ORIGINAL RESEARCH

Performance and satisfaction level among Chilean physical therapy students regarding the use of online problem-based learning (OPBL) in the pathophysiology course

Desempeño y nivel de satisfacción de estudiantes de fisioterapia chilenos con el uso de aprendizaje basado en problemas virtual (ABPV) en la asignatura fisiopatología

Paola Figueroa-González[1] Mauricio Viera-López[1] Luis Gómez-Miranda[1] Ruvistay Gutiérrez-Arias[1,2,3] Viviana Contreras-Pizarro[1] Paula Riquelme-Bravo[4] Armando Díaz-Cabrera[1,5]

[1] Universidad Andrés Bello - Faculty of Rehabilitation Sciences - Institute of Exercise and Rehabilitation Sciences - Santiago - Chile.
[2] Instituto Nacional del Tórax - Comprehensive Cardiopulmonary Rehabilitation Support Department - Santiago - Chile.
[3] Instituto Nacional del Tórax - INTRehab Research Group - Santiago - Chile.
[4] Universidad Andrés Bello – Faculty of Education and Social Sciences - Center for Strengthening Professional Training - Santiago - Chile.
[5] Hospital San Juan de Dios - Critical Care Unit - Santiago - Chile.

Abstract

Introduction: Online problem-based learning (OPBL) has been used to train health professionals, but there is limited evidence on student performance and satisfaction following its implementation.

Objective: To evaluate the performance of Chilean physical therapy students taking a pathophysiology course after implementing OPBL and to determine their level of satisfaction with this methodology.

Materials and methods: A retrospective, analytical, observational study was conducted on 106 second-year physical therapy students at a university in Santiago, Chile, enrolled in the pathophysiology course during the second semester of 2021. The students were divided into 30 groups, each with 2 to 6 members, and the intervention consisted of solving two clinical problems (OPBL1 and OPBL2) with a 5-week work period for each OPBL (4 weeks of group work and 1 week of evaluation). The differences in the scores obtained and the passing rate in the oral presentation (group evaluation), the individual written test, the self-evaluation rubric, and the differences in the co-evaluation rubric between OPBL1 and OPBL2 were analyzed using the Wilcoxon signed-rank test and the chi-square test, respectively.

Results: Participants were aged between 19 and 23 years and 50.95% were female. Regarding performance in the individual written test, it was found that the median score in OPBL1 was 13 points (p25-p75: 11-14) and 32.08% passed, while the median score in OPBL2 was 9 points (p25-p75: 7-12) and 15.09% passed. In the group evaluation (30 groups), the median score was 62.5 points (p25-p75: 59-67) in OPBL1 and 62.5 points (p25-p75: 60-67) in OPBL2, and the passing rate was 96.67% in OPBL1 and 100% in OPBL2. Concerning students' satisfaction with the use of this methodology in the course, most of them selected "agree" (24.53-39.62%) and "strongly agree" (35.85-55.56) in the evaluated items.

Conclusions: The students achieved their learning objectives in the pathophysiology course, so it can be concluded that their performance was adequate after implementing the OPBL, highlighting that group performance was superior to individual performance. Moreover, the level of student satisfaction with the use of this methodology was high.

Resumen

Introducción. El aprendizaje basado en problemas virtual (ABPV) ha sido usado en la formación de profesionales de la salud, pero la evidencia sobre el desempeño y la satisfacción estudiantil luego de su implementación es escasa.

Objetivos. Evaluar el desempeño de estudiantes de fisioterapia chilenos en la asignatura fisiopatología luego de implementar el APBV y determinar su nivel de satisfacción con esta metodología.

Materiales y métodos. Estudio observacional retrospectivo analítico realizado en 106 estudiantes de segundo año de fisioterapia de una universidad de Santiago (Chile) inscritos en la asignatura fisiopatología durante el segundo semestre de 2021. Los estudiantes fueron divididos en 30 grupos de 2 a 6 integrantes y la intervención consistió en la resolución de 2 problemas clínicos (ABPV1 y ABPV2) con un tiempo de trabajo de 5 semanas para cada ABPV (4 semanas de trabajo grupal y 1 semana de evaluación). Las diferencias en los puntajes obtenidos y en el porcentaje de aprobación en la presentación oral (evaluación grupal), la prueba individual escrita, la rúbrica de autoevaluación y la rúbrica de coevaluación entre ABPV1 y ABPV2 fueron evaluadas usando la prueba de Wilcoxon de muestras pareadas y la prueba de Chi cuadrado, respectivamente.

Resultados. Los participantes tenían edades entre 19 y 23 años y 50.95% eran mujeres. Respecto al desempeño en la prueba escrita individual, se encontró que en el ABPV1 la mediana de la puntuación fue 13 puntos (p25-p75: 11-14) y 32.08% aprobaron, mientras que en el ABPV2 la mediana de la puntuación fue 9 puntos (p25-p75: 7-12) y 15.09% aprobaron. En la evaluación grupal (30 grupos), la mediana de puntaje fue 62.5 puntos (p25-p75: 59-67) en el ABPV1 y 62.5 puntos (p25-p75: 60-67) en el ABPV2; la tasa de aprobación en el ABPV1 fue 96.67% y en el ABV1, 100%. Respecto a la satisfacción de los estudiantes con el uso de esta metodología en la asignatura, la mayoría expresaron estar "de acuerdo" (24.53-39.62%) y "muy de acuerdo" (35.85-55.56) en los ítems evaluados.

