Soils and Rocks
An International Journal of Geotechnical and Geoenvironmental Engineering
www.soilsandrocks.com
ISSN 1980-9743
ISSN-e 2675-5475

Students' perception of the impact of a Geotechnical Engineering field activity on their competences development

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Article

Keywords
Engineering curricular guidelines
Soil mechanics
In-class/ex-class activity
Competencies
Active learning

Abstract

The need to develop several students' competencies is one of the leading challenges for Engineering instructors in undergraduate courses. It has been quite exhausting in many cases, mainly due to the lack of professors' expertise in engineering education. Case studies may provide examples and help develop professors' ability to design effective learning experiences. In this context, this paper presents a case study of implementing an in-class/ ex-class activity conducted in the Soil Mechanics-I course at the Federal University of Rio Grande do Norte. Additionally, it aims to discuss students' perception regarding development of the proposed activity and competences. The activity comprised three phases: selection of Geotechnical Engineering problems on university campus, documentation and analysis of each situation, and presentation of solutions considering technical, environmental, and social aspects. Students' perceptions were assessed using an anonymous online survey (18 Likert and open-ended questions), divided into three categories: general impressions, competencies development, and open statements. General impressions and competencies development were mostly positive, with deadlines reported as the most challenging aspect. Open questions responses provided positive feedback, emphasizing the main developed competencies, according to students' perspective (*e.g.* leadership, interpersonal relationship, and analytical view of the problem). The need of dealing with real problems and work in groups appears to be a successful approach for teaching Geotechnical Engineering courses and developing competences in Engineering undergraduate courses. This case study can support innovation in teaching any engineering course and help students face future professional challenges.

1. Introduction

Although engineering education has been valuable, it is widely acknowledged that it requires modifications to address new issues, such as challenges on promoting diversity, equity, and inclusion (Zanata & Silva, 2021), and developing engineering students' professional competencies (Carvalho & Tonini, 2017). The current engineering professional landscape requires engineers to develop social competences (*e.g.,* creativity, critical thinking, communication, leadership and interpersonal relationship) besides those technical skills commonly taught in undergraduate courses. Augustine & Vest (1994) stated the position of the American Society for Engineering Education (ASEE) related to the changes in engineering education at the time of its publication. They state that "*in today's world and in the future, engineering education programs must not only teach the fundamentals of engineering theory, experimentation and practice, but be relevant, attractive and connected*" (p. 17). In accordance with that, De Los Ríos-Carmenado et al. (2015) stated that the European Higher Education Area (EHEA) proposes an innovative approach to educational learning and encourages the adoption of a model based on competence development.

Palma et al. (2011) provided a list of competences appropriate for Engineering in Latin America by means of decoding them within a holistic approach. In Brazil, the need for modifications in engineering education is also recognized in the new Brazilian Guidelines for Engineering Undergraduate Courses (Brasil, 2019). This guideline was designed by a collective effort of multiple stakeholders, named the Brazilian Society of Engineering Education (ABENGE), Brazilian Council of Engineering and Agronomy (CONFEA),

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Submitted on May 26, 2023; Final Acceptance on January 22, 2024; Discussion open until August 31, 2024.
https://doi.org/10.28927/SR.2024.006423

National Education Council (CNE), and Entrepreneurial Mobilization for Innovation of the Brazilian National Confederation of Industry (MEI/CNI). It introduces the competence-based framework to the Brazilian Engineering Education scenario and makes significant modifications to the way engineering is taught and learned at higher education level. For example, active learning is prioritized, which can promote practical development of both technical and social skills. Furthermore, the most recent guideline provided a more comprehensive list of competencies and abilities compared to previous Brazilian guidelines (Brasil, 2002) and proposed the foment of competencies such as entrepreneurship, research, communication, leadership, legislation, self-learning, among others.

The teaching-learning approach used in engineering education (e.g., lectures, laboratory experiences) is predominantly instructor-centered (Macedo et al., 2020) and remains the same even though engineering practice has been constantly changing due to technological revolution and globalization (Macedo et al., 2020). Similarly to other engineering branches, geotechnical engineering has also been taught in the same way over the years. Wirth et al. (2017) reported that many geotechnical engineering practices adopted nowadays are based on empirical aspects and limited by conventional boundaries. They emphasized that currently available geotechnical education curricula do not match the basis required to guarantee the engineer's success in the 21st century. Thus, the current engineering curriculum needs to be reviewed and reformatted in order to make significant modifications, which include encouraging multidisciplinarity and fostering transferable skills (Wirth et al., 2017).

