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Team-Based Questioning Battles in Construction and Building Engineering Educational Environments: A Useful Tool for Engaging Active Learning in the Classroom

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Abstract: This manuscript presents a comprehensive exploration of an innovative active learning approach implemented in a Master's Degree in Construction Engineering program. The pedagogical intervention involved a series of competitive battles among student teams, wherein each team formulated and presented multiple-choice questions to their peers. The study aims to provide a detailed account of the implementation process, assess the effectiveness of this approach, and evaluate its impact on students' learning and motivation. The assessment was conducted through triangulation of experiences, surveys, and interviews. The results provide key insights into how Team-Based Questioning Battles can foster highly competitive environments, enhancing the learning experience, understanding, and retention of concepts, all while motivating and engaging students.

Keywords: active learning; team-based questioning battles; construction engineering programs

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1. Introduction

Several common educational problems impact university students' performance across disciplines, including Construction and Building Engineering degrees [1]. Key issues include limited engagement in lectures and coursework [2–4] and lack of motivation [5,6], which often result in decreased overall performance [7]. Additionally, students frequently face a lack of practical skills, which hampers their ability to connect theoretical knowledge with real-world applications. Essential skills such as critical thinking and communication are often underdeveloped, limiting students' capacity for analytical reasoning and problem-solving in practical engineering scenarios [8–10].

Traditional pedagogical approaches in engineering education typically emphasize passive learning, where students primarily receive information rather than actively engaging in their own learning process. This textbook–chalkboard–lecture–homework–test model, while effective in delivering foundational knowledge, may fall short in promoting critical thinking, deeper comprehension, and sustained engagement among Construction Engineering students [11,12]. This gap highlights the need for educational strategies that more effectively bridge the gap between theory and practice.

Active learning offers a compelling alternative to traditional methods in engineering education, directly addressing many of the shortcomings previously mentioned [13]. By emphasizing student-centered and participatory methods, active learning engages students in activities that require them to analyze, synthesize, and solve problems, which in turn enhances their critical thinking and practical application skills [1–18]. In the context of engineering, this approach fosters intrinsic motivation and adaptability, both of which are essential for navigating modern engineering challenges [19–23]. Active learning also promotes interaction and exposes students to diverse perspectives, creating a dynamic classroom environment that contrasts sharply with traditional lecture-based formats. This

approach significantly improves communication skills and teamwork—critical competencies for engineering professionals [24–29]. Furthermore, active learning enhances content retention by requiring students to actively engage with course material, resulting in a more profound and lasting educational impact [30–32].

Tailoring active learning strategies specifically to engineering education can thus address existing issues and better prepare students for real-world engineering tasks, effectively bridging the gap between theoretical knowledge and practical application. These strategies encompasses a broad range of strategies, from simple activities to more complex, comprehensive approaches [33,34]. These techniques can be integrated into the classroom as occasional exercises or used to fundamentally redesign an entire course [35]. Simple techniques include the following: interactive questioning, the pause procedure, one-minute papers, Think–Pair–Share, debates, Half-and-Half, concept mapping, group discussions, online research, Socratic dialogues, commitment-generating exercises, and role-playing [35]. On the more intricate end of the spectrum, active learning strategies involve Project-based learning [36,37], Cooperative-based learning [38], Problem-based learning [39–41], Team-based learning [42–45], Competence-based learning [46–48], and Challenge-based learning [49–52].

However, active learning methods present several challenges for both teachers and students, particularly in fields like Construction Engineering [53]. One of the most significant challenges is resistance to change [54]. Students who are accustomed to passive learning approaches may be hesitant to embrace active learning strategies [55]. This reluctance often arises from discomfort with new methods and uncertainty about their effectiveness. To address this, it is crucial to ensure students' motivation and engagement [54,55].

Integrating competition into active learning activities can indeed enhance motivation and engagement. However, its impact on learning outcomes remains mixed. Research indicates that competition can effectively boost motivation and participation within gaming environments [56–59]. Despite these benefits, studies have reported inconsistent effects on the actual learning of content. For instance, while competition can enhance engagement during activities, it often does not lead to improved performance in post-test scores or long-term retention of the material [54,55]. To address this issue, incorporating supplementary activities—either before or after the main competitive task—can effectively complement the core activity and help maintain student engagement. These additional activities can ensure that students are well-prepared and that the primary tasks remain challenging and meaningful.