Conclusiones. Los estudiantes lograron los objetivos de aprendizaje de la asignatura fisiopatología, por lo que es posible concluir que su desempeño fue adecuado luego de implementar el ABPV, destacando que el desempeño grupal fue superior al desempeño individual. Además, el nivel de satisfacción estudiantil con el uso de esta metodología fue alto.

Introduction

The COVID-19 pandemic had a major impact on education, including medical training, since information and communication technologies had to be immediately implemented to maintain learning processes. While this situation brought to light problems related to the implementation of health science training processes in digital settings, such as a need for training in digital educational resources, it also presented an opportunity to reflect on teaching strategies and available educational resources and to update them.[1-3] Also, during the pandemic, the move to remote learning involved a paradigm shift consistent with the constructivist approach to the learning process, favoring student-centered education.[4-8]

Problem-Based Learning (PBL) is a student-centered educational approach focused on understanding and solving clinical problems. With PBL, students work in small groups to solve a problem or clinical case, guided by a professor who acts as a tutor or facilitator.[9,10] This method aims to encourage the development of communication and collaboration, decision-making, problem-solving, critical thinking, and self-learning skills.[11] PBL, by using real-life problems (clinical cases in the context of health science students), sets up a collaborative learning environment where students build knowledge and develop skills by defining problems, creating hypotheses, collecting and analyzing data, and proposing, evaluating, or defending solutions.[12,13]

PBL has been used to train healthcare professionals for over 50 years,[12] and its effectiveness has been addressed in several studies and areas. For example, Trullas *et al.,*[14] in a scoping review in which they evaluated the available international evidence on the effectiveness and usefulness of this methodology in undergraduate medical programs, determined that PBL is more effective than traditional methods in medical training for developing social and communication skills, problem solving skills, and self-learning skills. In turn, Pathmanathan *et al.,*[15] in a systematic review that aimed to assess the effectiveness of this methodology in undergraduate physical therapy programs, found that, compared to traditional educational methods, PBL is effective for physical therapy training in terms of promoting early evidence-based practice (EBP). According to these authors, this methodology also facilitates learning strategies, although there is no evidence confirming these findings.[15]

Even though PBL has proven to be effective in promoting students' skills in terms of self-directed and collaborative learning, critical thinking, self-reflection, and coping with new situations, the need for face-to-face interactions limits the potential of traditional PBL. For this reason, studies have been conducted to address these limitations[13] and, nowadays, especially following the COVID-19 pandemic, online PBL (OPBL) has been successfully implemented in the training process of medical students,[10,12,16] as well as students of other health sciences[17] such as speech therapy[13] and dentistry.[18]

Regarding student satisfaction with OPBL, studies conducted on medical[16] and dental[18] students have reported a high level of satisfaction. On this matter, Rosmaria *et al.*[17] demonstrated in their systematic review that OPBL implemented in various health degree programs had a positive impact on learning experience, knowledge improvement, self-learning, motivation, and communication.

However, as mentioned above, the COVID-19 pandemic led to the use of new teaching strategies,[1-4] and although it has been reported that the implementation of OPBL in medical student training is feasible,[10,12,16] there is limited evidence of its implementation and student satisfaction with this methodology in the context of physical therapy teaching. With this in mind, studies that have evaluated the use of this methodology to train physical therapy students include the one conducted by Arienti *et al.,*[19] which showed that

OPBL is more effective than the traditional method for improving knowledge, as well as the one conducted by Smith-Turchyn *et al.*,[20] which reported that OPBL helped achieve learning goals and resulted in high satisfaction.

The objective of this study was to evaluate the performance of Chilean physical therapy students in the pathophysiology course after implementing OPBL and to determine their level of satisfaction with this methodology.

Materials and methods

Study design and type

Retrospective, analytical, observational study using convenience sampling.

Study population and sample

The study population comprised all second-year physical therapy students who were enrolled in the pathophysiology course offered by the undergraduate Physical Therapy program at the Universidad Andrés Bello in Santiago, Chile, during the second academic semester of 2021 (N=183). A non-probabilistic sampling method was used, excluding students who did not complete the course and those who did not sign the informed consent form.

Procedures

Design and validation of the OPBL

The OPBL design and validation process was carried out as follows:

After defining the clinical problems and assessment tools to be used, an ad hoc committee of experts consisting of four professors with experience in the field (three professors of pathophysiology and one external professor) evaluated them using a checklist. This committee requested the following adjustments: to improve the wording of the clinical problems, to make it clear in the instructions that students had to change roles every week, and to make it explicit that the grade of the oral presentation rubric was not individual but collective.

Once the adjustments were made, the rubrics underwent a content validation process. This process was carried out by an ad hoc committee made up of five professors who are experts in university teaching. They made observations to improve the assessment tools, which were adopted in their entirety.

Finally, prior to the implementation of the OPBL in the pathophysiology course (second academic semester), a pilot test was conducted during the first academic semester of 2021 (between May and June 2021) with 18 students who had already taken the course to identify technical problems or difficulties in understanding clinical problems and the activities to be performed. None of the students reported any issues, so no further adjustments were made and the implementation proceeded with the student cohort.