Macedo et al. (2020) stated that non-traditional teaching approaches with the objective of promoting active learning in students bring relevant contributions to their professional and personal development. This approach addresses different learning styles and is more likely to be adapted to student's needs. In this regard, active learning activity may be defined as any activity that students engage in during class time that goes beyond a passive behavior (e.g., taking notes while listening to the teacher) (Hassan et al., 2012; Felder & Brent, 2016). It is also important to highlight that active learning is not a method, it orients methods that may promote active learning, but it is not a method by itself. It can be conceptualized as a mode of engagement in the learning process and centers the student as a co-constructor of their own knowledge (Chi & Wylie, 2014).

Among several active learning strategies, Problem-Based Learning (PBL) methodology uses real-world projects to foster critical thinking, problem solving, teamwork, and other skills (Larmer & Mergendoller, 2010; De Matos Junior et al., 2020). It has been widely used in different educational levels and study areas (Amaral, 2021). PBL implementation may vary based on the course and learning outcomes and may have the objective of creating a product and/or project, or only provide a solution to a common problem (Markham, 2003). In both cases it may be considered as one approach in which students can learn how to creatively deal with open-ended problems that resonate with their future professional practices (Larson et al., 2021). In addition, students can have the opportunity to present their contribution in front of an audience (Markham, 2011) and Amaral (2021) reported that PBL has been applied in all educational levels as well as in different study areas.

The implementation and results of PBL strategies are discussed in the literature (Quintela & Santana, 2007; Dalal et al., 2017; Zancul et al., 2017; Gratchev & Jeng, 2018; Chen et al., 2020; Oliveira et al., 2021; Larson et al., 2021; Naveh et al., 2022; Jumintono et al., 2022). They are widely applied in geotechnical engineering teaching contexts and their impacts are extensively discussed. Several examples are found in the literature regarding applications of PBL in geotechnical engineering courses (Pinho-Lopes & Macedo, 2014; Shiau et al., 2015; Larson et al., 2018; Macedo et al., 2020).

Engineering study cases are commonly used as part of the PBL methodology. Kelley (2008) presents them as a logical way to introduce the engineering design process to the students, who may not be familiar with it. He also describes the differences between 'case histories' (i.e., describing the problem, methods and procedures, and the actual implemented solution) and 'case problems' (i.e., an open-ended problem with several potential solutions in case problems). Through the use of engineering cases, students are able to learn how to search through the details of a case to find the key facts that will help them handle the pressing problems (framing). Students go from low-level knowledge and application to higher levels of learning, such as synthesis and assessment, when they are required to make judgments about the methods and practices used by a professional engineer (Kelley, 2008).

The objective of this paper is to discuss engineering students' perception regarding the development of a proposed activity and its relationship with the new Brazilian guidelines. It comprises a PBL-based case study of implementing an in-class/ex-class activity conducted in the Soil Mechanics-I course at the Federal University of Rio Grande do Norte, in the Northeast of Brazil.

2. Soil Mechanics-I course description

The Soil Mechanics-I course at the Federal University of Rio Grande do Norte (UFRN) is part of the Geotechnical Engineering field and is taught in the third year to undergraduate students after Engineering Geology and before Soil Mechanics-II. The course has in-person classes with both theoretical and practical activities and comprises both Civil Engineering and Environmental Engineering undergraduate programs. It corresponds to four credits (total of 60 h per semester), which include class and laboratory time. In addition, extra hours are commonly necessary for individual study time, preparation of reports, literature research and ex-class activities (e.g., field trips). Class size varies depending on the semester, but it consists of 20 to 30 students (average) per term.

Soil Mechanics-I is an introductory course in which the students are presented the basic concepts of Soil Mechanics. Its syllabus comprises soil formation and intrinsic properties, physical and mechanical properties of soils, weight volume relationship, soil classification, soil compaction, permeability and flow through soils, effective and geostatic stresses, and stresses due to applied loads. The perception of soil as an important factor in the behavior of any Civil and Environmental Engineering work can be mentioned as the main aspect to be taught in this course. For the semester in which the activity was conducted, most students (18) in class were enrolled in the Environmental Engineering undergraduate course. Only three of them were enrolled in the Civil Engineering course, resulting in 21 students.

