

Article

# Learning Course: Application of Gamification in Teaching Construction and Building Materials Subjects

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**Abstract:** This paper presents the experience of a group of Construction and Building Materials lecturers following the introduction of a new contest-based gamification activity aimed at improving interest and learning outcomes in the course. Students' motivation is of key importance in utilizing educational activities for study and learning in the subject. Evaluation is essential and, therefore, the proposed action makes it possible to earn an extra point in the continuous evaluation that contributes to passing the subject. The outcomes obtained in the first academic year in which this learning contest was implemented allow us to conclude that the activity had positive effects on motivation and the learning process, as well as on the number of students passing the subject. The students' opinion about the activity was very positive.

**Keywords:** gamification; active learning; cooperative learning



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## 1. Introduction

Learning is an activity of the mind that requires a complex process which some authors have described as the dynamic construction of concepts through the association of incoming information with experience [1]. Undoubtedly, the individual's motivation to learn plays a fundamental role in this process of constructing knowledge [2,3].

It is a proven fact that students' motivation and participation in the learning process is a key element in education. The motivation with which students undertake academic activities, both inside and outside the classroom, is one of the factors that determines the learning level they are going to attain [2,3]. The motivated student starts working sooner and therefore invests more effort and time compared with the unmotivated student. This is a reality that all lecturers encounter in their experience, particularly university lecturers, when they realize that no matter how much effort they invest in good teaching and knowledge transmission, not everything depends on the teacher's attitude. Lack of motivation represents a serious problem in teaching.

Various studies have associated students' motivation to learn with positive emotions [4–6]. Likewise, emotions have been highlighted as one of the most important elements generated from students' motivation [7], and a relationship between intrinsic and extrinsic motivation has been found to exist with happiness and vitality [8].

In today's society, the ease of access to digital technologies, in particular video games, the Internet and social media, and their high capacity for capturing attention and creating dependency, makes their presence massive in our environment. This has tremendous advantages in terms of quick access to all types of information, and an ability to relate to large numbers of people in a way that would otherwise be impossible. Nonetheless, beyond the clear dependency that this technology and these social media create, to a large extent superficial and artificial, is the subjective acceleration of the passage of time and the need for immediate gratification. All of this makes it difficult for today's student to connect to the rhythm of a class. In addition to dynamic adaptation of education, the adaptation of

the objective of the learning to the new demands of the job market is necessary, specifically regarding more attractive techniques.

With these boundary conditions, the use of games offers considerable educational benefits. Diverse studies highlight the effectiveness of transferring game-based elements and learning methodologies to the classroom for promoting assimilation of the complex concepts present in different areas of the curriculum [9–11]. Furthermore, they offer immediate feedback, information on progress and rewards that motivate that progress [12]. Gamification constitutes a technique based on the application of game-based elements in non-recreational contexts [11–13]. Accordingly, gamification is understood to be the application of elements and dynamics of play (points, rewards, gifts, etc.) in non-recreational or entertainment-oriented activities, such as the case of the aim of this paper, university education, for the purpose of achieving the proposed objectives.

In the literature, there are numerous works on the use of gamification in university education, particularly through the computer application Kahoot [14–18], that have obtained significantly positive results. D.T.A. Lin, et al. [14] did an extensive study based on surveys to analyze the extent to which the use of Kahoot improved undergraduate students' learning. This work was carried out with students of "English for the Media", which covers theoretical and practical contents. Their results highlighted its effectiveness in encouraging and reinforcing learning in both dimensions. J.M. Campillo-Ferrer et al. [15] examined the effect that a gamification activity based on Kahoot carried out in "Teaching Social Sciences", a second-year compulsory subject of the Primary Education degree at the University of Murcia, had on students' level of motivation and learning. They found that this teaching technique improved students' understanding of some concepts, increased their active participation in class and motivated them towards learning. In the same field of knowledge, J.P. Hernández-Ramos et al. [16] studied the influence of using a teaching methodology gamified with Kahoot in higher education, based on the students' opinion of several educational degrees. In this case, students expressed a positive opinion about the usefulness of the teaching technique to help improve motivation for the study of the subject, particularly when used for self-study and self-evaluation. However, they were not convinced that the gamification methodology had potential to be more effective than other traditional methodologies. A.M. Díez-Pascual and M.P.G. Díaz [17] studied the use of the computer application Kahoot in the chemistry area. They found an improvement in the teaching–learning process of the students who used the tool, in comparison with the control group that did not use it. The academic results showed an enhancement with an increased frequency of use of Kahoot. M. Stoyanova et al. [18] aimed to analyze the influence of gamification in the subject of mathematics with Kahoot on the students' learning process and emotions. The results obtained showed that the students were happier, more motivated and more focused on studying mathematics with the use of the teaching technique.