Implementation of OPBL in the pathophysiology course

All activities were carried out online and in real time using the Blackboard virtual classroom tool (version 1997-2022 Blackboard Inc.© United States), and students were randomly assigned to different working groups.

One week before classes began, a digital tutorial was emailed to students informing them that the activities to be carried out in the course would focus on the evaluation and resolution of two clinical problems (Online Problem-Based Learning 1 - OPBL1 and Online Problem-Based Learning 2 - OPBL2), with a working time of five weeks per problem (four working sessions and one evaluation session). The OPBL1 activities were carried out between September and the first week of October, and the clinical problem addressed was related to the cardiorespiratory system. Meanwhile, the OPBL2 activities were developed between the second week of October and the second week of November, and the clinical problem to be solved was related to the neuroendocrine system. It should be noted that the topics to be addressed in both clinical problems were selected based on the learning outcomes and contents that students are expected to achieve after completing and passing the course.

The instructions also informed students about the course format (one weekly synchronous 4-hour session in the Blackboard virtual classroom), the assessment system, the distribution of students into teams, and the roles they would take on in the team (roles were assigned randomly for the first session; however, they were informed that roles would be switched every week and that the group members would define the rotation themselves). The students were divided into 30 teams of between two and six students. The assessments were individual for the written test, self-evaluation, and peer evaluation, while the oral presentation (team performance) was evaluated collectively. Each session had a facilitating professor who was responsible for ten teams per online session.

Student performance evaluation

In both OPBLs, team performance was evaluated in the fifth session using four assessment tools (Table 1) described below. In all evaluations, the passing grade was defined as a score of ≥70% of the maximum score. In addition, a satisfaction survey was administered to students using the OPBL methodology. It is worth mentioning that the grade obtained in each OPBL represented 30% of the final grade for the course (i.e., a total of 60% for both OPBLs) and the remaining 40% corresponded to an online written test (20%) and a workshop (20%), which are not discussed in this study.

Table 1. Evaluation instrument.

Evaluation instrument	Type of instrument	Type of evaluation	Highest score	Weight
1. Individual written test	Multiple-choice test with single answer	Individual	20	10%
2. Oral presentation	Rubric	Group	Formal requirements: 28 Presentation: 16 Defense: 28 Total: 72	10%
3. Co-evaluation	Rubric	Individual	36	6%
4. Self-evaluation	Rubric	Individual	40	4%
5. Student satisfaction with the OPBL	Survey evaluated using a Likert scale	Individual	52	-

OPBL: online problem-based learning.

Individual written test: This instrument consisted of a 20-question multiple-choice test with a single answer, with a maximum score of 20 points (i.e., one point per answer). Students were required to complete this test within 60 minutes, and the questions, along with the answer options, were presented randomly on the student's screen. Students had to select one of the answers to move on to the next question; they were not allowed to go back to the previous question.

Oral presentation: A group oral presentation was conducted and evaluated using a rubric with 18 criteria assessed on a 0 to 4 Likert scale[21] (0: fail, 1: poor, 2: fair, 3: good, and 4: excellent) for a maximum score of 72 points. The dimensions of the rubric were formal requirements for the presentation and defense of the clinical problem (Annex 1).

Co-evaluation rubric: The evaluation was done using an instrument that allowed each student to co-evaluate each member of their group. Nine criteria were evaluated using a 0 to 4 Likert scale (0: fail, 1: poor, 2: fair, 3: good, and 4: excellent; item 2 was not considered on this occasion. An adjustment will be made for upcoming versions) for a maximum score of 36 points (Annex 2).

Self-evaluation rubric: This consisted of an instrument in which 10 criteria were evaluated using a 0 to 4 Likert scale (0: fail, 1: poor, 2: fair, 3: good, and 4: excellent; item 1 was not considered on this occasion. An adjustment will be made for upcoming versions) for a maximum score of 40 points (Annex 3).

Student satisfaction with OPBL: A survey consisting of 13 questions rated on a 0 to 4 Likert scale was administered (0: strongly disagree, 1: disagree, 2: indifferent, 3: agree, and 4: strongly agree) for a maximum score of 52 points.

Statistical analysis

Data are described using absolute frequencies and percentages for qualitative variables and medians and 25th and 75th percentiles (p25-p75) for continuous variables (individual test scores, group evaluations of oral presentations, self-evaluations, and co-evaluations) given their discrete nature.

Regarding inferential analysis, differences in scores obtained and passing grades in oral presentation (group assessment, n=30), individual written test, self-evaluation rubric, and co-evaluation rubric between OPBL1 and OPBL2 were evaluated using the Wilcoxon signed-rank test and the chi-square test (n=106). A significance level of $p<0.05$ was considered. All statistical analyses were performed using JASP 0.16.3.0 software.

Ethical considerations

The study adhered to the ethical principles for biomedical research involving human subjects established in the Declaration of Helsinki[22] and was approved by the Scientific Ethics Committee of the Hospital San Juan de Dios in Santiago, as per the research protocol review report No. 91, version 3, dated December 2021. Furthermore, as mentioned in the study population and sample subsection, informed consent was obtained from all participants.

