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STUDENTS' PERCEPTION OF TBL CLASSROOM: A CASE STUDY FOR A PORTUGUESE SCHOOL OF ENGINEERING

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Abstract. *This study aims to make a knowledge contribution of the impact of the use of the TBL – Team Based Learning – approach on higher education, and in STEM areas in particular. The results of TBL use presented were worked through a management curricular unit in an engineering degree course at ISEP. This approach was proposed and used in classes throughout the semester, and at the end the students responded to a survey about the impact of TBL. The results obtained indicate a good reaction of the students, especially in relation to their learning and group work. It was also observed the preference for multimedia study materials and some difficulty of the students in systematizing the study before and after classes. Thus, the conclusions suggest the validity of the TBL approach in higher education courses with students from STEM areas, as well as some of its limitations.*

Key words: Higher education, Team Based Learning, STEM, Active learning, Students' perceptions

1. INTRODUCTION

STEM (science, technology, engineering and mathematics) education research provides compelling evidence that active-learning classes improve the overall learning of students (Freeman et al., 2014). TBL is one of STEM's education frameworks. The benefits of team learning include increased achievement, motivation, and greater retention of concepts learned.

Currently, several higher education institutions have been betting on active methodologies as part of teaching practices. Innovative, they are increasingly present in the daily life of this higher education institutions, being part of the routine of thousands of university students worldwide (Eddy & Hogan, 2014).

Team Based Learning

One team learning pedagogy is team-based learning (TBL), a structured course design that combines individual preparation with collaborative problem-solving. But also, group work among students that can collaborate a lot for richer learning, creating interesting pedagogical processes at all levels of education, from kindergarten to graduation (Freeman et al., 2014).

Team-based learning (TBL) was initially developed in the 70s in the United States and its main goal was to improve learning processes for large classes of students. This pedagogical approach was first used in classes of administration courses in American universities and was then disseminated and applied in several undergraduate courses.

According to researchers in the area of higher education, team-based learning has some characteristics that differentiate it from other teaching strategies directed to small groups,

such as problem-based learning and peer learning (Parmelee, Michaelsen, Cook, & Hudes, 2012).

For Sweet & Michaelsen (2012), TBL benefits students in order to stimulate the defense of authentic positions; participation in best practice approaches that motivate students to persist; moreover, as the TBL exploits the strength of teams, teachers provide activities that require power to decision that would be difficult for individual students.

Studies on TBL report on their results, the effects on performance of the students with the methodology attendance: engagement, students' attitudes towards work in group, student satisfaction with their experience and team synergy (Beatty, Kelley, Metzger, Bellebaum, & McAuley, 2009; Clark, Nguyen, Bray, & Levine, 2008; Koles, Stolfi, Borges, Nelson, & Parmelee, 2010; Shankar & Roopa, 2009).

For Gullo, Ha, & Cook (2015), TBL contributes to the development of collaborative work skills, in addition to arousing interest in the search for information, making the student responsible for his or her own learning and that of his/her colleagues.

In addition, the findings of Silva, Colle, Cavichioli, & Souza (2018), shows that use of TBL gave students the strengthening and understanding of the process of learning, especially, in the development of personal, interpersonal and communication matters. According to the authors, evolution was perceived as a stimulus to the exercise of doubt, interaction, conflict resolution, motivation and defense of opinions.

2. MATERIALS AND METHODS

2.1 Course design

At the beginning of the semester, the functioning of the TBL classes was explained in detail to the students and highlighted the advantages of the method in the learning process. The curricular unit was organized in major themes related to Organizations Management: Planning, Organization, Control, Direction, Marketing, Financial and Operations, and in complementary topics such as Social responsibility, Circular economy, Productivity, and Industry 4.0, during a total of 15 weeks. In each week the curricular unit had 4 hours of contact classes: 2 hours online and the other 2 hours face to face. Figure 1 illustrates the pedagogical practice implemented according to the phases of the TBL (Ruder, Maier, & Simkins, 2021). Each week had a readiness assurance test (RAT), available to students on the Moodle platform.