3. Activity description

In order to address the engineering education changes necessary to the development of different students' competences, a new activity was performed in the Soil Mechanics-I course during the first semester of 2022, in which presential classes restarted after the Covid-19 Pandemic. The main objective of this activity was to evaluate the improvement in the competences established in the new Brazilian Guidelines for Engineering Undergraduate Courses (Brasil, 2019). The main competences aimed to be developed were related to the formulation, implementation and control of desirable engineering solutions, considering their users' needs, enhancement of communication skills in both written and oral forms, leadership and teamwork in multidisciplinary groups, and autonomous learning. As a secondary objective, we assessed the general aspects related to the performance of the activity (e.g., understanding the objectives, personal and group involvement, deadlines, instructor participation).

The activity was divided into three phases: (1) selection of the study areas, (2) field investigation and analysis, and (3) presentation of engineering solutions. The first stage of this activity comprised the search for different Geotechnical Engineering problems on and nearby the university campus. It was accomplished by the course instructor, accompanied by one randomly chosen student (volunteer). Eight locations were identified. From those eight spots, five were selected, as presented in Figure 1.

The criteria for choosing each location were based on two aspects: 1) presence of a typical geotechnical engineering situation, even though it was in its earliest stages, and 2) connection with the topics listed in the course syllabus. The selected spots presented geotechnical problems such as soil clogging, superficial erosion, bicycle lane pavement failure and intermixing of adjacent soils. The volunteer student made a presentation of the five locations to the class. It was considered part of her evaluation. Table 1 describes each location.

The second phase was performed by the students, organized in groups of 3 to 4 members. Each location was studied by one group with independent field work, documenting their observations related to geotechnical engineering, analyzing the problem and preparing the proposition of solutions, which must have considered technical, environmental, and social aspects. Competences related to the formulation, implementation and control of desirable engineering solutions, considering their users' needs, were thoroughly exercised in this step. This stage has ended with a 15 minute-long presentation to the class with the objective of providing a

Figure 1. Location of five selected Geotechnical Engineering problems used in the activity.

comprehensive description of the problem and introducing the proposed solution. We emphasize that the course instructor has accompanied this phase by indicating references to study and promoting off-class discussions, providing an opportunity to stimulate students' autonomous learning ability.

At the end of stage two presentations, the instructor has proposed further considerations on each location. They consisted of instructions for each group, summarized in Table 2, regarding the solutions the students have presented in phase 2 and potential studies they must conduct in each field. Students had 15 days to accomplish this task, which was delivered to the class in 15 minute-long lectures. We emphasize that students had two presentations to deliver, which were considered opportunities to improve their oral communication skills, while written reports that accompanied the presentations aimed to develop the competence related to written communication. In addition, since the students are from two different undergraduate courses (Civil Engineering and Environmental Engineering), they were required to work with multidisciplinary teams. This is fully related to the improvement of their ability to deal with real professional situations in the future.

Students' performance and grading were assessed in groups, considering their participation in the activity and their two presentations. Assessment was divided into three items, as follows: the technical aspects of the proposed solution and whether it met or not users' needs, the teamwork developed during the activity, and the quality of both in-person presentation and written reports. If students were able to demonstrate the abilities expected by the instructor, their performance was judged to be satisfactory.

4. Survey description and participants recruitment

An online anonymous form survey was designed to evaluate student's perception regarding the activity and the development of those competences reported in the new Brazilian guidelines for engineering undergraduate courses. The students were invited to participate in the survey via internal academic system memorandum three months after the conclusion of the course. Student participation was voluntary, and no compensation was offered. The survey comprised 18 questions (15 Likert scale from 1 to 5, two open-ended and one yes/no questions). The Likert scale consisted in a numerical rating ranging from 1 to 5; no textual options were used. The survey was divided into three categories: 1) general impressions, 2) competences development, and

Table 1. Description of the locations selected in the activity.

Location ID.	Coordinates	Identification	Main identified geotechnical problems
1	5°50'12.165"S 35°12'38.978"W	Campus flood control retention pool	Vegetation growth, soil clogging and infiltration capability reduction
2	5°50'15.567"S 35°12'29.544"W	Erosion in pavement-soil contact	Superficial soil erosion and transport of sediments
3	5°49'52.453"S 35°12'27.216"W	Nearby flood control retention pool	Infiltration problems prior to finishing construction works
4	5°50'37.572"S 35°11'54.837"W	Bicycle lane pavement[a]	Bricks movements and vegetation growth in recently built bicycle lane pavement
5	5°50'22.633"S 35°12'3.267"W	Garden soil-rock mixture	Intermix of adjacent soil

[a]Coordinates of the closest point to the Center of Technology. The bike lane goes around and crosses the university campus.