Results

Out of the 183 students enrolled in the pathophysiology course during the second academic semester of 2021, 5 did not finish the course and 72 did not sign the informed consent form, resulting in a sample of 106 students. Participants' ages ranged from 19 to

23, and 50.95% were women. Regarding student performance on the individual written test, the following was found: in OPBL1, the median score was 13 points (p25-p75: 11-14) and 32.08% obtained a passing grade, while in OPBL2, the median score was 9 points (p25-p75: 7-12) and 15.09% passed the test. The difference between the scores obtained by the students in OPBL1 and OPBL2 (Figure 1) was statistically significant ($p<0.001$). Likewise, a statistically significant difference was observed in the percentage of approval ($p=0.004$).
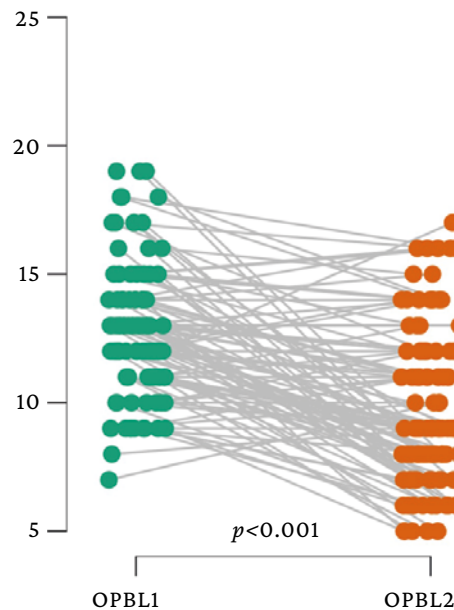
Figure 1. Scores obtained in the individual written test in OPBL1 and OPBL2.
OPBL: online problem-based learning.

For the oral presentation (group assessment; 30 groups), the median score was 62.5 (p25-p75: 59-67) in OPBL1 and 62.5 (p25-p75: 60-67) in OPBL2. Concerning the passing grade, all groups approved in OPBL2, and only one (3.33%) failed in OPBL1. The approval rate for the domain "Formal requirements" was 96.67% in both OPBL1 and OPBL2; the approval rate for the domain "Presentation" was 93.33% and 96.67%, respectively; and the approval rate for the domain "Defense" was 96.67% and 86.67%, respectively. There were no significant differences in the scores obtained by students between both OPBLs, neither in the overall evaluation or in each of the dimensions of the oral evaluation rubric, nor in the proportion of groups with passing grades (Table 2).

As for the co-evaluation and self-evaluation rubrics, although there were significant differences between both OPBLs in the scores obtained in both evaluation instruments ($p<0.001$), this was not the case for passing grade (92.45 vs. 91.51% and 98.11 vs. 100%) (Table 2).

Table 2. Results obtained in the evaluation tests in OPBL1 and OPBL2.

		OPBL1		OPBL2		Valor *p*	
		Total, points	Approved, n (%)	Total, points	Approved, n (%)	Scored	Approved
Individual written evaluation (n=106)		13 (11-14)	34 (32.08)	9 (7-12)	16 (15.09)	<0.001	0.004
Oral presentation evaluation (n=30) *	Formal requirements	26 (24.25-26.75)	29 (96.67)	26 (24-27)	29 (96.67)	0.73	1
	Presentation	14 (12.25-15)	28 (93.33)	14 (12.25-15)	29 (96.67)	0.75	0.55
	Defense	24 (21-25.75)	29 (96.67)	23 (21-25.75)	26 (86.67)	0.64	0.16
	Total	62.5 (59-67)	29 (96.67)	62.5 (60-67)	30 (100)	1	1
Co-evaluation (n=106)		36 (34.37-36)	98 (92.45)	35.25 (32.8-35.4)	97 (91.51)	<0.001	0.8
Self-evaluation (n=106)		40 (38-40)	104 (98.11)	40 (40-40)	106 (100)	<0.001	0.16

OPBL: online problem-based learning.
* Data from the 30 teams randomly created at the beginning of the course were taken into account for the oral presentation.