Implementing group activities plays a crucial role in this context [42–45]. Group-work interventions foster collaboration and ensure that each student is accountable to their peers, thereby promoting individual effort and commitment. When students understand that their contributions impact the group's success, they are more likely to prepare thoroughly and engage more deeply with the task. This collaborative approach not only enhances the overall learning experience, but also ensures that students are adequately prepared and motivated to contribute effectively. By integrating group work with competitive elements, educators can create a more engaging and effective learning environment that supports both individual and collective achievement.

Additionally, breaking large classes into smaller groups can help manage class size constraints. Apart from the aforementioned challenges, we should also highlight the often-limited time constraints of a course program. The teacher's role in guiding active learning activities is crucial.

This manuscript explores the implementation and evaluation of an active learning initiative grounded in foundational techniques such as interactive questioning, group discussions, and challenge-based learning, specifically through a series of Team-Based Questioning Battles. This initiative was integrated into a Master's Degree course in Construction Engineering to address key educational challenges. The battles involved teams presenting multiple-choice questions to their peers in a face-to-face setting, fostering a dynamic and engaging learning environment. Anchored in the principles of Construc-

tivism, Game-Based Learning, Experiential Learning, and Collaborative Learning, this activity aims to create an interactive educational experience that transcends traditional teaching methods.

2. Research Question

This study focuses on investigating students' perceptions of the novel active learning strategy—Team-Based Questioning Battles—within a Construction Engineering program. The primary research question guiding this study is "How does the implementation of Team-Based Questioning Battles influence students' engagement, motivation, and learning outcomes in a Construction Engineering program?" To address this question, the study will specifically examine students' perceptions of (a) their engagement and motivation: evaluating how the Team-Based Questioning Battles affect students' involvement and enthusiasm in the learning process, and (b) their learning outcomes: investigating how this active learning strategy influences students' understanding and retention of core engineering concepts.

3. Team-Based Questioning Battles Description

To foster active learning and engage students, an innovative pedagogical approach was introduced as a culminating activity, specifically within a mandatory course, which covers fundamental concepts in structural design and seismic resistance of buildings. This course is part of the 90 ECTS Master's Degree in Construction Engineering program offered by the Escola Politècnica Superior d'Edificació de Barcelona (EPSEB) at the Universitat Politècnica de Catalunya (Barcelona, Spain). The program admits 30 new students each academic year and is taught in Spanish, primarily for Spanish-speaking national and international students.

The approach involved the use of competitive battles designed to enhance students' understanding and mastery of core concepts. This method aimed to reinforce the key content of the course, enhancing student comprehension, motivation, and retention of core concepts, while simultaneously developing essential soft skills such as teamwork, communication, and problem-solving through an engaging and challenging active learning approach.

3.1. Preparation and Structure

Before the battles commenced, teams of three–four students were tasked with creating a set of 10 challenging multiple-choice questions, each with a distinct correct answer (for both academic years covered in the study, the battles were conducted with eight teams, but the exact number of teams can be adjusted considering the available time for conducting the battles). This process required each team member to thoroughly review the entire subject matter, actively collaborate, engage in discussions with their peers, and study and learn from their teammates. Questions had to be elaborated to review the fundamental concepts upon which the course is based, covering both theoretical and practical aspects. This stage took place 2–3 weeks before the battles began, allowing sufficient time for the teacher to review each set of questions. The teacher ensured that the questions were clear, the correct answers were accurate, and that only one correct answer was provided for each question, reinforcing the importance of precision and understanding.

3.2. Competitive Battle Format

The competitive battles took place in a face-to-face format (in order to reinforce communication skills); each team presented their set of 10 multiple-choice questions to their rival team. Each battle (i.e., Team A vs. Team B) had a time constraint of 20 min. During this period, Team A posed questions to Team B within the first 10 min, and then Team B proceeded with their questions for the next 10 min. Simultaneously, the remaining teams conducted their battles, following the same procedure, to ensure that no team could anticipate the questions or answers of their future opponents.

After the completion of the initial round of battles, a new round was to be initiated. In this subsequent round, each team competed against a different rival. For both academic years covered in the study, the battles were conducted with eight teams, resulting in seven rounds and a total of 28 battles. The outcome of each battle was determined by the number of correct questions answered, with a maximum score of 10. This process continued until every team had competed against all the other teams.