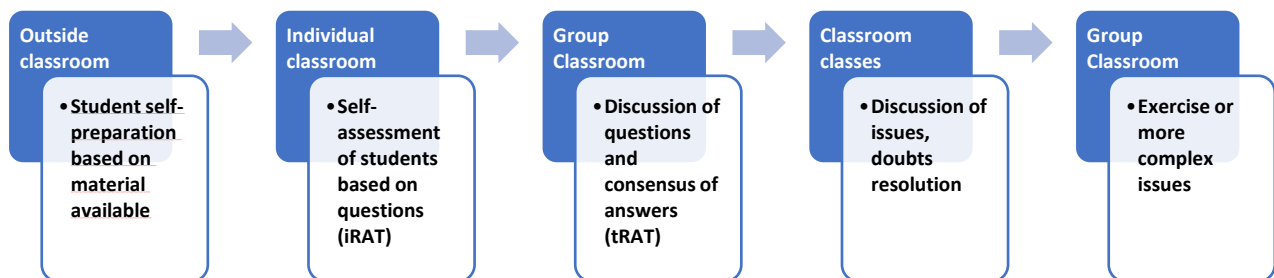


Figure 1. Drawing of the sequential phases of each TBL class.

In the first 2 teaching hours (online regime) the RAT was applied. For the individual readiness assurance (iRAT), that allows students to evaluate their prior preparation, were allocated between 10 to 15 minutes of the class and students were asked to take note of their answers (tRAT). After iRAT, students discussed the same group of questions (tRAT) during a period of 30 to 45 minutes and consensualized a group response. After the group discussion, each group submits the answers in the VoxVote e-application, which showed the results allowing teachers to correct errors and clarify concepts. In the second block of 2 hours (face to face), the groups discussed a case study of greater complexity related to the theme worked in the RAT and then applied the concepts to an organization chosen by them.

For the constitution of the groups, teachers used the questionnaire for evaluating learning styles developed by Kolb & Kolb (2012). Students were distributed in groups of 5 to 7 elements (Kibble, Bellew, Asmar, & Barkley, 2016).

The diversity of styles in each group was the main criterion for the constitution of the groups, since it emphasizes complementarity and pluralism in the way students think (Kyprianidou, Demetriadis, Tsiatsos, & Pombortsis, 2012). This groups remained the same throughout the semester and in the two blocks of classes (Ruder et al., 2021).

2.2 Procedures

The aim of this study is to evaluate the perception of the students' reaction to the application of TBL methodology, in the curricular unit of Organizations Management, using a quantitative methodology. For this purpose, an 8-item questionnaire was developed by the authors, based on the available literature (Aljaraideh, 2019; Guffey, Parrish, & Williams, 2021; Jaime, Tramontt, Gabe, Reis, & Maia, 2019; Vasan, DeFouw, & Compton, 2009). The authors decided to use a five-point Likert scale: 1-totally disagree, 2-disagree, 3-neither agree nor disagree, 4-agree and 5-totally agree. A set of questions were added with the aim to better understand how each student studies and works individually and in groups. The questionnaire was previously tested by members of the school community and their suggestions were incorporated into the final version of the questionnaire. The study was carried out at the School of Engineering of the Polytechnic Institute of Porto at the end of the first semester of the 2021/2022 school year. The participants are first-year students of the undergraduate course in Electrotechnical Engineering and Computers. The questionnaire was made available through an online tool and before the evaluation of the curricular unit. Prior to the distribution of the questionnaire, the objectives of the study were explained, and voluntary participation was guaranteed. It was also informed that all information would be treated in a pseudonymized manner and used solely for statistical purposes.

2.3 Sample

After data collection and validation, it was released and processed in the Statistical Package for Social Sciences (SPSS) version 26.0 for Windows. A reliability analysis of the scale was performed, obtaining a Cronbach's Alpha value of 0.86, a value that is within reference values (Cortina, 1993). This course has 227 students, and 58% participated in the study. Table 1 shows the overall characteristics of the sample.

Table 1. Demographic composition of the sample, in percentage. (N=131).

