Research Article

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Students' Perceptions of PBL Usefulness

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Abstract: Problem-based learning (PBL) is a teaching technique in which students' learning is conveyed using real-world problems. However, the implementation of PBL is confronted with several challenges, namely the involvement of students, the definition of the teacher's role, and the development of effective assessment mechanisms. This paper describes and analyses a teaching framework based on PBL followed in the Differential and Integral Calculus and Statistical Models courses in a Biomedical Engineering Bachelor, at the School of Engineering, Polytechnic of Porto. In order to assess students' points of view about the effectiveness of this PBL approach with regard to knowledge acquisition, development of soft skills, and assessment methods, a questionnaire was administered at the terminus of the semester. Data analysis revealed that newcomers are more likely to use PBL, while second-year students feel more pressure and report more workload with this type of assessment. In this regard, we consider that factors such as maturity, education level, workload in other courses, and prior PBL experience may influence students' willingness to adhere to PBL.

Keywords: problem-based learning, soft skills, students' perceptions

1 Introduction

Nowadays, the labor market requires competent people who possess problem-solving skills as well as creative and critical thinking to deal with rapidly changing business circumstances (Bierema, 2019; Hayes, 2020; Penkauskienė, Railienė, & Cruz, 2019; Schwab & Samans, 2016; Stevens & Norman, 2016; Suleman, 2016).

The development of problem-solving skills is an essential aspect of education as they are linked with the development of critical thinking and analytical skills necessary for academic, professional, and personal success. Effective problem-solving techniques help students avoid conflict, learn self-regulation, and improve academic performance. In addition, collaboration, communication, and creativity, essential skills for twenty-first-century students, are also developed. In general, problem-solving skills are vital in education as they equip students with tools that enable them to face complex challenges and succeed in their academic and personal lives.

Critical thinking empowers learners to objectively evaluate situations, make logical decisions, and tackle complex problems. It enables students to effectively process information, questioning assumptions, and identifying biases, resulting in better decision-making and problem-solving. Critical thinking is therefore an essential skill for success in many aspects of life and can lead to better outcomes for individuals, organizations, and society as a whole (Dumitru et al., 2018). Critical thinking has been identified as a planned outcome of education in 2050 (UNESCO, 2022).

Therefore, many higher education institutions are reflecting on pedagogical practices and seeking to implement teaching methods able to equip students with these personal qualities and skills desired by future employers (McGunagle & Zizka, 2020).

Approaches that prioritize active involvement from the learner and are centered around their needs have been proven to be more successful in boosting the development of essential skills for twenty-first-century students (Deep et al., 2020). One such approach that has been incorporated into teaching in a wide range of areas is problem-based learning (PBL). PBL is a student-oriented learning method that emphasizes self-directed learning and small group work, where students learn through hands-on experiences, identify and solve problems, and engage collaboratively with real-world issues.

The effectiveness of this approach has been investigated over decades, and several studies demonstrate that PBL enables better academic outcomes, greater student engagement, and improved critical thinking skills (Mursid,

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Saragih, & Hartono, 2022; Pinho, Mota, Conde, Alves, & Lopes, 2015).

Thus, the purpose of this article is to explore engineering students' experiences working in two math courses, Differential and Integral Calculus (CALCL), and Statistical Models (SM), which involve solving real-world problems to deepen their knowledge of the syllabus. CALCL students were first-semester freshmen, while SM students were second-semester sophomores. The article aims to assess students' points of view about the effectiveness of PBL as a teaching approach on various aspects such as knowledge acquisition, development of soft skills, and assessment methods.

The following set of research questions guided the investigation:

RQ1: How do students perceive their skill levels on teamwork and communication?

RQ2: How do students perceive their knowledge acquisition?

RQ3: How do students perceive the assessment methods?

RQ4: Are there any differences in the views of freshman and sophomore students regarding the PBL experience?

Overall, this article contributes to the understanding of how PBL can be implemented in specific courses in Biomedical Engineering and sheds light on the factors that may influence students' engagement with PBL.

The article is structured in four sections following the present introduction. Section 2 presents the background of the study, Section 3 describes the methodology adopted, and Section 4 shows the statistical analysis performed and the main results. Finally, the main conclusions and limitations of the study are presented in the closing section.