In the Construction and Building Materials I and II subjects, the authors have been working for over a decade on various actions for combining active teaching and evaluation methods with the traditional model in order to improve learning. Various innovative initiatives have been introduced to make students take a more active role in their learning process, while increasing the chances of improving their motivation using more current and engaging techniques. Cooperative learning activities and group projects are prominent among them, due to their good outcomes.

Through the experience acquired over all of these academic years, it has been observed that, despite the demand that students be more active, they have a general tendency, whenever it is possible, towards passivity. This may be because they encounter the same demand in all their subjects and feel overwhelmed by the large number of tasks and activities that accumulate. In addition, based on the experience of the authors, when a technique is applied in several subjects for two years, as happened in our case with gamification using Kahoot, it is no longer an attractive novelty for students and changes must be introduced in the teaching technique. Thus, the rate accelerates at which something ceases to be subjectively new, losing the interest that the new provokes in students. Lastly,

it should be noted that, due to the global crisis in the construction sector in recent years, the interest in studying civil engineering, which most people, due to ignorance, associate exclusively with new construction, has experienced a significant fall. In this way, the grade with which the students access the career, as well as their motivation, has been decreasing, particularly significantly in the last five years. Approximately 30% of the new students accessed the degree in the second call, coming from other degrees which their grade did not allow them to access. The grade of almost all of them was the minimum to access university studies.

In the 2018–2019 academic year, an innovation activity based on gamification was introduced with the proposal of a learning contest aimed at improving the students' motivation to study and learn about construction and building materials. The application of gamification activities to improve students' motivation to learn about construction materials in previous years, through the Kahoot computer application, has been positive, demonstrating that this methodology is viewed favourably by the students, despite starting to show stagnation in the interest in this software, based on the surveys and meetings conducted.

In this last academic year's project, the goal was to improve the outcomes obtained in other gamification activities by organizing a subject-matter knowledge contest between the students. The aim was to improve academic outcomes through the use of motivating activities. By participating in this contest, the students were able to earn additional points towards their continuous evaluation grade. This technique, attractive for its play-oriented and competitive nature, could help reduce the students' passivity and increase their motivation for learning the subject content, as they perceive the activity as helping them to pass the subject and improve their grades. Furthermore, activities that are intrinsically motivating can increase interest in the subject beyond simply achieving a passing grade, and lead students to acquire useful knowledge for their professional future.

The significance of this paper relies on the experience of using gamification techniques to foster interest and improve students' learning in the subjects of Construction and Building Materials. Prior experiences of the authors, based on the use of well-known computer applications such as Kahoot, are made note of as a previous step of the gamification now being analyzed, but are out of the scope of the paper.

## 2. Motivation of the Construction and Building Materials Student

All lecturers know that the motivation with which students approach academic activities is a key factor in the learning process. The motivated student starts working sooner, concentrates better on what they are doing, is more persistent and dedicates more time and effort than the unmotivated student. Therefore, it is understood that promoting the interest of students in the subject will always be a key aspect. To improve motivation and learning strategies, it is necessary to examine and assess our teaching patterns in relation to their effect on students' motivation, providing adequate feedback on the same. The authors have decided to dedicate this section to reviewing the most significant aspects of students' motivation, as it is one of the basic and most influential factors in the innovations introduced in the Construction and Building Materials subjects.