The final result was determined by summing the scores from each round. The team that correctly answered the highest number of questions across all rounds was declared the winner of the activity.

These encounters required every team member to meticulously examine the entire subject matter, engage in active collaboration, and discuss the correct answer for each question with their peers. Additionally, this provided a fresh opportunity for learning by playing and competing, generating not only a deep technical understanding of the material but also significant improvement in team-work and communication skills through interactions with both team members and participants from other teams.

3.3. Knowledge Sharing

The post-battle procedure involved analyzing all prepared questions, sharing and discussing the correct answers with the entire class, and then uploading them to the course's Moodle platform. This review served as a comprehensive knowledge-sharing tool, creating a repository that allowed students to benefit from a wide range of questions covering diverse aspects of advanced Construction Engineering for study and learning.

4. Materials and Methods

To investigate the effectiveness and usefulness of a Team-Based Questioning Battles implemented, this paper employs a mixed-methods approach, combining the experience of the authors together with a detailed survey and interviews, thus bringing a deep understanding of practical nuances and ensuring the validity and trustworthiness of our findings. The integration of both qualitative and quantitative methods allows for a comprehensive understanding of the perceptions and experiences of students.

4.1. Survey Design

4.1.1. Participants

The survey was designed to gather quantitative data from all students enrolled in Building Engineering, this being a compulsory course of the Master's Degree program. The surveys were conducted over two academic years, spanning from year A to B, with a total of 55 participants.

The study encompassed a diverse group of students, providing a comprehensive overview of the demographic composition. The class consisted of 25–30 students, this being a moderate class size that favorably affected the interactive and participatory learning. The student body was notably heterogeneous, comprising individuals from various academic backgrounds, including architects (40%), civil engineers (47%), and building engineers (13%).

Beyond academic diversity, the participants reflected a rich cultural tapestry. The majority of students were Spanish speakers, representing various countries: Spain (13%), and a predominantly Latin American representation (76%) from Chile, Peru, Uruguay, Colombia, Ecuador, and Brazil, as well as Central America, specifically Mexico (7%). Additionally, students from China (2%) and France (2%) were also enrolled in the course. This cultural diversity added a valuable dimension to the study, offering insights into how students from varied backgrounds engage with and benefit from the active learning experience.

4.1.2. Questionnaire

The survey was conducted at the end of the Building Engineering course to identify participants' perceptions of the impact of Team-Based Questioning Battles on their learning

experience and overall effectiveness. Conducting the survey at the end of the course allowed us to capture students' attitudes towards the Team-Based Questioning Battles experience and compare them with their experiences of the traditional teaching practices used earlier in the same course.

The survey was carefully developed and structured in four sections, which aimed to assess the following, with respect to the student:

(1) Previous Experience with Active Learning or Team-Based Questioning Battles: questions in this section aimed to gauge students' familiarity and prior exposure to similar learning activities, which could influence their engagement and performance.
(2) Learning and Motivation Impact: these questions were included to measure the perceived effectiveness of the activity in enhancing subject comprehension, motivation, and key soft skills such as team building and communication.
(3) Study Habits and Performance: this section sought to explore how participation in the activity influenced students' study habits, preparation time, and the perceived usefulness of resources provided during the course.
(4) Preferences and Enjoyment: these questions were designed to capture students' overall enjoyment of the activity and their preferences regarding its inclusion in future courses, which are critical for evaluating the sustainability and appeal of the initiative.

The questions were crafted to assess these areas by using a combination of Likert scales and binary choices, ensuring that responses could be easily analyzed and interpreted. In total, the participants answered a set of twelve questions (which can be found in Appendix A).

4.2. Interviews

To gain in-depth insights into students' experiences, we conducted individual semi-structured interviews with a subset of the survey participants. The interview questions were identical to those in the questionnaire, but the interview format allowed students to explore, and elaborate further on, their responses. Participants were invited via email, which included an overview of the interview's purpose and scheduling options. Although all 55 survey participants were given the opportunity to participate, only 16 individuals who responded positively and agreed to further discuss their experiences were selected for the interviews, of which 25% were from Spain, 62.5% from Latin America, and 12.5% from other countries. Each interview lasted approximately 30 min and was conducted either in-person or via virtual platforms, depending on participant preferences. Detailed field notes were taken during the interviews to capture responses.

