈgɜːdə(r)/

FIGURE 2 Content structure Example 2

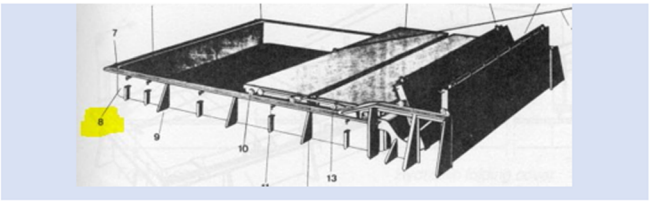
Reference	0501
Topic	Covers and hatches
Element name (SP)	Brazola
Element definition (SP)	Cualquiera de los cuatro laterales o piezas que sobresalen de la cubierta en los lados de toda boca de escotilla a fin de impedir la introducción del agua por ella, al tiempo mismo que sirven de asiento a los cuarteles con que se cierra.
Typology	Hatch; Load elements
Illustration	
Relationship by context	Hatch, Lengths, Counter-arms; Angular; Jaws; Cover
Element name (EN)	Coaming
Element definition (EN)	It is a raised border around a ship's hatch that keeps the water out.
Figurative pronunciation (EN)	/ˈkəʊmɪŋ/

FIGURE 3 Content structure Example 3

All possible options are covered: all possible knowledge fields and input and output variables are used.

On the basis of Table 4, the following learning complexity is defined, that is, the question–answer structure has to be incorporated into the different tools:

- Learning complexity 1 (L1):

• Lexicon. Element name (SP) → Element definition (SP)

• Lexicon. Element name (EN) → Element definition (EN)

- Learning complexity 2 (L2):

• Comprehension. Element definition (SP) → Element name (SP)

• Comprehension. Element definition (EN) → Element name (EN)

TABLE 4 Categories summary

	Knowledge	Input	Output
1	Lexicon	Element name (SP)	Element definition (SP)
			Element name (EN)
2	Lexicon	Element name (EN)	Element definition (SP)
			Figurative pronunciation (EN)
3	Comprehension	Element definition (SP)	Element name (SP)
			Element name (EN)
4	Comprehension	Element definition (EN)	Element name (SP)
			Element name (EN)
5	Relationship	Relationship by context	Typology
			Illustration
6	Visual	Illustration	Element definition (SP)
			Element name (EN)
7	Visual	Illustration	Element definition (EN)
			Element name (SP)
8	Hearing	Figurative pronunciation (EN)	Element definition (SP)
			Element name (EN)

Abbreviations: EN, English; SP, Spanish.

- Learning complexity 3 (L3):

- Relationship. Relationship by context → Typology
- Visual. Illustration → Element name (SP/EN)
- Visual. Illustration → Element definition (SP/EN)

2.4 | Gamification assessment

The assessment of this part of the subject was carried out by means of an exam using Google Forms. The exam lasted 45 min and consisted of 60 questions that conserved the same learning complexity of the information originally presented with the gamification tools. To avoid copying, the questions were presented to all students at random. The distribution of the questions based on the tools and learning complexity used are summarized in Table 5.

TABLE 5 Distribution of the number of questions in the exam according to the tool and learning complexity

	Learning complexity				
Tools	L1	L2	L3R	L3V	Total
T1	7	7	3	3	20
T2	7	7	3	3	20
T3	7	7	3	3	20
					60

Abbreviations: R, relationship; V, visual.

3 | RESULTS

3.1 | Gamification implementation

Classes of the subject Shipbuilding Principles took place on Thursdays from 08:00 to 12:00 a.m. (4-h long). As already mentioned, in the 2020–2021 academic year the classes were virtual due to Covid-19, conducted through Google Meet, and the class consisted of 70 students. Their attendance and participation were not constant, varying between 58 (minimum) and 67 (maximum).

In total, 270 questions were presented in this gamified experience. The gamified contents presented were always different, that is, they were not repeated. The experience crossed tools (T1, T2, T3) and learning complexity (L1, L2, L3) so that the presentation of content was always different with regard to the tool-learning complexity binomial. In Table 6, the summary of the sessions is shown. The first four sessions used two different gamification tools and the last session only used one tool. The fact that topics 5, 6, and 7 have fewer questions is explained by the simple density of the syllabus. In addition to the presentation of content in the

TABLE 6 Summary of gamified course content

Session	Students	Tool	Questions	Learning complexity	Category	Topics
1	65	T1	30	L1	Lexicon	1, 2
	65	T2	30	L2	Comprehension	3, 4
2	63	T3	30	L3	Relationship	5, 6, 7
	63	T1	30	L2	Comprehension	5, 6, 7
3	62	T2	30	L1	Lexicon	5, 6, 7
	62	T3	30	L2	Comprehension	1, 2
4	58	T1	30	L3	Visual	3, 4
	58	T2	30	L3	Visual	1, 2
5	67	T3	30	L1	Lexicon	3, 4
6	66	EXAM	60	All	All	All

classroom, the students had the course content in the traditional notes of the subject.