After a year of university studies at the Escuela de Ingenieros de Caminos (Civil Engineering School) at the Universidad Politécnica Madrid (UPM), the second-year student has already acquired the habit of studying, as well as synthesis and analysis capacities; tools that are fundamental for progressing individually based on the teaching received [19]. Nonetheless, these habits generally need to be further developed and consolidated, an important aspect to keep in mind when approaching teaching and assessment methods to be used in the subject. At this level, the student's critical reasoning is still limited. As a result, it is essential to foment the habits of work, synthesis, analysis and a certain critical capacity as the subject progresses, keeping in mind that this should be accomplished through actions that motivate the student to make adequate use of the same, with the accompanying satisfaction on the part of both the student and the lecturer [19].

Students' motivation is directly related to their personal and professional interests. Numerous investigations have tried to demonstrate the effect of different motivations of students regarding learning, such as the personal factors on which adequate motivation depends [4–6]. Utilizing the outcomes showed by these projects, and the different classifications that can be made depending on the author being followed, the interests of the second-year student can be summarized by the following three levels:

(a) Sole aspiration is to pass the subject. In the context of the Escuela de Ingenieros de Caminos of the UPM, this level is the most common, especially due to the fact that the first two years of the program have traditionally been difficult, with a high rate of university failure. This level of motivation is independent of the subject content; however, actions that may be regarded by the student as helpful for passing the subject will serve as an incentive for studying. As a direct consequence, the student will dedicate more time to the subject if they see it as accessible, thereby acquiring greater knowledge of its content. It is also possible that this creates favourable conditions for the student to advance to higher levels of motivation that go beyond simply passing the subject.

(b) Desire to accumulate useful knowledge for exercising the profession, which the student still sees in the distant future but is excited about. This level is much less common. Diverse studies have investigated this aspect [20], reaching the conclusion that university students are interested in acquiring knowledge when they can clearly see its relevance and utility for achieving later short-, medium- or even long-term goals. In the specific case of Construction and Building Materials subjects, as this is the first contact directly related to the civil engineering profession, the student will be attracted by anything that has a real and direct application. It should be remembered, of course, that the student is unaware of the practical utility of the subject beforehand, and therefore an essential task of the lecturer is to make this clear. As a result, it will be desirable to relate, to the extent possible, the theory and problems to real and professionally attractive practical situations.

(c) Interest in exploring specific knowledge of Construction and Building Materials more deeply. This last level of interest is only found in a very small group of students who have an exceptional predisposition for it. Despite being the interest level of very few students, it must be kept in mind to avoid discouraging them and causing them to descend to lower levels. This group of students constitutes a potential source of future researchers in the field of construction engineering, and therefore it should be supported as much as possible. This is easier if the subject has an internal coherence that enables the student to assimilate the overall knowledge schema presented, along with—and this is no less important—the gaps that require further study and development.

The teaching and evaluation methodologies must address students' three motivation levels in order to attract the students, regardless of their interests, and to optimize their performance. When approaching complementary teaching–learning tools that are satisfying for the students to use, another important aspect to keep in mind is that technology use is a strong point of today's students that is good to consider and support, in order to fully exploit it. These students generally have developed a good capacity for work with computers and computer applications which, in many cases, is also a passion for them. Moreover, they are familiar with searching for information online and making use of the resources this allows. For this reason, since the 2007–2008 academic year, a space on the Moodle platform for the subject has been opened where students can access diverse subject information that has been introduced during the academic year for self-study and self-evaluation. As more and more material has been posted, use of the platform has been quite extensive and very useful as a communication tool, particularly between students and the lecturer and between the students themselves. Specifically, the self-evaluation questionnaires provided have been widely used to study for exams.