The integration of the quantitative survey findings with qualitative interview insights, alongside the authors' experience, as proposed by [60], provided a comprehensive overview of the effectiveness and usefulness of the Team-Based Questioning Battles in the Construction subject program. This mixed-methods approach ensured that the results were robust and well-rounded, offering valuable guidance for educators seeking to enhance their teaching practices [61].

5. Results and Discussion

5.1. Previous Experience with Active Learning or Team-Based Questioning Battles

The first question in Section A1 (Q1) examined how often respondents participated in active learning experiences. Most participants had some experience with active learning, with 16.4% reporting "Rarely", 47.3% "Occasionally", and only 36.4% of the participants reported "Regularly". Notably, no respondents selected "Very frequently" (see Figure 1). It is particularly significant that this activity is not a regular part of the students' educational experience. When an educational intervention is commonplace, it risks being perceived as "just another task" by students.

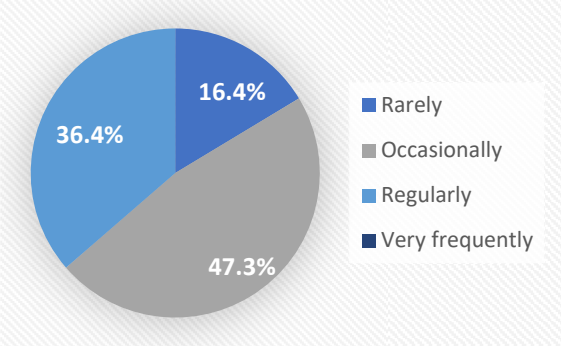


Figure 1. Frequency of active learning experiences among respondents (Q1).

The second question sought to ascertain the extent of students' involvement in Team-Based Questioning Battles during their previous or current Construction Engineering university education (Q2). The data presented in Figure 2 revealed that a significant portion of students did not experience this specific collaborative learning approach. Particularly, 78.2% of respondents had not participated before, while 21.8% affirmed their engagement in such educational activities.

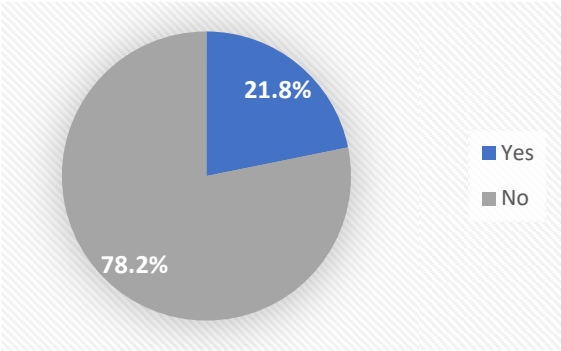


Figure 2. Students' involvement in Team-Based Questioning Battles during their previous or current Construction Engineering university education (Q2).

5.2. Learning and Motivation Impact

The first question of Section A2 aimed to assess students' perceptions on the level of competitiveness and difficulty of the multiple-choice questions posed during the team rivals during battles in the course (Q3). The results presented in Figure 3 show that the majority of respondents, 69.1%, rated the difficulty of the battle questions as "High" (49.1%) or "Very High" (20.0%). Additionally, 30.9% of participants described the level as "Medium". Notably, no respondents rated the difficulty as "Low" or "Very Low". These findings suggest that the activity successfully achieved the intended level of competitiveness and difficulty.

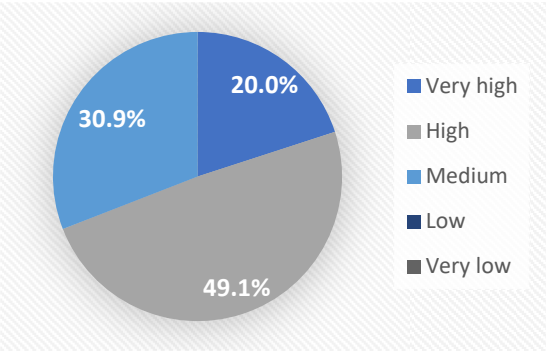


Figure 3. Students' perception of the level of competitiveness and difficulty of questions (Q3).