Finally, concerning student satisfaction with the use of OPBL in the course, most students rated the items evaluated as "strongly agree" (35.85-55.66%) and "agree" (24.53-39.62%). Furthermore, when comparing the proportion of students who selected "strongly agree" with those who selected "agree," only question 5 (Did the OPBL allow you to achieve the expected learning outcomes for the course?) showed a higher proportion of participants selecting the "agree" option (39.62% vs. 35.85%) (Figure 2).
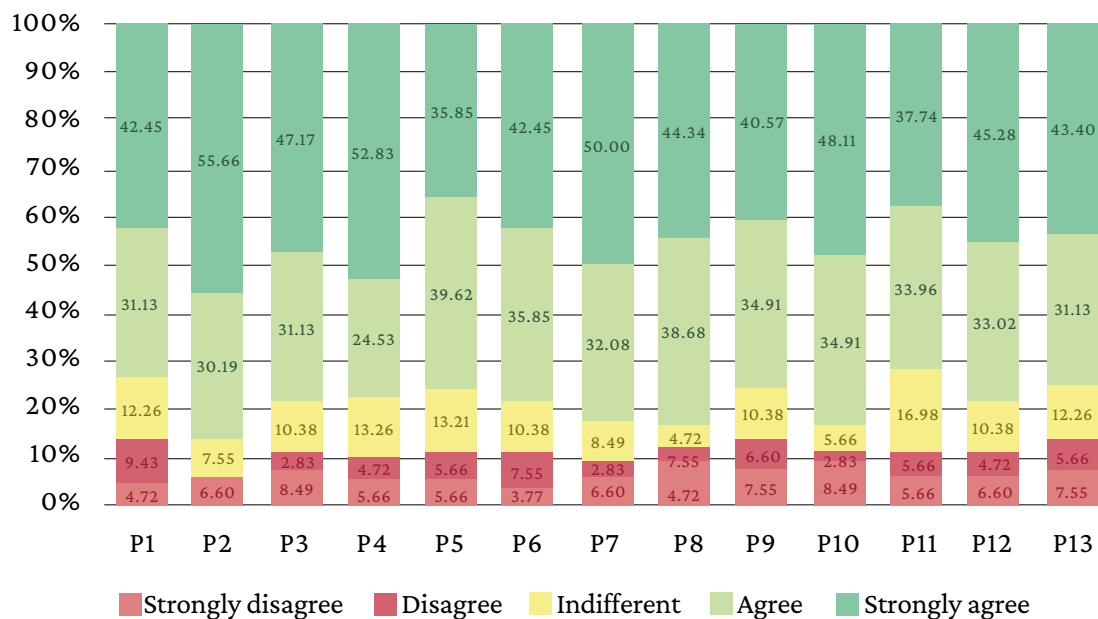
Figure 2. Level of satisfaction with the OPBL reported by students.
P1: I was well informed about the PBL methodology. P2: The activities carried out during the PBL were carried out in accordance with the instructions. P3: The facilitator (professor) provided effective guidance to the teams. P4: The facilitator (professor) encouraged our discussions. P5: The PBL allowed us to achieve the learning outcomes of the course. P6: PBL is a good method for putting knowledge into practice. P7: The clinical cases inspired me to use additional learning resources. P8: The PBL team presentation helped us understand and use the appropriate terminology. P9: The PBL allowed me to learn from other students and work as a team. P10: The PBL work was characterized by mutual respect and teamwork. P11: PBL allowed me to improve my communication skills. P12: PBL is an effective learning tool. P13: I recommend PBL to other students.

Discussion

This study describes the results achieved after implementing OPBL (2 clinical problems to be solved in 1 session of 4 hours per week for 4 weeks) in the pathophysiology course of a physical therapy undergraduate program in Chile during the COVID-19 pandemic. Such a health crisis entailed a change in learning paradigms at all educational levels, including medical education and health sciences training, because it was necessary to cancel all face-to-face educational activities and introduce online education as the only way to ensure the continuation of the training processes carried out by these students during that period, requiring the use of various e-learning strategies.[10,16,18,23,24]

Evidence suggests that OPBL was successfully used in the training of medical[10,16] and other health sciences students[18,25] in the context of the COVID-19 pandemic. Regarding the implementation of the OPBL, contrary to our study, Haley & Brown,[18] who conducted a study in first and second year dental students at the University of Illinois (2 weekly sessions of 3 hours each with working groups consisting of 8 students and a professor acting as facilitator), reported that the clinical problems used were regularly modified to achieve different case-related objectives at the end of each session and not at the end of the case, resulting in a more natural guided clinical problem-solving process. This aspect, given its relevance, could be considered for future implementations of OPBL when teaching the pathophysiology course to physical therapy undergraduate programs.

In the case of medical students, Coiado et al.,[10] in a study conducted during the COVID-19 pandemic at a medical school in Illinois (United States) to assess the pros and cons of OPBL versus face-to-face PBL, reported that, after 12 two-hour sessions, the overall performance of the students was similar in both PBL modalities, despite the disadvantages of the online learning environment, such as a greater risk of student distraction and the fact that online sessions tend to progress more slowly as pauses are necessary, as well as more time for participants to speak and for others to understand. Based on these findings, the authors conclude that the OPBL model they present can help improve medical training and can also be easily adapted by other institutions.[10] Another important aspect to consider is that the implementation of OPBL in that study was similar to ours in terms of the number of hours used to analyze the clinical problem, the roles of the students, and the facilitating role of the professor.

According to the data reported in the present study, it can be stated that OPBL is a potentially effective strategy to achieve learning outcomes in physical therapy students in the context of online training processes (either as a voluntary approach or due to a situation such as the COVID-19 pandemic), as this methodology allowed the students' knowledge and skills to improve since, after weighting the grades obtained in the different evaluations, all the students passed the course. This finding is consistent with a systematic review of 9 randomized clinical trials (RCTs) conducted in medical students (890 students in total) by Tudor et al.,[12] who concluded that, first, OPBL is as effective as traditional PBL in improving students' knowledge and superior to traditional learning and, second, OPBL may be more effective than traditional learning or traditional PBL in improving students' skills.

It is also consistent with the study carried out by Rosmaria et al.,[17] who conducted a systematic review that included 7 studies on the use of OPBL-based interventions or training strategies in health sciences students in different courses such as physiology, anatomy, nursing, community health, etc. (654 students in total) and concluded that OPBL has a positive effect on knowledge acquisition, self-learning capacity, motivation, learning experience, communication, and application of knowledge. Notwithstanding

the above, it should be pointed out that none of the studies included in their review were conducted on physical therapy students.