Our experience tells us that the student is uncomfortable with and feels put-off by autonomous work in the first years, as this requires reflection and personal initiative. Students do not easily accept this autonomy, which is also necessary for them to advance smoothly in their university studies. They are also reluctant to expand on classroom

explanations by using reference books, preferring published notes and a book with solved problems, which ideally includes exams from previous years, as essential study materials. Additionally, there is a long-standing problem that students are less motivated to attend class, as they think that they can access a great deal of information on the subject at any time on the Internet, and fewer and fewer of them take notes in class. The need to counter this tendency is a great handicap. There is tremendous inertia because students today arrive at the university with significant knowledge gaps and demand methods of working which are unavailable at our Civil Engineering School due to the basic principles and objectives on which the degree rests: the substitution of personal work, and the application of reasoning to studying by using simple manuals that apply solutions to classical problems. To this, it must be added the aggravating factor of students' great concern about the high rates of academic failure in the first two years of the degree, along with the fact that, as pointed out above, in recent years students have entered the degree with a significantly lower grade and motivation.

In view of all of these conditioning factors, the authors have approached, and continue to approach, the Construction and Building Materials subjects with a series of methodological and evaluative innovations, considering the interaction between the goals the students are pursuing in their academic work and the preferred modes of addressing these in order to design adequate strategies. The empirical evidence contained in the works consulted demonstrate the effectiveness of following these trends if one wants to improve motivation and the approach to learning through adequate strategies. Therefore, the authors hope to continue seeing the positive results that they have started to see on this path. To improve, it is obviously necessary to reflect and systematically review the outcomes, as well as what lecturers are doing in class, in order to be able to evolve adequately.

### 3. Design/Methodology/Approach

Construction and Building Materials is a subject that is offered in two subjects, Construction and Building Materials I and II, in the Civil and Territorial Engineering degree of the Escuela de Ingenieros de Caminos, Canales y Puertos at the Universidad Politécnica de Madrid (UPM). Both subjects have a workload of 4.5 credits in the European Credit Transfer and Accumulation System (ECTS). These subjects are taken in the second year, in the third and fourth semesters, of the Civil and Territorial Engineering degree program and serve as the nexus between the basic subjects taught in the first year of the degree (Mathematics, Physics, Chemistry of Materials and Graphic Design, among others) and the more technological subjects taught in subsequent years (Concrete and Metal Structures, Design of Structures, Hydraulics and Hydrology, General Construction Procedures and Soil and Rock Mechanics). This is possible thanks to the study of a wide variety of materials used in civil construction, from both the purely scientific standpoint and the practical and regulatory one. Together, Construction and Building Materials I and II encompass the study of the general properties of materials—wood, metals, steel, ceramics and glass, rocks, limes, plaster, plastics, adhesives and paints, geotextiles, fuels, explosives and, naturally, a special emphasis on concrete in Construction and Building Materials II.

The changes introduced in the Construction and Building Materials subjects in the period from the 2006–2007 academic year until today have crystallized in significant changes in the teaching and evaluation techniques employed [21,22]. Classic teaching has been transformed, through master classes and evaluation based on two partial examinations and a final examination, into a much more elaborated process. This has been implemented gradually through ten educational innovation projects promoted by the UPM. These projects have focused on the introduction of cooperative learning, group projects, continuous evaluation, co-evaluation, audio-visual materials, the use of new technologies via the Moodle platform and, in the last three years, gamification. These innovative techniques have been introduced gradually, based on the students' response and the experience acquired. This has made it possible to make corrections and improvements, strengthening the learning process, whilst enhancing students' motivation.



Throughout the process, the inclusion of the Moodle platform as a tool for daily use by students has had special importance. This utilization has focused on enabling fluid communication between students and the teaching unit, with notifications of the most important dates, as well as grades. The platform provides a repository of rules, videos and images and presentations that contain relevant academic material for the subject. Additionally, it stores the exams from recent years so that the students can familiarize themselves with the evaluation systems and models of the proposed exercises.