A certain degree of competitiveness and challenge in educational activities can be valuable for fostering student engagement and effective learning. From our experience, we observed that including a competitive element helps keep the activity challenging and meaningful without creating unhealthy rivalry. This approach helps prevent students from crafting overly simplistic questions to meet minimum requirements, thereby preserving the educational value of the exercise. The goal is to motivate students to engage more deeply with the material, challenge themselves intellectually, and take the exercise seriously.

As stated in the introduction, competition does not always enhance learning content. Thus, the second question of this section aimed at assessing the impact that the team-based battles had on enhancing student's understanding and retention of subject concepts (Q4) (see Figure 4). Results show that the substantial majority (72.7%) rated the impact as "Very high and 27.3% rated the impact as "High". Remarkably, no respondents selected "Medium", "Low" or "Very low", indicating a unanimous consensus among participants that the activity had a substantial positive effect in the understanding and retention of the subject.

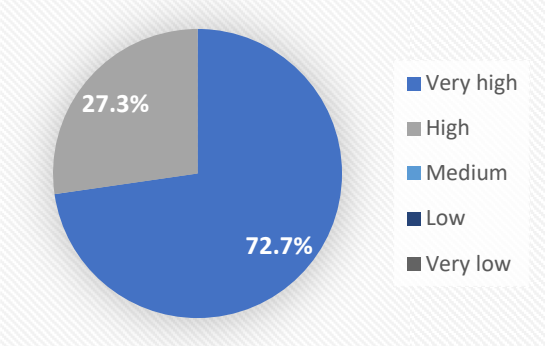


Figure 4. Student's perception of how the activity helped them in the understanding and retention of subject concepts (Q4).

These results align with some of the comments gathered in the interviews; for example, interviewee No. 3 stated: "*I believe that in a few years, I will remember the experience and the questions from the battles more than other class content. Doing it as a group, playing, and having such a good time will make it unforgettable*". The effectiveness in enhancing understanding and retention can be attributed to the activity being structured in three stages and conducted in groups, which encouraged greater student engagement with the activity. This is further supported by comments from the interviews. For example, interviewee No. 3 also noted: "*This structure made us more involved and attentive, as each stage built on the previous one, and working in groups allowed us to share insights and clarify doubts together*".

The question that intended to assess the impact of the activity on improved team-building skills (Q5) reveals a positive trend (see Figure 5). A significant portion of respondents, totaling 91.0%, rated the impact as either "Very high" (45.5%) or "High" (45.5%) indicating a substantial positive influence on team-building skills. In contrast, a relatively small portion of students (9.1%) rated the impact as "Medium". Furthermore, the absence of responses in the "Low" and "Very low" categories reinforces the notion that the majority of participants experienced a meaningful impact on their team-building skills. In this sense, some comments raised by the students during the interview are in agreement with these percentages; for example, interviewee No. 5 stated: "*The activity has compelled us to review content, but it has also prompted us to gather with our team and make the effort to exchange ideas and reach agreements to formulate the best possible questions. Additionally, it has encouraged discussions about the potential answers posed during the battles. I believe it has helped strengthen bonds with team members*".

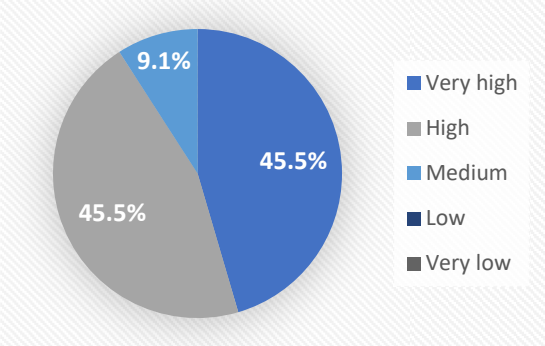


Figure 5. Students' perception of how the activity improved their team-building skills (Q5).

The results of the question regarding the impact of the activity on improved communication skills (Q6) reveal a generally positive perception among the participants. However, these results also highlight the fact that the activity has not been perceived as overwhelmingly positive compared to the team-building aspect (Q5). A majority of respondents perceived the efficacy of the activity in enhancing communication skills as either "Very high" (54.5%) or "High" (25.5%), while a smaller proportion rated the impact as "Medium" (18.2%) and "Low" (1.8%); none rated it as "Very low" (see Figure 6).