Other studies, such as the one conducted in 2020 by Aslan *et al.*,[25] which compared the results of two groups of university students in Turkey who received online first aid training, one through traditional methods (n=25) and the other through PBL (n=20), conclude that, in the context of the pandemic, OPBL improved students' problem-solving and interaction skills in synchronous activities, which was assessed using a questionnaire that measured the level of interaction in online classes. This issue was not evaluated in our study and could be considered for future implementations of OPBL.

Evidence regarding the effectiveness of OPBL in the training of physical therapy students is scarce, as we only found two studies. The first was conducted by Smith-Turchyn *et al.*,[20] in Canada, and its aim was to evaluate the perspective of 241 students and 85 tutors on the effectiveness of tutoring in OPBL compared to face-to-face PBL in occupational therapy, physical therapy, and speech therapy undergraduate programs, concluding that OPBL was effective for achieving the course objectives. The other was conducted by Arienti *et al.*[19] in Italy on 121 first-year physical therapy students, with the purpose of evaluating the effectiveness of OPBL as an educational tool to teach EBP competencies, finding that, following the educational intervention, students showed a significant improvement in all the domains analyzed ($p<0.001$) except for "sympathy", in which the average score decreased from 25.0 points before the intervention to 21.0 points after the intervention; furthermore, according to these authors, improvement was greater in the terminology and practice domains (45.5±1.4 vs. 55.2±1.1 y 18.6±1.4 vs. 24.7±1.1).

However, the body of literature on the use of traditional (face-to-face) PBL in physical therapy training is more robust.[15,26] For example, Pathmanathan *et al.*,[15] in a systematic review on the effectiveness of PBL in the training of physical therapy students that included 2 studies (291 students in total), reported that PBL is effective for developing different competencies, especially for promoting early EBP. Along the same lines, Lennon *et al.*,[27] in a study conducted in physical therapy students at the University of Dublin, reported that PBL applied in early stages (second year) is effective for promoting EBP.

Based on what has been reported by Pathmanathan *et al.*,[15] Arienti *et al.*,[19] Smith-Turchyn *et al.*,[20] and Lennon *et al.*,[27] as well as the results of our study, it is possible to state that, in addition to being effective for achieving learning outcomes, the use of OPBL in the early stages of physical therapy students' training promotes collaborative learning and contributes to the early development of EBP competencies, which are necessary for proper professional performance.

However, despite the benefits that OPBL offers, as mentioned above, studies on the implementation of this methodology in the training of physical therapy students are scarce,[19,20] and there are no studies that report the results of its specific use in pathophysiology courses included in physical therapy programs. This scenario is similar to the situation observed for this course in medical programs, since the systematic review by Tudor *et al.*[12] found that the field of study in only 1 of the 9 included RCTs comparing the effectiveness of OPBL with traditional PBL or traditional teaching was human physiology (150 first-year students), a course that is potentially related to pathophysiology. This demonstrates that there is a shortage of studies on the use of OPBL in pathophysiology courses, not only in the context of physical therapy training, but also in medical programs, which have more literature on the implementation of this methodology.[10,12,16]

A notable finding of our study is that, in both OPBL1 and OPBL2, students' performance was much higher in the group evaluation (passing rate: 96.67% and 100%) than in the

individual written test (passing rate: 32.08% and 15.09%). Unfortunately, after reviewing the available literature on the subject, we found no studies comparing group and individual performance in the context of OPBL.

Concerning student satisfaction with OPBL, our study showed high levels of satisfaction. Specifically, in questions 1, 8, 10, and 11, results were consistent with those reported by Alkhowail *et al.*,[16] who evaluated OPBL satisfaction among medical students, finding a high score in aspects related to delivery of instructions, adequate testing to assess learning outcomes, and interactivity of the group and students in the context of online activities. With respect to satisfaction related to learning achievement and OPBL effectiveness (questions 5, 6 and 11), our results were similar to those reported by Smith-Turchyn *et al.*,[20] who found that students were satisfied with the use of online tutorials and considered them useful in achieving the course objectives.

As for the limitations of our study, although OPBL and traditional PBL promote student interaction and teamwork when analyzing a clinical problem, our study only made this evident through some questions related to the level of student satisfaction, and this was not evaluated as a study variable through a questionnaire designed for this purpose, particularly considering that university activities became virtual in the context of the pandemic. Moreover, the effect of the facilitator on student performance was not measured either. Finally, there are no studies that allow us to compare and discuss our findings regarding a much higher performance of students in the group evaluation than in the individual evaluation in the context of the implementation of OPBL in the training of physical therapy students.

The strengths of this study include the rapid implementation of PBL in a virtual context due to the COVID-19 pandemic and the high level of student satisfaction. Further research should be directed at demonstrating the effectiveness of OPBL in undergraduate physical therapy students.

Conclusions

The students achieved the learning objectives of the pathophysiology course, so it is possible to conclude that their performance was adequate after implementing OPBL. It is worth noting that group performance was superior to individual performance. In addition, the level of student satisfaction with the use of this methodology was high.

Conflict of interests

None stated by the authors.