Student-worker		Gender		Age	
Yes	19.1	Female	7.1	18 to 21 years old	86.3
		Male	92.8	22 to 25 years old	6.9
No	80.9	N/A	0.1	26 to 29 years old	0.8
				30 or more	6.1

The analysis of the previous table shows that the sample consists mainly of non-working students, male and aged 18 to 21 years. This group of students attends a set of six subjects with a total of 26 hours per week. Of this set of subjects only Management of Organizations, with 4 hours per week, used the TBL methodology. It should be noted that the classes of all disciplines took place in a mixed regime, the classes of theoretical nature on an online basis and the theoretical-practical or laboratory classes, in a face-to-face regime.

3. RESULTS AND DISCUSSION

Table 2 shows the descriptive statistics for the questionnaire items about the reaction to TBL methodology. All items obtained higher scores than the intermediate value of the scale, a result that seems to indicate that most students had a positive perception of the method in use. The students significantly value the provided TBL opportunity to communicate more with colleagues than in exhibition classes, a result that can also be explained by the current pandemic situation (Cicha, Rizun, Rutecka, & Strzelecki, 2021). They also state that the use of RAT, both in the individual and in the group format, contributed to the learning process and that it helped them to prepare for the moments of evaluation of the curricular unit. The items with the highest number of answers "I do not agree or disagree" are related to the way students felt during the classes, the level of motivation to participate in these classes in relation to traditional classes and the perception of the advantages they would have for applying the methodology to other disciplines.

These results can be explained by the fact that TBL is a pedagogical practice considerably different from the practices of the other subjects they attend, because it is the first time that students use this methodology and because it a disruptive situation in relation to the work habits that students acquired in secondary education.

Table 2. Means and standard deviations of the students' perceptions of TBL, items are ranked in a descending order by mean (N=131).

Item	Mode	Mean	Sum	SD
TBL classes gave me more opportunity to communicate with colleagues than traditional (exhibition classes)	4	3.78	495	1.09
The discussion of the questionnaire (RAT) in group allowed me to correct errors and improve the understanding of the curricular unit subjects	4	3.57	468	1.07
The individual resolution of the questionnaire (RAT) helped me learning the subjects of the curricular unit	4	3.47	454	0.99
I felt more comfortable in a TBL class than in a traditional (exhibition class)	3	3.34	438	1.11
The TBL classes helped me prepare for the evaluation of the curricular unit	4	3.24	425	1.05
I would like to take TBL classes in more curricular units	3	3.15	412	1.25

TBL classes helped me to better understand the subjects of the curricular unit	4	3.15	412	1.14
TBL classes motivated me more than traditional (exhibition classes)	3	3.05	400	1.16

The following tables show the complementary questions results of descriptive statistics. These issues allow a deeper understanding of student's involvement, not only in the methodology adopted but also in their own involvement with the course and discipline. They provide even greater clarity regarding the learning tools that have been made available. The available study materials consisted of a set of texts prepared by the teachers, in which short videos were introduced to illustrate some more complex concepts. Students had to study weekly a text with an average dimension of 5000 words. The results show that the materials fit their method of study, but they preferred to have more videos to study than texts (table 3).

Table 3. Means and standard deviations of the students' perceptions of study materials, items are ranked in a descending order by mean (N=131).

Item	Mode	Mean	Sum	SD
The study materials available on moodle are suitable for my study method	4	3.52	461	1.04
I like studying by videos more than reading texts	4	3.50	458	1.11

A central issue for the success of TBL is the prior materials study before class realization (Sannathimmappa, Nambiar, Aravindakshan, & Kumar, 2022). The results show that only about 43% (sum of answers I totally agree and agree) of the students regularly studied the materials before classes. Tomas, Evans, Doyle, & Skamp (2019) found an identical result and identified the lack of time, lack of motivation and inability to manage the individual study as the main explanations for the non-compliance with this task. It should be noted that the students did not feel comfortable during classes in which they had not had the previous study and that they did not acquire the habit of consolidating the study of the contents of the discipline after classes (table 4).

Table 4. Means and standard deviations of the students' perceptions of individual work, items are ranked in a descending order by mean (N=131).