The outcome achieved with the introduction of teaching and evaluative innovations allows the students to acquire not only knowledge, but also transversal skills in demand in the current job market. Within these transversal skills, familiarity with computer environments is of great importance, and use of the Moodle platform can be an element that helps students become acquainted with this environment [23]. In any case, lecturers must not lose sight of the fact that what makes a particular action interesting for the students is, in the final analysis, that it counts towards their final grades, which is their overwhelming concern [24]. This, in the context of gamification, is what is called rewards, which, in our experience, are necessary to incentivize the students' interest. Only a very small percentage of the students would be interested simply to deepen their learning.

One of the actions that has been confirmed to be beneficial for increasing motivation, as explained earlier, is the use of gamification. With the aim of using the technique for increasing interest, in addition to evaluating the effect of same on the motivation of the students in Construction and Building Materials, a series of Kahoot-type interactive questionnaires of knowledge and assessment of the activity were introduced in the 2016–2017 academic year. Once the results of the opinion questionnaires from two academic years were analyzed, the influence of the gamification activities up to then in learning (based on the answers to the question: “did the gamification technique (Kahoot) help you to achieve a better understanding? Very much, quite, average, a bit or null”) was considered by over 80% of students to be positive or very positive. In the case of the relationship between gamification and increased motivation (based on the answers to the question: “does the use of Kahoot forment your motivation to study the subject? Very much, quite, average, a bit or null”), the positive influence of the methodology, in the opinion of the students surveyed, was also preponderant, although to a slightly lower degree, around 75%. The authors began to observe a decrease in the attraction to the technique and the computer application as its use was more extended into various subjects. This point was confirmed at the meetings organized with the students to collect their opinion in more detail; that is what we call a “focus group”. The authors organized two or three focus groups in order to establish a more direct communication among students and lecturers. These focus groups were organized to analyze and evaluate students' opinions regarding three or four key questions to encourage debate and dialogue in groups of around eight people. The participants were selected with an effort to be heterogeneous with respect to the diversity existing in the subject in terms of sex and academic performance. Through this procedure, the authors sought information regarding students' concerns, feelings and attitudes, so that the lecturers' prejudices or opinions did not affect the results, as may sometimes occur when applying other techniques such as surveys or structured interviews [25]. Valuable information on student opinions is obtained from these meetings and also, in our experience, these activities might help to improve students' motivation as they feel their opinion being actively valued and more involved in the design of teaching activities.

Based on these results for the introduction of gamification by using Kahoot, and with the idea of utilizing the potential improvement in the interest of students in their learning, and the results of the same, to help them consolidate the knowledge in an enjoyable way, a learning contest activity was proposed. In the approach of the activity considered in this paper, firstly in class, the students were given an explanation of the dynamics of the contest, the tools to be used in its preparation and its mechanics. They were also informed of the dates scheduled for a preparation workshop and of the two phases of the contest.

The participants were divided into four-student groups. Each group, in an assisted autonomous way, prepared part of the material of the curriculum on which they would later have to answer questions in the form of various tests during the contest phase. As the contest subject matter formed part of the curriculum, participation in the contest was oriented towards improving academic outcomes, which helped them to prepare the material needed to pass the subject.

To study the subject matter for the contest, the lecturers prepared and selected materials to be used throughout the process related to the same. They selected documents, specialized articles, photographs and videos, and they were provided with a reference bibliography that they could use to expand and deepen their knowledge. The process also included guidance from the lecturers in the form of tutorials and an optional workshop lasting an hour and a half. The groups that so desired, on a voluntary basis, used group tutorials to request guidance from the lecturer in preparing the material. During the workshop, also offered on a voluntary basis for each group enrolled, the students shared the material they had prepared individually, developing and advancing in the subject matter jointly with the lecturer. The lecturer, together with the different groups, improved the learning that they were developing, clarified doubts and corrected errors, proposing a global discussion on the aspects that all the participating students had shown the most interest in.