2 Background to the Study

2.1 Literature Review

PBL is an educational approach that has been used for decades in a variety of disciplines to foster critical thinking and problem-solving skills (Liu & Pásztor, 2022). PBL is a student-centered method in which students are exposed to complex real-world problems to construct learning about a subject. This strategy is implemented in a self-learning environment where the "trigger" is given by a proposed problem that must be solved. Students have to conduct research, learn new information, integrate theory and practice, and apply knowledge and skills in order to develop a solution to the problem at hand.

Real-world problems and teamwork are the core around which students develop knowledge, and learning outcomes are achieved by the team actively working on these unstructured problems. In PBL classrooms, teachers provide a challenging problem for their students to solve together through collaborative discussion and research activities. Students work together to identify relevant facts related to the issue at hand while developing strategies for finding solutions or making decisions about how best to proceed with the given task. Summarizing, the process involves identifying the problem, gathering information, analyzing the data, and coming up with a solution. During this process, teachers act as facilitators who guide student inquiry by asking open-ended questions that encourage deeper exploration into potential answers or approaches towards resolution of the issue presented before them. Students decide their own way of finding the solution to the problem they have to solve.

This type of learning encourages students to become active participants in their own education, rather than passive recipients of information that comes from the teacher. By taking a central role in their own learning, students are better prepared for higher education and are more empowered in their educational experiences (UNESCO, 2022).

It has been argued that by using real-life problems as a focus, students would *effectively learn how to learn* (Tan, 2003). This type of problem challenges students to think about new situations and to integrate previous knowledge creatively. In addition, they represent an opportunity to introduce diversified topics of interest into the curriculum. Goti, Akyazi, de la Calle, Oyarbide-Zubillaga, and Alberdi (2020) found that students solving real-world problems using PBL achieved better results when compared to traditional teaching methods.

Additionally, PBL fosters teamwork among classmates and encourages students to ask questions and explain topics in their own words, which helps to build a deeper understanding of the material.

According to Nilson (2016), a well-designed PBL provides students with the opportunity to develop skills related to teamwork, management, leadership, oral and written communication, self-awareness, working independently, critical thinking and analysis, explaining concepts, self-directed learning, applying course content to real-world examples, researching and information literacy, problem-solving across disciplines.

These generic skills are commonly referred to as soft skills or emotional intelligence. Their importance lies in their transferability across disciplines and situations. They prepare students to respond to the challenges of society, fostering the entrepreneurship and adaptability needed in the labor market. These competencies enable individuals to effectively navigate diverse work environments and contribute to the overall success of organizations (Suryanti & Supeni, 2019).

Some authors have also noted that PBL encourages life-long learning and language acquisition by developing self-directed learning skills through group brainstorming, problem definition, and clarification of knowledge about the material (Razak et al., 2022).

As stated by Seibert (2021), a key role of tutors in PBL is to facilitate the learning process.

The tutor acts as a guide, providing support and guidance to students throughout the learning journey, helping them develop problem-solving strategies, and encouraging independent learning. To guarantee the successful implementation of this student-centered approach and optimize the learning outcomes, it is imperative to adapt the role of the tutor in PBL.

Instead of lecturing, the instructor in PBL adopts the position of facilitator. By providing scaffolding, guiding inquiry, reiterating comprehension of challenging topics, and presenting resources, the facilitator aids the groups in creating understanding and making connections between ideas. Furthermore, the facilitator encourages reflection on the group's procedures and results.

Facilitators play a crucial role in guiding groups through PBL sessions, providing support, criticism, and motivation. They help students overcome setbacks and foster resilience, while also helping them understand complex ideas. Facilitators also offer supplementary materials and encourage reflection on group activities, ultimately creating a positive and productive PBL environment.

PBL problems that are too simple or too complex may not engage students effectively, so it's important to strike a balance. A good problem challenges students to think critically and creatively, encourages collaboration and communication, and fosters a deeper understanding of the subject matter. It can inspire curiosity and motivate students to pursue further inquiry beyond the classroom.