The detail of the number of questions for each topic and learning complexity presented is shown in Table 7.

In the presentation of the information, beyond the contents covered (Topics, the base of the teaching material), the crossing between different gamification tools and different learning complexity has been considered. Table 8 shows a summary of the different examples and content involved.

The following Figures 4–12, are intended to clarify the contents that have been used through the simplified presentation of the different examples with regard to the tool-learning complexity binomial.

TABLE 7 Number of questions for each topic and learning complexity

	Learning complexity			
Topics	L1	L2	L3	Total
1	15	15	15	45
2	15	15	15	45
3	15	15	15	45
4	15	15	15	45
5	10	10	10	30
6	10	10	10	30
7	10	10	10	30
Total	90	90	90	270

3.2 | Gamification assessment results

Below, the academic results for the year 2020–2021, corresponding to the year in which the gamified experience was carried out, are compared with the academic results for the years 2017–2020 in which the teaching of this part of the subject was taught in a traditional manner (Table 9). In comparison, in order not to distort the values, the zero marks have been eliminated as they normally correspond to a no-show or to someone who simply attends the exam in a testimonial manner.

In total, during the 2020–2021 academic year, 270 questions were shown. Regarding the exam, it consisted of 60 questions, the examined students were 61 (out of a total of 70 enrolled), which give us a total of 3660 questions. Considering the combination of tools and learning complexity, the disaggregation would be as shown in Table 10. Introducing the variable shown in the last column of the table (MARK) facilitates the understanding and bonanza of the results obtained. This variable reflects the theoretical mark that each combination would have obtained. This theoretical mark results from the combination of the number of questions answered correctly and incorrectly, taking into account that the questions incorrectly answered subtracted the student a quarter of a point with respect to the question correctly answered, which added 1 point (the blank questions did not add up to nor did they subtract).

TABLE 8 Relationship between tools and learning complexity, and number of questions generated

	Learning complexity			
Tools	L1	L2	L3	Total
T1	30	30	30	90
T2	30	30	30	90
T3	30	30	30	90
Total	90	90	90	270

FIGURE 4 Kahoot!—Lexicon example (The correct answer is: "Es la parte del casco que, de forma permanente, está sumergida"—Spanish language)

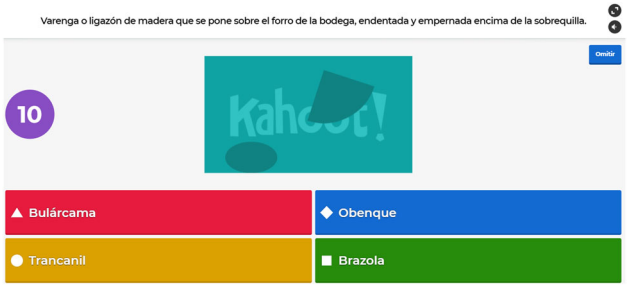


FIGURE 5 Kahoot!—Comprehension example (The correct answer is: "Bulárcama"—Spanish language)

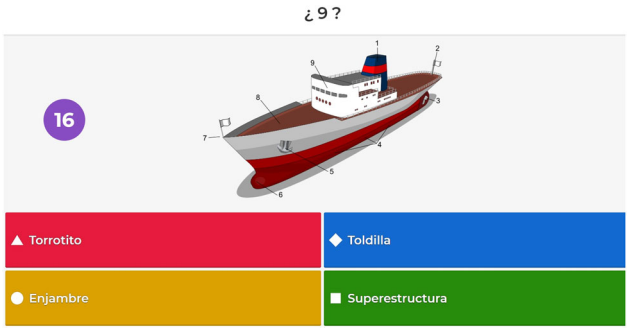


FIGURE 6 Kahoot!—Visual example (The correct answer is: "Superestructura"—Spanish language)

By type of gamification tool used, the summary of the questions is shown in Table 11.