Table 2. Further instructions provided after the first round of presentations.

Location	Identification	Main identified geotechnical problems
1	Campus flood control retention pool	Perform *in situ* permeability tests of the bottom soil of the retention pool and compare with those obtained by Amorim (2016) and Guedes (2017).
2	Erosion in pavement-soil contact	Prepare a detailed photographic record of the site and measurements of displacement of granite rock blocks (create a classification, for example a quantity of displaced blocks and loose blocks).
3	Nearby flood control retention pool	Provide a timeline of the retention pool water level during its construction using satellite images. Predict the infiltration rate through an indirect measurement of the water level in the pond.
4	Bicycle lane pavement	From walking along the entire stretch, identify and classify the points of damage on the bicycle path around UFRN.
5	Garden soil-rock mixture	Create an instructional video about the process identified, addressing the experiment conducted in class.

3) open statements and opinion. The survey was designed and shared with the participants in Brazilian Portuguese. Table 3 presents an English version of the questions used in this survey.

5. Survey results

The survey was responded to by eight students, from 21 enrolled in the course, which corresponds to 38% of the students. The results from the survey are presented in Table 4 and discussed as follows.

5.1 General impressions

A group of seven Likert scale questions comprised the first part of the survey. They were designed to assess general aspects of the activity development. Question 1 was intended to inform if the activity was well understood by the students and 100% of the answers were number 5 in Likert scale. It demonstrates that participants clearly understood the activity objectives. The clear understanding of the learning objective enacts students' motivation and allow a more effective learning process, since students are able to comprehend the reason faculty design each specific activity (Reed, 2012). Clear objectives also support faculty in the assessment process, since it is explicit what outcomes each activity should provide (Fiegel, 2013).

Questions 2 and 3 are related to the participation of students, by referring to their own and other members' involvement in the task. Regarding their own involvement, every student reported a high level of engagement. On the other hand, one student reported a very low involvement of group members. The instructor was able to identify the student who did not participate properly in the second phase of the activity, which may be the case reported herein. In order to avoid such behavior, the instructor may participate in the field work with each group. This may stimulate students' engagement in every phase of the activity.

Table 3. Questions used in the survey to evaluate student's perception and development of competences.

Question ID.	Type	Question
Q1	Likert 1-5	Did you understand the objectives of the activity during the explanations presented in the classroom?
Q2	Likert 1-5	What is your level of involvement with the activity?
Q3	Likert 1-5	What is the level of involvement of the other group members in the activity?
Q4	Likert 1-5	Did you like the topic[a] you developed?
Q5	Likert 1-5	Did you like the second part of the activity (completion of the solution)?
Q6	Likert 1-5	Was the professor attentive to questions outside of class hours?
Q7	Likert 1-5	Did you find the time available to perform the activity sufficient?
Q8	Likert 1-5	Do you think there was development of Competence 1 - formulating and designing desirable engineering solutions, analyzing and understanding the users of these solutions and their context?
Q9	Likert 1-5	Do you think there was development of Competence 2 - analyzing and understanding physical and chemical phenomena through symbolic, physical and other models, verified and validated by experimentation?
Q10	Likert 1-5	Do you think there was development of Competence 3 - conceiving, designing and analyzing systems, products (goods and services), components or processes?
Q11	Likert 1-5	Do you think there was development of Competence 4 - implementing, supervising and controlling Engineering solutions?
Q12	Likert 1-5	Do you think there was development of Competence 5 - communicating effectively in written, oral and graphic ways?
Q13	Likert 1-5	Do you think there was development of Competence 6 - working and leading multidisciplinary teams?
Q14	Likert 1-5	Do you think there was development of Competence 7 - knowing and ethically applying the legislation and normative acts within the scope of the profession?
Q15	Likert 1-5	Do you think there was development of Competence 8 - learn autonomously and deal with complex situations and contexts, keeping up to date with advances in science, technology and the challenges of innovation?
Q16	Open-ended	In addition to the general competences described in the new National Curriculum Guidelines, do you think you developed any additional competence(s) during this activity?
Q17	Open-ended	Feel free to use this space. Comments, suggestions, negative and positive aspects. All are very welcome.
Q18	Yes/No	One final and simple question. In view of all the experience with the activity, did you like it?