The key components of a typical PBL process include (a) identifying the problem or scenario, (b) researching and gathering information, (c) analyzing the information, (d) proposing solutions, and (e) evaluating the outcomes (Tan, 2003).

PBL activities and duration can be designed in a variety of ways, depending on the objectives and goals of the curriculum. A problem could be on a particular topic, or it could be interdisciplinary, requiring students to draw on knowledge and skills from multiple subjects. The duration can also vary, from a short-term project to a semester-long endeavor (Chen, Kolmos, & Du, 2021). However, all

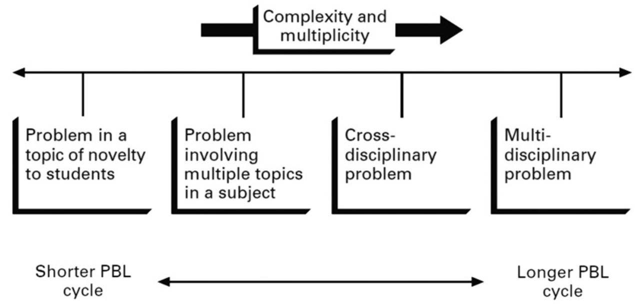

Figure 1: Problem complexity and multiplicity steps (adapted from Tan, 2003).

PBL variations must include a focus on teamwork and presentation skills, as it is an opportunity for students to develop their ability to listen to others, communicate their ideas clearly, and assume leadership responsibilities through collaborative work (Figure 1) (Tan, 2003).

In the meta-analysis performed by Liu & Pásztor (2022), the authors summarize the Problem-based Learning steps in Figure 2.

The implementation of PBL presents several challenges. Chen et al. (2021) categorized three levels of challenges faced in PBL implementation at the individual level, institutional level, and culture level. Challenges at the individual level include issues faced by students and teachers. Teachers frequently refer to challenges in how to design the course activities, how to play the role of learning facilitator rather than lecturer, and how to balance between helping and influencing the students' work. Some studies have focused specifically on the role of the teacher in this context (Hmelo-Silver, Bridges, & McKeown, 2019).

One of the goals of PBL is to enhance students' transferable skills, including communication, collaboration, critical thinking, and independent learning. To measure the development of these skills and learning outcomes, effective assessment methods are needed combining traditional and new methods, namely self-assessment, peer review, presentations, observation, joint with quizzes, exams, lab reports, attendance, etc. (Chen et al., 2021). Teachers must also figure out how to encourage students to be truthful in the self and peer assessment. It is important to establish clear guidelines and expectations for the assessment process, as well as providing training and support for students to develop their assessment skills and ethical values. Incorporating technology and anonymous evaluations can also help advance accuracy and fairness in the evaluation process.

The PBL environment requires students to transfer from traditional learning methods to PBL methods. Without rich teamwork and PBL experiences, students may struggle to

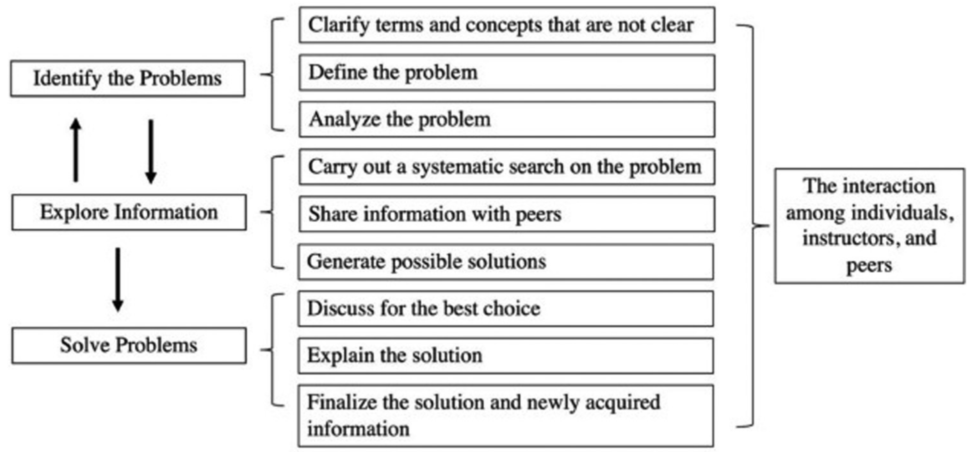

Figure 2: PBL steps (adapted from Liu & Pásztor, 2022).