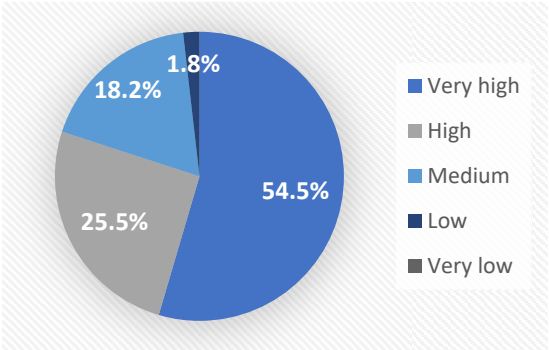


Figure 6. Students' perception of how the activity improved their communication skills (Q6).

Finally, the last question of this section aimed at evaluating the impact of Team-Based Questioning Battles on overall motivation to learn; (Q7) revealed a notably positive trend (Figure 7). A significant majority of respondents (69.1%) rated the impact on their motivation as "Very high" and 29.1% assessed the impact as "High". Only a small percentage (1.8%) rated the impact as "Medium". This aligns with the interview insights, where students expressed enjoyment, and the perception of a motivational appeal; for example, interviewee No. 10 stated: "*The activity seemed very entertaining to me, even though it was mentioned that it wouldn't be graded. The competition among groups motivated us to exert more effort, and personally, I greatly enjoyed that*". Additionally, this reinforces the point made in the literature review that competition can increase motivation and participation in gaming environments [56–59].

In summary, the analysis of the learning-and-motivation impact section presents a thorough and positive evaluation of team-based questioning battles as an educational tool. Students generated a competitive environment by formulating high-quality and challenging questions, and such a circumstance, together with the activity dynamics, contributed to heightened motivation to learn. This underscores the effectiveness of the activity in establishing a stimulating and engaging learning atmosphere. Furthermore, the activity was positively perceived as a tool for enhancing communication skills, but specially in improving teamwork.

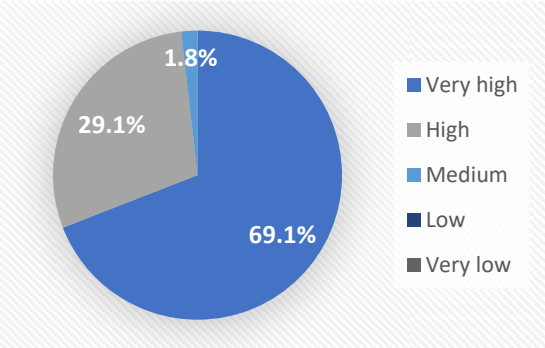


Figure 7. Students' perception of how the activity improved their overall motivation to learn (Q7).

5.3. Study Habits and Performance

According to the results presented in Figure 8 the majority of students (90.9%) reported dedicating a substantial amount of time to prepare for Team-Based Questioning Battles (Q8); in particular, 63.6% of the students invested between 2 and 5 h, and 27.2% invested more than 5 h. This suggests a significant level of engagement and effort invested in readiness for the activity. On the other hand, 9.1% of students reported spending less than 2 h on preparation. In this regard, during the interviews, some students (interviewees No. 5 and 13) remarked: "*The session has been very productive. If I were to do it again, I would have devoted even more time to both preparing the questions and reviewing for the battles*" and "*It has been great to see the fruits of the previous efforts in getting the questions right. In any case, if the activity were to count toward the final grade or be rewarded in any way, I would have dedicated even more time to the activity*".

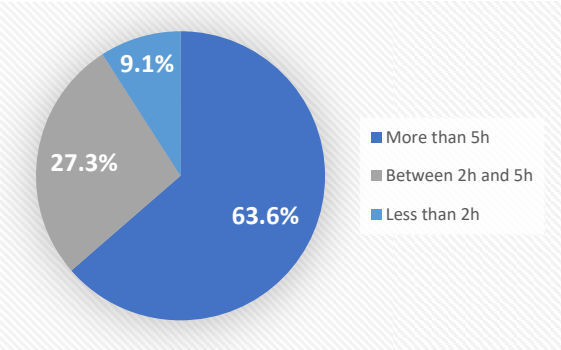


Figure 8. Students' dedication to preparing for Team-Based Questioning Battles (Q8).