The contest was organized in two phases: an elimination round and a final round. Each phase included different sets of test questions and games on the material prepared, with an increasing level of difficulty. In the elimination round, the level of the tests ranged from low to medium. In the final round, the tests required deeper knowledge of the subject, and the difficulty ranged from medium to medium-high in the last three, in order to determine which of the finalist groups were the best-prepared. Figure 1 shows an example of a test in the final phase of the contest.



This damage is due to.....

This occurs in environments where.....

It is increased by .....which is caused by the presence of.....

The use of..... is what best works in order to avoid this problem

**Figure 1.** Example of test from the final phase of the contest. The students had to fill in the gaps.

Each phase was carried out with the presence of all the students participating in the contest. The lecturer was the moderator. Given the large number of students enrolled in the subject, the preliminary phase was developed for each class group in a different

classroom, simultaneously, with the expectation that the final three teams from each class group would move forward and, therefore, that nine groups would go on to the next phase. Lastly, due to several ties, fourteen teams passed to the final phase in practice. The final phase was developed with all students in the same room, and with only the groups that had passed the initial phase competing. All the students who participated productively in the contest had the possibility of obtaining one extra point out of ten, distributed as follows: 0.75 for the elimination phase and 0.25 for the final phase, to be added to the class grade in proportion to the tests passed during the contest.

In the Construction and Building Materials subjects, students who take continuous assessment take a weekly test throughout the academic year with the aim that students achieve a higher level of learning progressively. The mark obtained by the students who take the subject by continuous assessment has a component achieved by the active learning activities performed throughout the academic year (especially based in cooperative learning or one minute paper), to which, in the academic year of study, the learning contest is added. This component is called “mark class,” and is equivalent to 30% of the final grade. This year, the learning contest represents 10%, and the rest of the activities 20%. The rest of the mark obtained by continuous assessment is composed of two partial exams. There is the possibility of passing the subject only by exams (the mark is the average of the two partial exams); however, the reality is that the vast majority of students, around 98%, pass the subject by continuous assessment.

After the contest, a final survey was conducted to measure the students’ assessment and degree of satisfaction with the proposed activity, as well as any improvements they felt were needed. It is important to determine the influence of the activities on their personal motivation and knowledge of the academic matters for dealing with the subject.

#### 4. Outcomes

It is very important to carry out an assessment of the experience obtained from the activities implemented during the academic year in order to provide appropriate feedback. The aim is to improve the teaching activities in subsequent academic years, correcting possible deficiencies and errors. For that purpose, it is necessary to quantify the results of learning and evaluation of students, as well as collect and analyze, as far as possible, the students’ and lecturers’ opinions in relation to the learning activity.

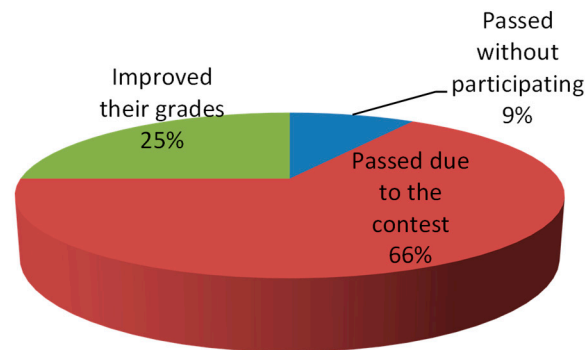
In the 2018–2019 academic year, the first year the learning contest described in this communication was held, 125 students participated, which represents participation from 53% of the enrolled students in the subject.