identify problems and translate knowledge into practical problem solutions. Teachers and facilitators can support this development by providing ongoing guidance and incorporating relevant skills training into the PBL curriculum. PBL practice has created new challenges for both teachers and students in devoting more time and effort. Teachers face a heavier workload in PBL courses by providing guidance, practical experiences, and teamwork facilitation. Students have to devote more effort to overcoming expected and unexpected issues, which can lead to anxiety or depression. In their study, Chen et al. (2021) found that teachers have expressed the need for more PBL-supportive materials, resources, and policies at the faculty or university level. Also, the high number of students and a lack of infrastructure for teamwork can limit the PBL application.

At the culture level, Chen et al. (2021) refer to the language barriers arising for participants in international PBL. This aspect carries less weight when PBL is developed at a more restricted level.

Trends in PBL research emphasize the use of technology to improve learning outcomes. This involves establishing dynamic and captivating settings for problem-solving through the use of virtual platforms (Sistermans, 2020), simulations (Reilly, Kang, Grotzer, Joyal, & Oriol, 2019), cooperative online tools (Hursen, 2021), or augmented reality (Fidan & Tuncel, 2019).

2.2 Teaching Framework

Engineering students are expected to seamlessly transition into professional roles that demand problem-solving, analytical thinking, innovation, and the application of theoretical concepts to real-world problems. These roles require engineers to apply their technical knowledge and skills to solve complex problems and design innovative solutions. Additionally, engineers must possess strong communication and teamwork skills to effectively collaborate with colleagues and stakeholders. As technology continues to advance, engineering students must also stay updated with the latest tools and techniques to remain competitive in the ever-evolving job market. The integration of PBL into engineering education not only enhances students' problem-solving abilities but also prepares them for real-world scenarios. For these reasons, PBL is a suitable approach for engineering students.

In this study, the PBL approach was followed in two math courses, CALCL and SM. Both courses are from the Bachelor's degree in Biomedical Engineering, from the first year, first semester (CALCL), and second year, second semester (SM).

2.2.1 Differential and Integral Calculus (CALCL)

The Differential and Integral Calculus (CALCL) aims to provide students with (a) a basic scientific knowledge and techniques by consolidating and complementing students' mathematics training, gained during the third level of education; (b) developing students' ability to reason and abstraction; and (c) encouraging the development of a mathematical language and the acquisition of critical thinking. These are crucial to developing a strong engineer profile and laying the groundwork for later comprehension and interpretation of other courses in the bachelor's program in biomedical engineering.

The course's syllabus started with a brief chapter on differential calculus, followed by a chapter on indefinite integrals. The next chapter was devoted to definite integrals. The penultimate chapter was about a numerical series of non-negative terms. The last chapter consisted of case studies on sustainable mathematics. The case studies were proposed by the teacher on a PBL model and consisted of the application of differential and integral calculus to solve real-world problems, namely studying information from epidemic outbreaks and analyzing data from rainfall in certain areas of the globe, amongst others.

The lectures were delivered by the students in the course's final weeks, with reference to the final chapter of the syllabus. They presented their solution to the PBL problems. The students were actively engaged in this teaching framework, working autonomously. To encourage their classmates' active participation in class, they created slides and searched the internet for math and other educational resources. They used *PollEv*, *Kahoot*, *EclipseCrossword*, among others. Some groups prepared leaflets on climate change to distribute among their peers. Each group complemented their work with a poster and a written assignment. The students created the poster using a variety of tools, including *Canvas* and *Piktochart*, as well as *Microsoft Publisher* and *PowerPoint*. The written assignment had a series of tips to help structure and organize the contents.

2.2.2 SM

The syllabus of the SM course is designed to provide students with a) a solid base of mathematics and b) statistical knowledge to solve medium-complex problems in the field of Biomedical Engineering, particularly those involving data analysis and interpretation, forecasting, and decision-making. The course comprises topics of Probability Theory and Discrete and Continuous Distributions, the Central Limit Theorem, Confidence Intervals and Hypothesis Testing, and Linear Regression. The final chapter addresses real-world applications of statistical methods in a PBL format.