Funding

Acknowledgments

References

1. Núñez-Cortés JM. Educación médica durante la crisis por Covid-19. Educ Med. 2020;21(3):157. doi: 10.1016/j.edumed.2020.05.001.

2. Giri J, Stewart C. Innovations in assessment in health professions education during the COVID-19 pandemic: A scoping review. Clin Teach. 2023;20(5):e13634. doi: 10.1111/tct.13634. PMID: 37698032.

3. Wilcha RJ. Effectiveness of virtual medical teaching during the COVID-19 crisis: Systematic review. JMIR Med Educ. 2020;6(2):e20963. doi: 10.2196/20963. PMID: 33106227; PMCID: PMC7682786.

4. Gandhi MH, Mukherji P. Learning Theories. In: StatPearls [Internet]. Treasure Island: StatPearls Publishing; 2023 [cited 2025 Mar 28]. Available from: https://bit.ly/4j9C35s.

5. Do HN, Do BN, Nguyen MH. 3How do constructivism learning environments generate better motivation and learning strategies? The Design Science Approach. Heliyon. 2023;9(12):e22862. doi: 10.1016/j.heliyon.2023.e22862. PMID: 38125439; PMCID: PMC10730747.

6. de Caprariis P. Constructivism in online learning: A view from the science faculty. Educational Technology. 2000;40(6):41-5.

7. Mbhiza HW. Shifting paradigms: Rethinking education during and post-COVID-19 pandemic. Research in Social Sciences and Technology. 2021;6(2):279-89. doi: 10.46303/ressat.2021.31.

8. Alismaiel OA, Cifuentes-Faura J, Al-Rahmi WM. Online learning, mobile learning, and social media technologies: An empirical study on constructivism theory during the COVID-19 pandemic. Sustainability. 2022;14(18):11134. doi: 10.3390/su141811134.

9. Jardines-Garza FJ. Comparación de la educación a distancia con la educación presencial: modelos de educación, diseños instruccionales y rendimiento académico de los alumnos. Innovaciones de Negocios. 2010;7(14):293-314. doi: 10.29105/rinn7.14-6.

10. Coiado OC, Yodh J, Galvez R, Ahmad K. How COVID-19 transformed problem-based learning at Carle Illinois college of medicine. Med Sci Educ. 2020;30(4):1353-4. doi: 10.1007/s40670-020-01063-3. PMID: 32864181; PMCID: PMC7444895.

11. Vergara-de la Rosa E, Vergara-Tam R, Alvarez-Vargas M, Camacho-Saavedra L, Galvez-Olortegui J. Educación médica a distancia en tiempos de COVID-19. Educación Médica Superior. 2020;34(2).

12. Tudor-Car L, Kyaw BM, Dunleavy G, Smart NA, Semwal M, Rotgans JI, *et al.* Digital problem-based learning in health professions: Systematic review and meta-analysis by the digital health education collaboration. J Med Internet Res. 2019;21(2):e12945. doi: 10.2196/12945. PMID: 30816846; PMCID: PMC6416535.

13. Ng ML, Bridges S, Law SP, Whitehill T. Designing, implementing and evaluating an online problem-based learning (PBL) environment - A pilot study. Clin Linguist Phon. 2014;28(1-2):117-30. doi: 10.3109/02699206.2013.807879. PMID: 23837407.

14. Trullas JC, Blay C, Sarri E, Pujol R. Problem-based learning in medical degree teaching: a scoping review. Research Square. 2021. doi: 10.21203/rs.3.rs-514038/v1.

15. Pathmanathan C, Maddumage SP, Rajasinghe U. Problem based learning in Physiotherapy undergraduate curriculum: A systematic review. Research Square. 2022. doi: 10.21203/rs.3.rs-1817388/v1.

16. Alkhowailed MS, Rasheed Z, Shariq A, Elzainy A, El Sadik A, Alkhamiss A, *et al.* Digitalization plan in medical education during COVID-19 lockdown. Inform Med Unlocked. 2020;20:100432. doi: 10.1016/j.imu.2020.100432. PMID: 32959020; PMCID: PMC7494503.

17. Rosmaria, Ashar R, Muhaimin, Herlambang. Problem based learning model in virtual environment class in health: a sistematic review. Nsc Nursing. 2022;1(4):46-62. doi: 10.32549/OPI-NSC-61.

18. Haley CM, Brown B. Adapting problem-based learning curricula to a virtual environment. J Dent Educ. 2021;85(S1):878-9. doi: 10.1002/jdd.12189. PMID: 32396223.

19. Arienti C, Lazzarini SG, Pollet J, Negrini S. Students 4 Best Evidence as a digital Problem-Based Learning method to improve Evidence-Based Practice competencies in undergraduate physiotherapy students: an observational study. BMJ Evid Based Med. 2021;26(5):251-2. doi: 10.1136/bmjebm-2020-111395. PMID: 33087451.

20. Smith-Turchyn J, Hamilton J, Harris JE, Wojkowski S. Evaluation of virtual problem-based tutorials in health-care professional education. Disabil Rehabil. 2024;46(18):4315-22. doi: 10.1080/09638288.2023.2269841. PMID: 37837336.

21. Vagias WM. Likert-Type Scale Response Anchors. Clemson International Institute for Tourism & Research Development, Department of Parks, Recreation and Tourism Management [Internet]. Clemson: Clemson University; 2006 [cited 2024 May 3]. Available from: https://bit.ly/4cifl8U.