The students of this academic year had had a significantly lower university entrance grade, which had been progressively observed since the previous two years, and the worse results of some tests carried out in class were worrying. These conditioning factors suggested a probably significant decrease in the number of pass grades with respect to previous years. However, the number of students who passed the subject during the 2018–2019 academic year was 69% of the students examined, being 9% higher than the previous academic year and only 3.4% lower than the value corresponding to the 2016–2017 academic year. Furthermore, when considering the grade obtained regardless of the contest, the average grade obtained by the students who participated in the contest was 0.9 points higher than that of the students who did not participate in the contest. In this way, although the rest of teaching the activities carried out throughout the academic year also might be influencing in the improvement of the learning results, it can be said that participation in the learning contest had a positive effect. Figure 2, with respect to the students who passed the subject, shows the influence resulting from participation in the contest, both in terms of those who achieved a passing grade and those who passed without it but improved their final grade. It can be said that the influence of the contest in this sense was highly favorable. As shown in the graph, 66% of the students who passed (pass grade) did so thanks to their participation in the contest, and 25% of them improved their grades (with



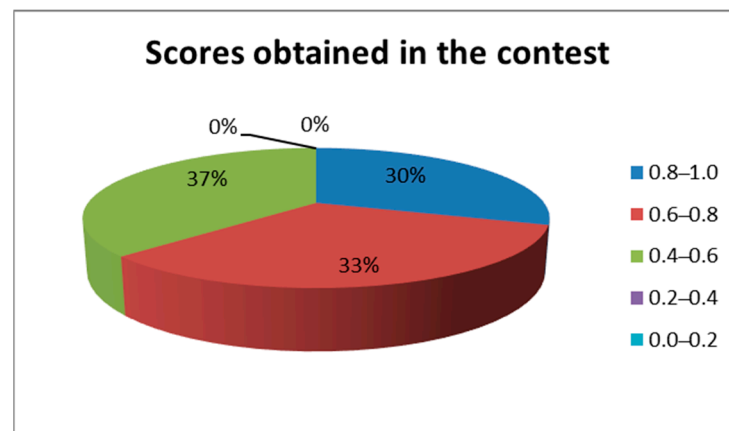
an average mark slightly higher than 7). Only 9% of the students who passed the subject, obtaining an average grade of around 5, did not participate in the contest.

### Influence of the participation in the contest on the students who passed



**Figure 2.** Influence of the participation in the contest on the students who passed.

The score achieved from participation in the contest, to be added to the class grade, is shown in Figure 3, divided into five segments with intervals of 0.2 points each. The figure shows that all of the students achieved a score above 0.4, highlighting the fact that the score obtained was between 0.8 and 1 point in 30% of the cases. Therefore, the score obtained was significantly good, allowing the improvement of results shown in Figure 3.



**Figure 3.** Scores obtained in the contest.

An opinion survey with only one question was conducted with the students who had participated in the activity to find out whether they felt that the activity had a negative, neutral, positive or very positive effect on motivation. Over 87% of students expressed a positive or very positive opinion of the activity in terms of motivation. In the same way, the opinion about the learning contest expressed by the students in the focus groups was very positive. The participants in the focus group believed that this technique based on gamification could contribute significantly to improving the possibilities of increasing learning and better consolidating knowledge of the subject. Furthermore, participation in this activity encourages the student to work on fundamental transversal skills for the professional future of the current civil engineer, mainly the ability to work in a team, autonomous learning, logic and critical reasoning. However, additional work is necessary to be able to quantify the learning of these competences that is left for the future.

The authors have valued the experience regarding the learning contest very positively in the meetings of the teaching unit. In order to quantify their opinion on this teaching

activity introduced, the lecturers involved in the learning contest have answered a brief survey based on the research in autonomous learning performed by Marcé-Nogué et al. [26], as the elements evaluated could be applicable to the case of the present work. Following the cited authors, the opinion of the lecturers on the learning contest was valued through four aspects: the balance of the workload carried out by the lecturers and the students (workload balancing), an adequate student level of academic maturity required for performing the activity (maturity), the effectiveness of the learning process (effectiveness) and the adequacy of the structure and guide of the teaching activity (structure and guide). Each aspect was valued from zero to five, with the ideal situation being five. Table 1 shows the results obtained from this survey.