Some observations are highlighted:

- On the one hand, due to the distribution of questions, each group should have had 33% randomly.
- For each tool, it is weighted with respect to the total number of questions, that is, 1220.
- Once again, the MARK column is incorporated, which assesses the idea that wrongly answered questions had a negative weight in the final mark.

According to the type of learning complexity used, the answer summary is the one shown in Table 12.

Some observations are highlighted:

- Both L1 and L2 have their average at 35%.
- For L3, the average is 30%.
- The weighting of groups L1 and L2 is on 1281 questions.
- For L3, the weighting is on 1089 questions.
- The MARK column is incorporated again, which, in addition to absorbing the difference between the percentages, also considers the idea that the wrongly answered questions were subtracted.

4 | DISCUSSION

The general quantification (between years and according to average grades) does not show a significantly high value with regard to the teaching experience of gamification. Thus, it cannot be said that the exposure of content in a gamified way offers a higher hit rate or general grade in students. These academic performance results are consistent with other studies, such as References [1,25], in which it cannot be concluded that gamification improves performance.

In general, the analysis of all the variables does not allow us to affirm that any option has stood out significantly from the rest. So, it can be stated that the general behavior of results has been quite homogeneous with respect to the expected results. Even though the homogenization was detected, the combination between T3–L3 (Socrative—Visual & Relationship) stands out, being able to affirm that this is the best combination of tool and learning complexity. Similarly, the worst combination was T2–L2 (Mentimeter—Comprehension). In fact, in the independent comparison between tools and learning complexity, it was T3 (Socrative) that obtained the best success ratio. And with regard to the learning complexity used, although all the values are similar, L2 (Comprehension) stands out very slightly. So, regarding the gamification tool, it can be stated that T3 (Socrative) is the one with the best results. We recall that this tool is not so competitive and that in the classroom the tool was used in groups of four to five students. These findings agree with some other studies, where the achievement orientation in gamification was promoted but not in a competitive way [27].

Taking into account the new and exceptional scenario with which the teachers and students have had to face due to virtual classes, the presentation of content has been optimal. The lower efficiency of global results has not been appreciated. Moreover, the contents have been

FIGURE 7 Mentimeter—Lexicon example (The correct answer is the second one: "Sección transversal de un buque en el punto de mayor manga"—Spanish language)

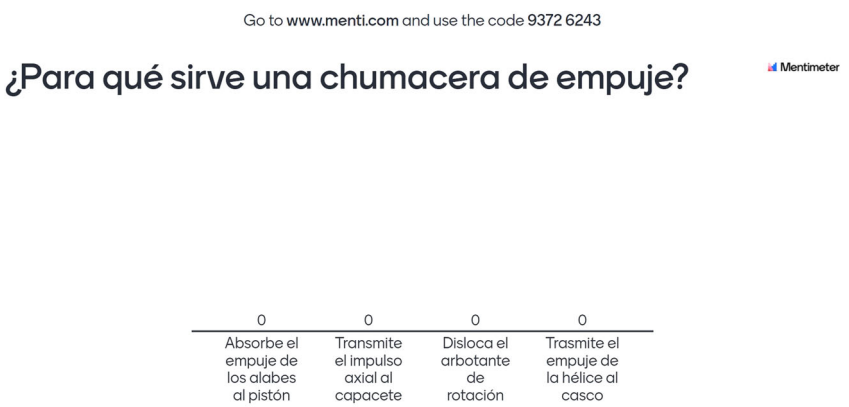


FIGURE 8 Mentimeter—Comprehension example (The correct answer is: "Trasmite el empuje de la hélice al casco"—Spanish language)

FIGURE 9 Mentimeter—Relationship example (The correct answer is: "Starboard"—Spanish and English languages)

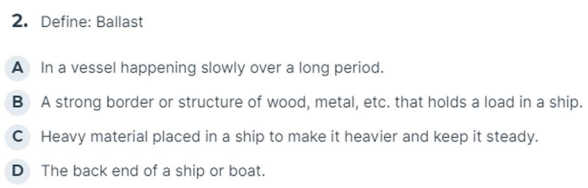


FIGURE 10 Socrative—Lexicon example (The correct answer is option "C"—English language)

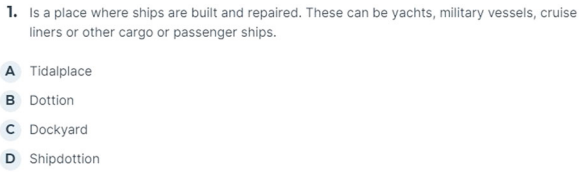


FIGURE 11 Socrative—Comprehension example (The correct answer is option "C"—English language)