[a] Topic refers to the subject developed by each group of students.

Table 4. Answers delivered to Likert scale questions.

Question ID.	Likert scale response frequency				
	1	2	3	4	5
Q1	0	0	0	0	100%
Q2	0	0	0	0	100%
Q3	12.5%	0	0	0	87.5%
Q4	0	0	0	0	100%
Q5	0	0	0	12.5%	87.5%
Q6	0	0	0	0	100%
Q7	12.5%	0	0	12.5%	75%
Q8	0	0	0	0	100%
Q9	0	0	0	0	100%
Q10	0	0	0	12.5%	87.5%
Q11	0	0	12.5%	0	87.5%
Q12	0	0	0	12.5%	87.5%
Q13	0	0	0	0	100%
Q14	0	0	0	0	100%
Q15	0	0	0	0	100%

Questions 4, 5 and 7 were related to the activity development. All students have reported they enjoy the activity as a whole (Q4) and phase 3 was also reported as positive (Q5). We have gathered one answer at Likert scale 1 regarding the deadlines. In fact, the activity was executed in the last month of the semester, which might have affected the performance of some individuals due to other activities in different courses. Question 6 was elaborated to identify the instructor's availability in off-class hours and resulted in 100% Likert scale 5 answers. Instructor remained able to participate in both in person and online discussions about each location.

5.2 Competence development

The purpose of questions 8 through 15 was to assess how well the eight competencies listed in the new Brazilian guidelines (Brasil, 2019) were developed in the opinion of each student. Each question is related to one of the eight competences. Answers were mostly positive (Likert scale 4 to 5), with one neutral (Likert scale 3) in competence 4. It is related to the implementation, supervision and control of engineering solutions, which were only fictionally proposed in this activity.

5.3 Open statements

Questions 16 and 17 provided an open discussion space in which the students were able to freely write their opinions. Answers were de-identified in case the participant described their names or third-party names. Participants answered in their native language, the statements provided in this section were translated. They were first asked to list any additional competencies they developed while participating in the exercise (Q16). Leadership skills, interpersonal relationship and real problem understanding were the most mentioned topics. Despite these are considered in competences 1 and 6, students' perspective is that they are competences not listed in the new Brazilian guidelines. First author, who was the course instructor, analyzed the answers.

According to the open ended answers, the activity supports students' development of the target competences. This result is exemplified in one student's which describes that a broad group of competences were developed during the activity.

> *I believe I developed a broader view of situations. Predict future consequences that the proposed solutions could generate, and not only in the technical dimension of the proposed problem, but also social, economic, cultural, etc.* (Participant A).

Question 17 provided an opportunity to deliver comments, suggestions, drawbacks and limitations of the activity. Regarding the negative aspects, the deadlines were reported twice as a drawback. It is imperative to review this aspect and it is suggested to include the activity from the beginning of the semester. The main positive aspects cited in Q17 were related to the application of theoretical background in the solution of a practical problem. This is in accordance with the new Brazilian guidelines' purpose of promoting engineering learned based on competences. One student's answer is presented below to illustrate the positive aspects reported in Q17.

> *The assignment was well thought out by the instructor. We were able to surpass the theoretical knowledge and put into practice other theoretical aspects and competences. Besides, students' engagement created a very pleasant atmosphere during the semester. Everyone was dedicated to finishing the activity properly.* (Participant A).

A final question invited the students to simply answer if they enjoyed the activity. It resulted in 100% of the students answering positively. This question was included to summarize the activity survey and provide instant feedback about it. Despite being a Yes/No question, it can be used to inspire similar approaches to be used in class. Other literature were found with similar PBL assignments (Pinho-Lopes & Macedo, 2014; Shiau et al., 2015; Zancul et al., 2017; Gratchev & Jeng, 2018; Larson et al., 2018; Macedo et al., 2020; Oliveira et al., 2021; Naveh et al., 2022) in which positive results were also reported.

6. Instructor's perspectives

The PBL activity's instructor has shared his thoughts on how it was performed. The level of students' engagement was outstanding and there was a lot of discussion outside of class hours. Each group has visited their respective locations properly and followed individual instructions regarding the procedures and aspects to document and analyze. Instructor has provided specific explanations for each group, according to each geotechnical problem, and the students were clearly able to demonstrate their recently acquired theoretical knowledge accurately in class presentations. Every suggestion made after the first presentation was accomplished, except that related to *in situ* soil permeability tests in the retention pool (Location 1) due to operational difficulties. This also shows students' commitment during the assignment.