Item	Mode	Mean	Sum	SD
When I didn't study the materials available on Moodle, I felt uncomfortable in TBL classes	4	3.46	453	1.05
I regularly studied the materials available in the Moodle before the TBL class was held	4	3.15	412	1.07
Often, after the TBL class, I reviewed the study materials available on Moodle	3	2.84	372	1.15

Finally, questions were asked to assess the perception of the efficiency of group work, another critical success factor of the TBL (table 5). Students need to have teamwork skills, be able to have a collaborative attitude towards the group and learn from others (Kibble et al., 2016). The groups had the dimension suggested in the literature, between 5 and 7 elements, with diversity in the way they perceive and process the information in order to enhance the discussion and motivation for learning. The results show that the group training technique led to a integration high level and the students claim to have had a collaborative

attitude towards the group. However, this motivation is low when it comes to discussing the RAT, this result can be explained by the lack of study of the materials available above.

Table 5. Means and standard deviations of the students' perceptions of teamwork, items are ranked in a descending order by mean (N=131).

Item	Mode	Mean	Sum	SD
I felt integrated into my working group	4	4.10	537	0.867
I had a collaborative attitude in the discussions of the questionnaire (RAT) with my group	4	3.87	507	0.91
I learn better working in groups than working alone	4	3.50	459	0.97
My group has shown to be motivated to discuss the questionnaire (RAT)	4	3.18	417	1.12

4. CONCLUSIONS

A limitation of this study was its use of a pedagogical approach (TBL - Team Based Learning) different from the traditional one, with students who were having the first contact with higher education, and in the context of a pandemic. This context meant that half of the classes took place online, sometimes with large groups of students (between 80 and 100 students) giving a limite to the possibility of interaction between teachers and students. The students' perception of the TBL may be different if the classes are all face-to-face. The results obtained suggested a positive reaction of the students to the use of the TBL approach Management classes, of the 1st year of the Undergraduate course in Electrotechnical and Computer Engineering of the School of Engineering of the Polytechnic Institute of Porto. In their responses to the survey, students highlight aspects such as the opportunity to communicate more with colleagues in the group or a better understanding of the subjects (table2). Interestingly, when faced with the general question of whether The TBL contributed to better learning, the students' response was clearly more neutral. The impact of TBL in preparing for the evaluation also revealed a positive trend. However, students did not show a clear preference for the use of TBL in other subjects or for the advantages of TBL over the traditional exhibition approach.

In line with previous studies (Tomas, Evans, Doyle, & Skamp, 2019), one of the difficulties pointed out by the students in this pedagogical approach was the management and systematization of their study, namely the preparation before and after classes, as well as the discomfort they felt when they did not prepare classes (table 4). Teachers involved, tried to mitigate this difficulty by elaborating study materials that included multimedia elements, which were valued by students (table 3).

The establishment of groups of students with diverse learning styles (Kyprianidou, Demetriadis, Tsiatsos, & Pombortsis, 2012) contributed to the success of this pedagogical experience, depending on the good work environment that the students reported (table 5).

The authors are able to conclude that, in line with previous studies, the data collected point to the effectiveness of the use of TBL in engineering courses, although with due care in the preparation of activities to be carried out in classes, in the preparation of dynamic study materials and in the balanced constitution of groups.

It will also be interesting to continue to monitor the results of the use of TBL in engineering courses, particularly in the context of fully face-to-face classes.