FIGURE 12 Socrative—Visual example (The correct answer is option "B"—Spanish language)

TABLE 9 Summary and comparison of exam marks between the years 2017 and 2021

	Years				
	2021	2020	2019	2018	2017
Number of exams	61	65	65	47	49
Minimum mark	4.67	3.71	5.10	1.54	2.80
Maximum mark	9.75	9.00	8.00	10.00	9.00
Average	7.59	7.92	6.87	3.86	7.02
Median	7.67	8.18	7.00	3.85	7.16
Standard deviation	1.29	1.11	0.65	1.69	1.26

TABLE 10 Detail of final results for each combination of tool and learning complexity

	Correct	Incorrect	Blank	Total	MARK
T1–L1	329	58	40	427	7.37
T1–L2	350	61	16	427	7.84
T1–L3	270	31	65	366	7.17
T2–L1	338	66	23	427	7.53
T2–L2	320	68	39	427	7.10
T2–L3	271	49	46	366	7.07
T3–L1	349	55	23	427	7.85
T3–L2	348	41	38	427	7.91
T3–L3	318	30	18	366	8.48

TABLE 11 Comparison of final results by tools

	Correct (%)	Incorrect (%)	Blank (%)	MARK
T1	32.8	32.7	39.3	7.47
T2	32.1	39.9	35.1	7.24
T3	35.1	27.5	25.6	8.06

TABLE 12 Comparison of final results by learning complexity

	Correct (%)	Incorrect (%)	Blank (%)	MARK
L1	35.1	39.0	27.9	7.58
L2	35.2	37.0	30.2	7.62
L3	29.7	24.0	41.9	7.57

taught in a dynamic, entertaining, and active way. Participation and attendance have always been high (between 58 and 67 attending students of 70 enrolled students, see Table 6); it can be said that regarding student engagement, this experience leads to higher student motivation, as in References [7,16,18,31]. Some important factors that have been taken into account were the game design and student diversity when responding to gamified elements, as in References [24,29,34], using here different gamification tools and different learning complexity. In general, no student has been left behind, neither in the use of tools nor in the transmission of teacher–student information. As for technology, this experience has not been a problem, as the students have smartphones, tablets, or laptops, as considered in References [3,8,39]. The contents presented, as well as the tools, have fit perfectly within the tools that the institution has provided to its teaching staff. Likewise, the contents have all been able to be translated from their original format to the different learning complexity used. The adaptation of classes to online learning has meant higher workloads and stress than face-to-face classes for higher education faculty, as stated in Reference [30]. Several challenges concerning online education during the Covid-19 lockdown have been considered in this implementation, such as the quality of online teaching that students received [4], the correct adaptation of teaching to the online format, including the classes, assessment methods, the contact with other students and teachers [15,33], and students' boredom due to prolonged lockdown [6].

The final evaluation has been, compared to the traditional one carried out before the 2020–2021 academic year, very dynamic and efficient. In addition, the correction has also been improved: no mistakes and almost immediate correction speed. Conducting assessment remotely has been another challenge in teaching–learning activities [20].

4.1 | Limitations of the study

The results of this study should be interpreted in the context of some limitations, which can be addressed in future research.

This experience has been carried out under a triple new scenario: (1) the virtuality due to the Covid-19 pandemic, added to, (2) the gamified training of the explained experience, and (3) the assessment (exam) carried out not face-to-face and online using new tools. This triplet of novelties undoubtedly masks and adds noise when trying to assess the initially established objectives. So, if we wanted to reproduce the test in the future, it would be difficult to resimulate the low context conditions under which this study was carried out.

It should also be noted that the exams of all the years have been different in their questions, so it is risky to make a direct comparison between the marks obtained by the students. In addition, the final analysis is based on

the examination of the students, and as in any exam, it is impossible to ensure that the knowledge acquired by the students is the sole result of the presentation of information in the classroom.

The design of the experience has not been entirely satisfactory since the same number of concepts have not been worked on for the L3 group as for L1 and L2. This situation, for practical purposes, has made it difficult to quantify and analyze the final data. While it does not dilute the results, it does make it difficult to manipulate. The problem would have been solved, for example, increasing the questions from 60 to 90 (10 questions per Tool–Learning complexity pair) and proportionally increasing the exam time.