A positive trend is observed in response to question Q9 (see Figure 9), with the majority (56.4%) expressing a positive likelihood of utilizing the repository for further learning or reference. This is evidence that a substantial portion of students recognize the value of having access to the question repository and intend to leverage it for ongoing educational purposes. Another sizable portion (43.6%) indicated a neutral stance, which may imply a need for further exploration or clarification of the potential benefits of utilizing the repository. Notably, no respondents expressed a negative likelihood, indicating a general acceptance or openness to the idea of utilizing the repository for future learning or reference.

A noteworthy aspect of this innovative approach could be the incorporation of selected battle questions into the final assessment. The teacher, based on the quality and relevance of the questions, could strategically include some of them in the final test. In this regard, some of the interview insights (interviewees No. 2 and 14) i supported such reflection: "*Even though I plan to go through all the questions again, it would be advisable to merit somehow the work done*" and "*Including some of the questions from the winning team in the final exam could be a meaningful way to acknowledge our efforts*".

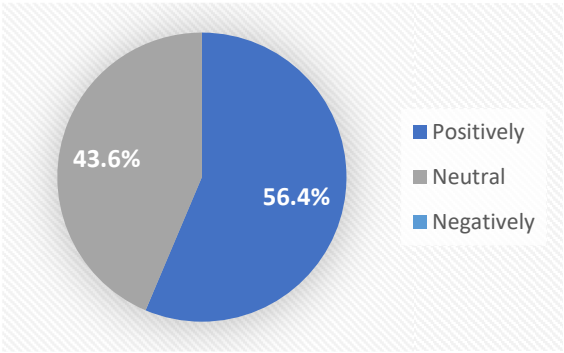


Figure 9. Students' preferences on likelihood of utilizing the repository for further learning or reference (Q9).

Such a circumstance aligns with the comments received regarding the prior preparation time, so including or rewarding the activity would translate into the study time both before and after the battles and, consequently, into the positive benefits of the activity and the students' learning.

5.4. Preferences and Enjoyment

The first survey question of this section inquired about the participants' enjoyment of the Team-Based Questioning Battles experience (Q10) and the second survey question delved into the participants' willingness to recommend the repetition of the Team-Based Questioning Battles activity in future courses (Q11). The data presented in Figure 10 revealed unanimous enthusiasm among respondents; 100% of students provided a positive sentiment in both questions. This unanimous endorsement underscores not only the potential of Team-Based Questioning Battles as an enjoyable and engaging educational tool, but also stresses the potential for its incorporation into future educational modules (even in other subjects).

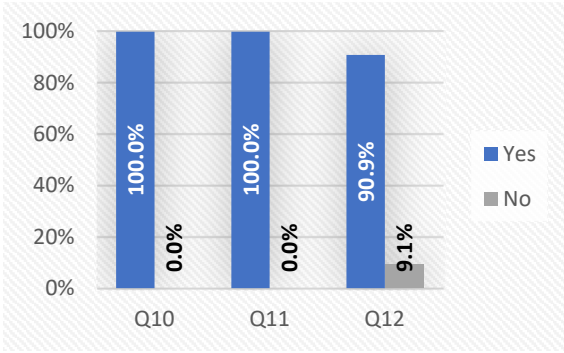


Figure 10. Students' answers about preferences and enjoyment regarding the Team-Based Questioning Battles experience (Q10, Q11 and Q12).

The potential benefits of repeating the Team-Based Questioning Battles throughout the course (Q12) was also supported—the majority of students expressed a positive stance, stating that they believe that the periodic repetition would be beneficial. However, a non-representative marginal minority (five students) held a contrasting view, stating that the frequent use of this approach is unnecessary.

In this regard, an analysis of interview insights revealed several potential reasons contributing to this observation, which include interviewees No. 7, 9 and 11: "*I worry that frequent repetitions could compromise our ability to cover all the essential content in a timely manner*"; "*If done too frequently, it might become lose its excitement over time. We might disengage if we feel we already know what to expect*" and "*Spacing out the activity and strategically integrating*

it at key points in the course would be beneficial. This way, we can keep it fresh and exciting without it becoming routine".

Based on this feedback, it is important to emphasize that, although the presented approach is enjoyable and educationally beneficial, the activity itself is time-consuming. Depending on the number of groups, it may take up to three hours for a medium-sized class to complete all the rounds. Repeating it throughout the course may compromise the timely delivery of the curriculum content and might lead to a decrease in novelty, potentially causing the activity to become predictable and/or less exciting. Based on our experience, we recommend incorporating the activity as a final wrap-up of the course or within a specific block.