References

- Aljaraideh, Y. (2019). Students' perception of flipped classroom: A case study for private universities in Jordan. *Journal of Technology and Science Education*, 9, 368. doi:10.3926/jotse.648
- Beatty, S. J., Kelley, K. A., Metzger, A. H., Bellebaum, K. L., & McAuley, J. W. (2009). Team-based learning in therapeutics workshop sessions. *American journal of pharmaceutical education*, 73(6), 100-100. doi:10.5688/aj7306100
- Cicha, K., Rizun, M., Rutecka, P., & Strzelecki, A. (2021). COVID-19 and Higher Education: First-Year Students' Expectations toward Distance Learning. *Sustainability*, 13(4), 1889.
- Clark, M. C., Nguyen, H. T., Bray, C., & Levine, R. E. (2008). Team-based learning in an undergraduate nursing course. *J Nurs Educ*, 47(3), 111-117. doi:10.3928/01484834-20080301-02
- Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Appl. Psychol.*, 78-98.
- Eddy, S. L., & Hogan, K. A. (2014). Getting Under the Hood: How and for Whom Does Increasing Course Structure Work? *CBE—Life Sciences Education*, 13(3), 453-468. doi:10.1187/cbe.14-03-0050
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci. USA*, 111(23), 8410-8415. doi:10.1073/pnas.1319030111
- Guffey, S., Parrish, C., & Williams, D. (2021). Students' perceptions of team learning across teaching frameworks and settings. *Current Issues in Education*, 22. doi:10.14507/cie.vol22iss3.1960
- Gullo, C., Ha, T. C., & Cook, S. (2015). Twelve tips for facilitating team-based learning. *Med Teach*, 37(9), 819-824. doi:10.3109/0142159x.2014.1001729
- Jaime, P., Tramontt, C., Gabe, K., Reis, L., & Maia, T. (2019). Students' Perceptions of Team-based Learning in an Undergraduate Nutrition School [Version 2]. *MedEdPublish*, 7. doi:10.15694/mep.2018.0000226.2
- Kibble, J. D., Bellew, C., Asmar, A., & Barkley, L. (2016). Team-based learning in large enrollment classes. *Adv Physiol Educ*, 40(4), 435-442. doi:10.1152/advan.00095.2016
- Kolb, A., & Kolb, D. (2012). Kolb's Learning Styles. In N. Seel (Ed.), *Encyclopedia of the Sciences of Learning*: Springer US.
- Koles, P. G., Stolfi, A., Borges, N. J., Nelson, S., & Parmelee, D. X. (2010). The impact of team-based learning on medical students' academic performance. *Acad Med*, 85(11), 1739-1745. doi:10.1097/ACM.0b013e3181f52bed
- Kyprianidou, M., Demetriadis, S., Tsiatsos, T., & Pombortsis, A. (2012). Group formation based on learning styles: can it improve students' teamwork? *Educational Technology Research and Development*, 60(1), 83-110. doi:10.1007/s11423-011-9215-4
- Parmelee, D., Michaelsen, L. K., Cook, S., & Hudes, P. D. (2012). Team-based learning: a practical guide: AMEE guide no. 65. *Med Teach*, 34(5), e275-287. doi:10.3109/0142159x.2012.651179
- Ruder, P., Maier, M. H., & Simkins, S. P. (2021). Getting started with team-based learning (TBL): An introduction. *The Journal of Economic Education*, 52(3), 220-230. doi:10.1080/00220485.2021.1925187

- Sannathimmappa, M. B., Nambiar, V., Aravindakshan, R., & Kumar, A. (2022). Are Online Synchronous Team-Based-Learning (TBL) pedagogy effective?: Perspectives from a study on medical students in Oman. *J Adv Med Educ Prof*, 10(1), 12-21. doi:10.30476/jamp.2021.92361.1481
- Shankar, N., & Roopa, R. (2009). Evaluation of a modified team based learning method for teaching general embryology to 1st year medical graduate students. *Indian J Med Sci*, 63(1), 4-12. doi:10.4103/0019-5359.49076
- Silva, S., Colle, F., Cavichioli, D., & Souza, R. (2018). Aprendizado e desenvolvimento de habilidades no curso de Contabilidade: uma pesquisa-ação com o método Team-Based Learning (TBL). *Enfoque: Reflexão Contábil*, 37, 1. doi:10.4025/enfoque.v37i3.39579
- Sweet, M., & Michaelsen, L. K. (2012). *Team-based learning in the social sciences and humanities: Group work that works to generate critical thinking and engagement* (M. Sweet & L. K. Michaelsen Eds.): Stylus Publishing, LLC.
- Tomas, L., Evans, N., Doyle, T., & Skamp, K. (2019). Are first year students ready for a flipped classroom? A case for a flipped learning continuum. *International Journal of Educational Technology in Higher Education*, 16(1), 5. doi:10.1186/s41239-019-0135-4
- Vasan, N. S., DeFouw, D. O., & Compton, S. (2009). A survey of student perceptions of team-based learning in anatomy curriculum: favorable views unrelated to grades. *Anat Sci Educ*, 2(4), 150-155. doi:10.1002/ase.91