Two main limitations can be listed regarding the assignment. Firstly, as mentioned in the survey, the deadlines were quite difficult to meet. The activity was conducted during the last month of the semester. This period is recognized as the busiest part of the semester, in which several exams are taken, and other presentations are delivered. In case of repeating the activity, another period might be considered. The second limitation is related to the lack of instructor-guided field work. The instructor has decided not to join the students to each location. It has resulted in several off-class discussions that could have been avoided or mitigated. Both aspects may be changed in future PBL assignments.

Two aspects must be considered in this paper. Firstly, the survey was conducted three months after the end of the semester. This may change the students' perception. In order to clarify the objective of the survey and to remember the details of the assignment, the first page of the survey provided a detailed description of what they have done. Furthermore, the survey was sent to the students by the class instructor, which may have led to some discomfort in answering the questions honestly. These aspects need to be considered in future surveys.

Despite the limitations mentioned above, the instructor was able to list meaningful positive aspects of the activity related to the development of students' competencies. Firstly, the instructor emphasizes that undergraduate classes in both Civil Engineering and Environmental Engineering courses at UFRN are commonly based on passive strategies, focused on teaching one or a few more ways to solve a specific problem. This aspect is under modification and the implementation of active strategies has been strongly stimulated. The activity described herein is an approach to deal with this aspect and provided the opportunity to investigate an engineering problem without any first clue, which simulates real professional situations. Secondly, the students were highly stimulated to use and develop important social competences for current engineers, such as creativity, critical thinking, communication, leadership, interpersonal relationship, and time management. Moreover, the activity promoted integration among students from different undergraduate courses. Finally, the instructor mentioned the importance of encouraging students in an outdoor activity, which differs from the common classroom and laboratory ones. This aspect plays an important role in engineers' professional life, mainly in the geotechnical field, which frequently involves field works. In addition, it allowed the use of the UFRN campus infrastructure, which is not usually known by the students given that they are commonly restricted to the engineering courses area.

7. Conclusions

A PBL activity was assigned at the Soil Mechanics-I course at the Federal University of Rio Grande do Norte. It comprised the evaluation and analysis of a geotechnical engineering problem at the university campus, followed by the presentation of a solution considering technical, environmental and social issues. A survey with Likert scale and open-ended questions was performed to acquire student's perception of the activity. Instructor's perspectives were also provided. The following aspects can be drawn from the results.

- The students have evaluated the activity positively. Both Likert scale and open-ended questions show a high degree of acceptance and engagement.
- Likert scale questions regarding the development of competences listed in the new Brazilian guidelines were mostly positive (Likert scale 4 to 5), with one neutral (Likert scale 3) in competence 4 (implementation, supervision and control of engineering solutions). It demonstrates this PBL assignment has promoted the development of such competences.
- Leadership skills, interpersonal relationships and real problem understanding were the most mentioned topics in the open-ended question in which the students were asked to mention other competencies developed during the activity.
- There was a high degree of students' commitment in the activity. Every group has visited their location and followed the instructor's suggestions properly. Also, presentations were delivered accordingly and instructions for the final lectures were followed.
- Two main limitations were noted in this assignment. Firstly, the deadlines were quite difficult to meet due to its conduction at the end of the semester. Secondly, the field works might have been accompanied by the

instructor. Both aspects are quite simple to modify in future PBL assignments.

- Regarding the survey, it can be emphasized that it was performed three months after the end of the semester, which may have some impact on students’ perception. In addition, the survey was sent by the class instructor, which may have led to some discomfort in answering the questions honestly.

Acknowledgements

The authors express their gratitude to Dr. Adam Carberry (The Ohio State University) and Dr. Medha Dalal (The Arizona State University) for their support to this initiative.

Declaration of interest

The authors have no conflicts of interest to declare. All co-authors have observed and affirmed the contents of the paper and there is no financial interest to report.

Authors’ contributions

Fagner Alexandre Nunes de França: conceptualization, investigation, data curation, methodology, supervision, writing – original draft. Marcus Vinicius Melo de Lyra: conceptualization, methodology, data curation, writing – original draft. Matheus Gomes de Carvalho: methodology, writing – review & editing. Wagner José Opolski: methodology, writing – review & editing.

Data availability

The datasets generated analyzed in the course of the current study are available from the corresponding author upon request.

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