The SM course is delivered mainly by lectures and practical classes, supported by active-learning strategies such as *Think-Pair-Share, Buzz, Q&A* sessions (Pinto, Mendonça, & Babo, 2020; Zimmermann, Stallings, Pierce, & Largent, 2018), and a modified version of *eduScrum* (Wijnands & Stolze, 2019).

The last chapter of the SM course included the students' public presentation of the solutions to the previously assigned PBL. Each team had to "sell" their solution and respond to audience questions in a scientifically rigorous manner. Moreover, they also had to present a written report of up to 20 pages and make a scientific poster. Peer assessment, flipped learning, and brainstorming were the primary active learning reflections at this point. This activity prepares students for real-world scenarios where they would need to communicate their findings to stakeholders who may not have a statistical background. This also helps students develop their presentation and communication skills.

3 Methodology

To ascertain students' opinion, a questionnaire was distributed in the Moodle platform to all students enrolled in the courses of CALCL and SM, after the semester's end for the academic year 2021–2022.

The questionnaire aimed to gather valuable insights from participants regarding their PBL experiences in the two courses considered. It consisted of 16 questions replied on a 5-point Likert scale, ranging from strongly disagree to strongly agree. The same set of questions were answered by the CALCL freshmen and the SM sophomores about teamwork, communication, learning outcomes, and assessment. Continuous feedback is essential to identify areas for improvement and enhance the overall quality of education. The feedback collected will be used to improve the learning experience and ensure that students receive the best possible education.

In total, 36 validated responses from CALCL and 41 from SM courses were obtained.

A quantitative approach was adopted in this paper. Using exploratory descriptive statistics and nonparametric Mann-Whitney tests, the statistical analysis sought to understand the differences or similarities in the feedback from students in the two courses CALCL and SM regarding their learning experience using PBL.

In the annexes, it is shown an example of a proposed PBL given to students of the SM course. The overall assessment is done using the following weighted formula:

$$CF = 0.35\,M1 + 0.3\,M2 + 0.35\,EG,$$

where:

- M1 includes the grade of the group report, the poster and the oral presentation grade, with weights: 60, 20, and 20%, respectively;
- M2 is the assessment of each student individual report on a scientific paper, on the application of Probabilities and Statistics in Engineering;
- EG is the grade of the individual written test, assessing students' knowledge of all syllabus.

4 Data Analysis and Results

This section aims to present and discuss the results derived from a statistical analysis conducted on the responses obtained from the questionnaire described above.

The detailed results of the analysis are listed in Table 1. Mean scores and standard deviations were calculated, and nonparametric Mann–Whitney tests were employed to identify significant distinctions between freshman (CALCL) and sophomore (SM) students.

Significant differences were observed in three specific questions among the student groups. These questions include “The PBL approach enhanced my learning under pressure” (sig. <0.01), “I would like to see this evaluation method used in other Curricular Units” (sig. <0.001), and “This evaluation method required more effort on my part” (sig. <0.001). Sophomore students acknowledged that this approach is more demanding, although they expressed hesitance in applying it to other curricular units. The differences highlighted in the radar chart (Figure 3) of the means obtained in each question are visually illustrated and provide a clear representation of these distinctions.

It is noteworthy that all questions received positive evaluations, with average scores higher than 3. Scores higher than 3 indicate a positive overall perception of PBL among students including the recognition of PBL’s effectiveness in developing crucial soft skills, fostering enhanced learning opportunities, and a nuanced understanding of the practical trade-off involving increased effort and workload. This suggests that students perceive tangible benefits in terms of skills development and learning outcomes, coupled with a practical awareness of the challenges associated with the PBL approach. Students also considered that the PBL approach allowed them to learn more, although they felt that the effort and workload were higher.

5 Conclusions/Final Considerations

In this article, we analyze and discuss four main research questions related to students’ perceptiveness of the development of soft skills, knowledge acquisition, and assessment methods in a PBL teaching framework. Were enrolled in two groups of students, freshmen, and sophomore, attending two Math courses, CALCL and SM, respectively.