**Table 1.** Results of the lecturers' survey about the learning contest.

Aspects	Lecturer 1	Lecturer 2	Lecturer 3	Truncated Average
Workload balancing	4	5	5	5
Maturity	3	4	4	4
Effectiveness	4	4	3	4
Structure and guide	4	5	4	4
Total	15	18	16	17

Based on these results, the lecturers considered that the teaching activity obtained the results expected in all the aspects evaluated. In the opinion of the lecturers, the workload performed by the lecturers and the students was well balanced (a value of five) and the rest of the elements assessed (maturity, effectiveness and structure and guide) were properly achieved, with a value of four.

Participation in this first year of implementation of the activity was somewhat low (53% of the total number of enrolled students), but in view of the positive results and opinion of the participating students, it is thought that it will be much higher in subsequent subjects.

## 5. Discussion

The ultimate objective pursued with the teaching and evaluative innovations introduced in all the years since the 2006–2007 school year was to promote students' motivation in the subject. To do so, measures designed to capture interest were taken at three different levels, the results were analyzed and changes were made based on them. Firstly, there is an attempt to provide sufficient opportunities to pass the subject, so that the student views it as more accessible, but also to the student work on it in depth continuously so as to achieve good knowledge of the material. Based on experience, the use of alternative teaching methods, as well as the support of information technologies, improve the student's opportunities for learning in a way that maintains motivation while also boosting work in the subject. To maintain the attention and awaken the curiosity of the students, the authors also consider it essential to make the chosen sample cases topical and relevant, attempting to also make them surprising to the extent possible. After years of applying methodological and evaluative improvements, the authors have confirmed that some students, who simply wanted a passing grade, reveal themselves to be more predisposed to achieving a higher level of motivation and want to learn useful knowledge for their professional future. The satisfaction of the students at the highest level of interest is quite complicated. An attempt was made to achieve this by highlighting the advanced nature and benefits of the material covered, whilst also explaining the limitations more in terms of possible improvements to be made, so that the student does not have the sense that the subject is defective. The possibility to learn more about the research work of the lecturers is also offered to them. Another significant fact that indirectly indicates that students positively value this way of working in the subject is the high percentage, between 80–85% on average, of class attendance during the academic year.

In the gamification activity proposed in the 2018–2019 academic year, the objective was the use of an attractive methodology for the current students to continue with the main

purpose of attempting to motivate and improve learning possibilities. The activity, in view of the outcomes achieved, had a significant influence on the increased number of students passing the subject and earning higher grades. Based on the survey of the students, they consider that the activity had a positive or very positive effect on motivation.

Based on these premises, the authors believe that the outcomes obtained in this activity are quite satisfactory. Therefore, the idea was to continue using this learning technique during the 2019–2020 and 2020–2021 academic years. However, as a consequence of the global health emergency in early 2020 triggered by the COVID-19 pandemic, the Universidad Politécnica de Madrid (UPM) was forced to modify its teaching methodologies. UPM scrambled to adapt and apply digital systems for remote learning. Due to this, the contest could not be held during the years 2020 and 2021.

## 6. Conclusions

In the development of an educational innovation project implemented in the 2018–2019 academic year, a gamification activity, in the form of a learning contest, was proposed to improve students' interest in studying a portion of the course subject matter and to help them learn and master it.

Based on the outcomes achieved and the survey conducted, the effects of this gamification activity on the subject were analyzed. The results were positive, in terms of both the learning process and passing the subject. What was actually achieved with this teaching activity was the improvement of the students' engagement, which resulted in more of them passing the subject. Moreover, the students rated the approach of the activity very positively.

The general opinion of both the lecturers and the students, based on the surveys, focus groups and meetings of the teaching unit conducted, is that, despite the difficulties related to it being the first implementation of the activity, the experience was significantly positive. On the other hand, these methodological innovations undoubtedly require greater dedication on the part of the lecturer to the teaching task, which translates into a significant increase in the amount of time spent on teaching, as well as greater involvement of students in their learning.

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