4.2 | Future research

This study could be continued in the future. In this way, it would serve to broaden the results and conclusions that show clearer patterns regarding gamification within the classroom. Furthermore, this experience can be extrapolated to other subjects in which the content to be covered (glossary) is similar. In relation to possible extensions to this study, it is difficult to establish new learning complexity, although learning complexity 3 could be divided into two: visual and content relationships. So a new learning complexity would be added (going from 3 to 4). The same is not the case with gamification tools as it is probable that new tools will emerge in the future to be incorporated into future studies. Many gamification tools have been found to be extremely powerful, and the factor that was really valued was the design of the learning complexity than the tool itself. This fact introduces a very powerful idea: in gamification, the design of the game to be carried out is more important than actually using a specific tool. Taking the idea to the extreme, it would be possible to work with a single tool (the most powerful and flexible), including badges and adapting different strategies to it. Another suggestion for future lines of research would be to conduct interviews or to collect some qualitative data to assess students' motivation or engagement while using these gamification tools.

5 | CONCLUSIONS

This study assesses the academic performance of some themes of the subject Shipbuilding Principles of the Universitat Politècnica de Catalunya · BarcelonaTech (UPC) through the use of different gamification tools and learning complexity. This study has been based on the promotion of new learning strategies, fostering active learning. The use of gamification has greatly increased the interaction between students and teachers. It is important to note that in a remote environment, being able to increase this interaction is in itself an added value. Presenting information in a novel way has itself created new and high expectations. The expectation of novelty has turned out to be a motivating vector in its own right. The key issue of each of the gamification tools used (T1, T2, and T3), more than their aesthetics or level of usability, has been the type of challenge that was proposed to the students. Kahoot! (T1) introduces the idea of peer challenge without teacher supervision; students compete in real-time with each other (who is faster? who knows more?). Mentimeter (T2) plays with the challenge supervised by the teacher; it is the teacher who asks the question and the only one who knows the answer, there is no challenge among the students. Finally, Socrative (T3) is based on the particular challenge, without competition between peers; the challenge is only personal, apart from the rest of the teammates. Regarding the learning complexity used (L1, L2, and L3), they are based on different learning complexity: Lexicon (L1) where a word is memorized and associated with a concept; Comprehension (L2) makes a concept understood and is related to a specific term to be memorized; and Visual & Relationship (L3) that relates a term/definition to a visual image, or to other related terms.

From the results obtained, it can be stated that the use of gamification tools, even offering a good result compared to previous academic years, did not provide a significant improvement in the overall grade for the class. Regarding the tools, the one that presented a slight advantage over the rest was Socrative (T3), based on the particular challenge, without competition between peers or groups. Regarding the learning complexity, all presented a similar level of success. Finally, the combination that stood out among the rest was the one that combined T3–L3 (Socrative—Visual & Relationship). In other words, the one that used a noncompetitive gamification tool with the presentation of visual or relational content. This experience of gamification had a positive impact on student motivation, class attendance, participation, collaborative learning, and the classroom climate, which is key in a scenario like the current one, with an adaptation of classes to online learning due to the pandemic. The fact of using different gamification tools has favored the possibility of offering competitive group learning strategies as well as alone. In general, the reality has been to share group reactions. Virtual gamification has undoubtedly made it possible for different talents to develop and adjust to different requirements. In other words, the environment has been presented as fluid, adjusting both to the characteristics of the student and to the good practices designed.

One of the advantages of digital tools is fast feedback. In addition, the time invested in presenting each content block has been found to be very efficient.

CONFLICTS OF INTERESTS

The authors declare that there are no conflict of interests.

AUTHOR CONTRIBUTIONS

Conceptualization: Alejandro Leon. *Methodology*: Alejandro Leon and Marta Peña. *Software*: Alejandro Leon. *Validation*: Alejandro Leon and Marta Peña. *Formal analysis*: Alejandro Leon. *Investigation*: Alejandro Leon and Marta Peña. *Resources*: Alejandro Leon and Marta Peña. *Writing—original draft preparation*: Alejandro Leon] and Marta Peña. *Writing—review and editing*: Alejandro Leon and Marta Peña. *Supervision*: Alejandro Leon and Marta Peña. Both authors have read and agreed to the published version of the manuscript.

DATA AVAILABILITY STATEMENT

The data and materials that support the findings of this study are available from the corresponding author upon reasonable request.

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