Generically, the study’s findings revealed that the majority of participants felt positively about their learning experience. They claimed it enabled them to acquire knowledge more effectively and develop important soft skills such as critical thinking, communication, and collaboration. These findings are consistent with those previously reported by Suryanti & Supeni (2019) who concluded that PBL is an effective instructional model for fostering essential soft skills in higher education. Furthermore, the students who participated in the present study highlighted that the applied assessment methods were more engaging, when compared to those of traditional courses. The main evidence presented to justify this claim was that they could apply what they learned directly in real-life scenarios, rather than just taking tests or writing papers with no practical application, a finding echoed by other studies (Rézio, Andrade, & Teodoro, 2022).

Table 1: Descriptive statistics and Mann–Whitney test

	CALCL		SM		U M-Whit	Sig.
	Mean	SD	Mean	SD		
I properly managed the tasks attributed to me by my workgroup	4.25	0.65	4.05	0.55	608	0.123
As a member of my group, I made a positive impact on the learning process of my colleagues	4.11	0.67	4.05	0.63	700	0.661
My workgroup had a positive impact on my learning	4.14	0.72	4.07	0.69	695.5	0.623
I was anxious during oral presentation	3.61	1.10	3.85	1.13	633.5	0.266
I developed my public speaking skills	3.75	0.87	3.46	0.98	610.5	0.156
I was pleased with my presentation	3.81	0.79	3.66	0.91	687.5	0.564
I managed to properly convey the concepts to the public (colleagues from other groups and the lecturer)	4.08	0.55	3.93	0.61	653	0.281
The PBL approach allowed me to learn more about the course than if I studied exclusively for the written tests	3.61	1.13	3.39	1.00	645	0.312
The PBL allowed me to apply knowledge of the course in the area of engineering	3.89	0.71	3.88	0.95	705	0.71
The PBL promoted my learning under pressure.	3.50	0.97	4.12	0.84	481.5	0.006
The PBL developed my time management skill.	3.50	0.97	3.61	1.02	686	0.572
I would like this assessment method to be used in other Curricular Units	3.78	1.05	3.07	0.88	429	<0.001
This assessment method required more effort on my part	3.50	1.00	4.27	0.55	407.5	<0.001
With this assessment method I had a more active role in the classes	3.56	1.16	3.54	0.95	698.5	0.672
With this approach I received more feedback from the teacher about my learning	3.22	1.10	3.61	1.07	572	0.074
This approach allowed me to better understand my learning difficulties	3.58	0.87	3.32	0.99	652.5	0.343

Figure 3: Radar chart of the means of each question from CALCL and SM students.

This study revealed some disparities in the perceptions of the students attending the CALCL and SM courses. Newcomers (CALCL course) are more prone to have PBL in other courses, whereas second-year students (SM course) felt more pressure and reported more workload with this type of assessment.

Students' maturity, level of education, workload in other courses, and no prior PBL experience may induce differences and willingness to adhere to PBL.

According to Liu & Pásztor (2022), the maturity of the students, type of instruction, and group size are factors that may affect the effectiveness of PBL.

Overall, the obtained results suggest that PBL can benefit students' academic growth by providing opportunities for active engagement, while developing twenty-first-century essential skills needed outside of the classroom. As for educators, PBL helps them to engage different learners in mathematics classrooms, by utilizing different approaches beyond traditional methods. The later are often less appealing, universally across all types or groups of students and do not always yield desired outcomes for everyone involved. New educational settings are win–win situations, on the one hand, teachers gain more insights into what works best and where improvements should be made in their classes, to achieve successful educational experiences, for teachers and students alike, and on the other hand, students achieve higher academic goals and better preparation to cope with the rapidly changing labor market.

This article can contribute to the body of knowledge on PBL and provides some practical ideas for its implementation. It also emphasizes that the students' responses can be different depending on some internal or external factors such as maturity and workload. For a more comprehensive insight, the study would need to be extended to encompass a larger and more diverse sample size that we are considering as future work.