6. Conclusions

The implementation and evaluation of Team-Based Questioning Battles were purposefully designed to address critical issues such as understanding, retention, motivation, and overall effectiveness. This manuscript aimed specifically to answer the research question: how does the implementation of this activity influence students' engagement, motivation, and learning outcomes in a Construction Engineering program? To address this question, a comprehensive study of participants' perceptions was conducted, encompassing experiences, surveys, and interviews. The results revealed that students consistently recognized the positive impact of this approach on their learning experience. Key findings include the following:

- Students unanimously perceived the activity as highly competitive and dynamic, effectively fostering active learning—an outcome that aligns with the broader advantages of such methods in creating an engaging and multifaceted classroom environment.
- The team-based structure facilitated the development of critical thinking and collaborative skills, while also promoting individual effort and commitment, consistent with the technical literature. It played a crucial role in enhancing team-building skills and promoting active participation. This, in turn, positively impacted the collaborative abilities and dynamics within the teams, addressing the unique challenges faced by Construction Engineering students.
- Even though the literature review shows discrepancies with respect to the usefulness of competency, by introducing an element of gaming and competition that deviates from traditional instructional methods, the activity captured students' attention and fostered deeper motivation and engagement. It also led to more meaningful learning, maintaining a challenging level of questions that ensured the activity's relevance and effectiveness.
- Additionally, the three-stage structure—comprising pre-battle preparation, the battles themselves, and post-battle review—further reinforced understanding and retention.

To improve the understanding and effectiveness of Team-Based Questioning Battles, several research directions are proposed to address the study's limitations. Longitudinal studies could reveal the long-term effects on knowledge retention. Comparative studies might evaluate how this method stacks up against other active learning strategies, such as problem-based learning, across various disciplines. Expanding research to more students and other fields beyond Construction Engineering could assess its broader applicability and allow more advanced analytical and statistical analysis. Additionally, investigating the response of different student demographics would help tailor the approach to diverse needs and cultural context. Finally, integrating digital tools or online platforms could further enrich the learning experience, especially in hybrid or online settings. These avenues will deepen insights into the method's effectiveness and optimize its use in various educational contexts.

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Appendix A

This Appendix A presents the set of twelve questions from the questionnaire, designed to assess four key areas: (1) Previous Experience with Active Learning or Team-Based Questioning Battles, (2) Learning and Motivation Impact, (3) Study Habits and Performance, and (4) Preferences and Enjoyment.

Section A1: Previous Experience with Active Learning or Team-Based Questioning Battles

- Q1—How frequently did you engage in active learning experiences?
  - Rarely
  - Occasionally
  - Regularly
  - Very frequently
- Q2—Have you ever participated in Team-Based Questioning Battles as part of your Construction Engineering university education? (Yes/No)

Section A2: Learning and Motivation Impact

- Q3—On a Likert scale of very low to very high (very low, low, medium, high or very high), how would you describe the level of competitiveness and difficulty of questions during the team-based battles?
- Q4—On a Likert scale of very low to very high (very low, low, medium, high or very high), how would you rate the impact of the activity on enhancing your understanding and retention of the subject concepts?
- Q5—On a Likert scale of very low to very high (very low, low, medium, high or very high), how would you rate the impact of the activity on improved team building skills?
- Q6—On a Likert scale of very low to very high (very low, low, medium, high or very high), how would you rate the impact of the activity on improved communication skills?
- Q7—On a Likert scale of very low to very high (very low, low, medium, high or very high), how would you rate the impact of Team-Based Questioning Battles on your overall motivation to learn?

Section A3: Study Habits and Performance

- Q8—On average, how much time did you dedicate to preparing for Team-Based Questioning Battles?
  - Less than 2 h
  - Between 2 h and 5 h
  - More than 5 h
- Q9—Considering the value of having access to all questions, how likely are you to utilize the repository for further learning or reference?
  - Positively
  - Neutral
  - Negatively

Section A4: Preferences and Enjoyment

- Q10—Did you enjoy the Team-Based Questioning Battles experience? (Yes/No)
- Q11—Would you recommend repeating the activity in future courses? (Yes/No)
- Q12—Do you think it would be beneficial to repeat the experience more times throughout the course? (Yes/No)

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