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ANNEXES

Example of a proposed PBL in the Statistical Models course 2021/2022

Consider the file data_case_study_IV.csv, which contains the weight variation of young patients with anorexia, in 3 different treatment groups.

a. Describe the statistical distribution of the data.
b. Present boxplots of weight differences before and after treatment and calculate outliers.
c. Test the hypothesis that there was an increase in weight in the young women after treatment (use a left-sided test).
d. Discuss the *p*-value of question c. in terms of the problem at hands.
e. Repeat question c. for a two-sided test.
f. Compare the results from questions c. and e. from the perspective of the problem at hands.
g. Use linear regression to find the function that relates the two weights for each young person. Approximate the value of the weights after treatment for 3 young patients per treatment. Compute the approximation errors and comment on the obtained results.

Written report

The written report must comply with the following requirements:

(a) Cover – which must include the title, authors and date;
(b) Index;
(c) Introduction – identification of the subject covered, paragraph with the structure of the work;
(d) Methods used in the resolution – briefly present the theoretical foundations of the work, the methodologies applied and the tools used;
(e) Solution of the proposed problem and discussion of the results obtained. It must be done in *R*.
(f) Conclusion – summary of the results obtained;
(g) Bibliographic references – presentation of the bibliography used in the development of the work;
(h) Annexes – additional information, if justified;
(i) Written report must be presented in Times New Roman format, 12, with a maximum of 20 pages.

Oral presentation

The *oral presentation* must comply with the following assumptions:

- All group members must present a part of the work;
- Duration is 10 min presentation and 5 min questions.
- The number of slides must be at most 10
- Every team member has to answer questions from their classmates, if applicable, and the teacher;
- The presentation must be active, that is, it must create class situations in which other classmates actively participate. Tools you can use (examples): Mentimeter; AhaSlides; Quizizz, Kahoot, GpConqr, Padlet, Genially, etc.

https://learninginnovation.duke.edu/faculty-opportunities/art-and-science-of-teaching/active-learning-techniques-classroom/.

https://eduscrum.org/about-us-and-how-we-try-to-make-it-happen/.

https://www.scrumalliance.org/ScrumRedesignDEVSite/media/ScrumAllianceMedia/Certification/Guide_to_Agile_K-12_Education.pdf.

https://www.techlearning.com/tl-advisor-blog/tech-tools-for-active-learning-classrooms.

https://www.prodigygame.com/blog/active-learning-strategies-examples/.

https://sites.google.com/site/jhdou363/.

Creating slides

Your slides should be created with a purpose of conveying your work in an effective and clear way to your teacher and colleagues. Read the following tips:

- The content should be straightforward, brief, and centered on essential details;
- The visuals should include graphs, charts and tables;
- Include essential formulas and provide oral explanation to them.
- The Design and color scheme should be consistent. The font size should be readable;
- Interpret and explain the statistical results, in the scope of the proposed problem;
- The slides need to have a coherent and logical structure, with Introduction.
- Limit text, use keywords and brief phrases;
- Limit the number of animations;
- Check your slides for data, grammar and spelling errors;
- Engage the audience, encourage interaction and discussion of topics;
- Do not forget to practice your presentation time;

http://www.garrreynolds.com/preso-tips/design/.

https://www.slideshare.net/edahn/10-tips-for-making-beautiful-slideshow-presentations-9210564~.

http://www.garrreynolds.com/preso-tips/design/.

https://www.slideshare.net/edahn/10-tips-for-making-beautiful-slideshow-presentations-9210564.

Scientific poster

The scientific poster should be written in English. It should be effective, clear, concise in conveying the information, and visually engaging.

- The title should be coherent with the work and the goals must be stated in a comprehensible way;
- The organization of the poster should have a logical sequence and suggest the reading path to the readers.
- Focus on transmitting the most important information. Use visuals (graphs, charts, tables), bullet points, short sentences.
- The visual elements should be easily understandable. Avoid immoderate detail and too few or too many visuals.
- The letter fonts should be consistent and readable.
- The design and color framework should be as to ensure readability and spot the most important information.
- Include references and acknowledgements.
- During poster presentation, be ready to explain your work, and engage with the audience to answer questions and discuss your findings.

Deliverables

At the deadline for completion of the PBL, you should submit, at Moodle, the following files:

– The written report, in pdf format;
– The scientific poster, in pdf format;
– The slides.

Good job!
The teacher