22. World Medical Association (WMA). WMA Declaration of Helsinki – Ethical principles for medical research involving human subjects [Internet]. Fortaleza: 64th WMA General Assembly; 2024 [cited 2025 Feb 3]. Available from: https://bit.ly/40k4BRS.

23. Gordon M, Patricio M, Horne L, Muston A, Alston SR, Pammi M, *et al*. Developments in medical education in response to the COVID-19 pandemic: A rapid BEME systematic review: BEME Guide No. 63. Med Teach. 2020;42(11):1202-15. doi: 10.1080/0142159X.2020.1807484. PMID: 32847456.

24. Khobragade SY, Soe HHK, Khobragade YS, Abas ALB. Virtual learning during the COVID-19 pandemic: What are the barriers and how to overcome them?: What are the barriers and how to overcome them? J Educ Health Promot. 2021;10(1):360. doi: 10.4103/jehp.jehp_1422_20. PMID: 34761046; PMCID: PMC8552260.

25. Aslan A. Problem- based learning in live online classes: Learning achievement, problem-solving skill, communication skill, and interaction. Computers & Education. 2021;171(2021):104237. doi: 10.1016/j.compedu.2021.104237.

26. Frota Da Silva P, De Azevedo GR, Saad-Rodrigues CI. Problem-Based Learning in physiotherapy teaching: An integrative revision. International Journal of Developmental Research. 2022;12(01):53585-91.

27. Lennon O, Phelan D, Wallace D, King J, Barrett T. "The more you did, the more it made sense": Problem-based learning to improve early evidence-based practice in an undergraduate physiotherapy professional programme. Physiother Res Int. 2019;24(3):e1774. doi: 10.1002/pri.1774. PMID: 30994262.

Annex 1. Clinical case presentation evaluation rubric.

	Category	Excellent (4)	Good (3)	Fair (2)	Poor (1)	Failed (0)
			1. FORMAL REQUIREMENTS FOR THE PRESENTATION OF THE CLINICAL CASE (10%)			
1	Presentation structure	Coherent, logical presentation. There is relevant information pertinent to the case. Adequate use of transitions and animations	Coherent presentation. Use of relevant but redundant information. Adequate use of transitions and animations.	There are coherence problems in the presentation, and the information is poorly organized and insufficient. It is difficult to follow the presentation	The presentation has consistency errors. The information is unstructured and has sequencing errors.	Unorganized presentation with inadequate use of transitions and animations. It is not possible to follow the presentation
2	Text presented	No grammar or spelling errors		There are up to 2 grammatical and/or spelling errors		There are more than 2 spelling and/or grammatical errors
3	Support media (ppt, videos, photos, tables, pointer, charts, graphs, images, others.	Support media make the presentation easier to understand and provide relevant information	The support media make the presentation easier to understand but do not provide relevant information	The support media is partially helpful to understand the presentation	The support media are insufficient for the presentation of the subject matter	No support media are used or if used, they undermine the value of the presentation
4	Time limit (10 min)	The presentation complies with the time allotted				The presentation exceeds the allotted time
5	Terminology, proper professional language, diction and personal appearance	The entire team uses appropriate professional language throughout the presentation and expresses themselves fluently, coherently, and concisely	Only 4 team members use appropriate professional language during most of the presentation, expressing themselves fluently and coherently	Only 3 team members use appropriate professional language, which is redundant or limited, thus impairing the coherence and fluency of the presentation	Only 2 team members use appropriate professional language and partially, thus hindering the clarity of the presentation	All team members fail to use appropriate professional language during the presentation
6	Attitude during the presentation	The entire team exhibits confidence and ownership of the topic and the presentation. All speakers make eye contact with their interlocutors. They use their voice tone to stress certain topics and are able to draw the attention of the audience	The team is confident and demonstrates ownership of the topic and the presentation. They fail to make eye contact with interlocutors or use their voice to stress certain topics, yet they are able to attract the attention of the audience	The team demonstrates confidence but needs support from the presentation. They make little eye contact with interlocutors and partially attract the attention of the audience during the presentation	They make minimal eye contact with interlocutors. They fail to engage with the audience	The team is insecure and needs support from the presentation. They make no eye contact with the interlocutors and only read the slides
7	References (as per the Vancouver Style)	Bibliography is provided in accordance with the Vancouver Style and all supporting material is cited, if applicable	Bibliography and references are presented according to Vancouver Style, but the supporting material is incomplete	Bibliography and references are presented but do not follow the Vancouver Style, and the supporting material is incomplete	Only the bibliography is presented in accordance with the Vancouver Style, but the supporting material is not referenced	There is neither bibliography nor references in the support material
			2. DESCRIPTION OF THE PRESENTATION (40%)			
8	Pathophysiologic description of the health condition (causes, risk factors, signs, and symptoms)	The team fully describes and comprehensively explains and justifies the pathophysiology of the health condition (causes, risk factors, signs, and symptoms). They always explain and enable the understanding of the pathophysiology	The team makes a description without comprehensively addressing the pathophysiology of the health condition (causes, risk factors, signs, and symptoms). The explanation is provided most of the time, but the pathophysiology is still understood	The team provides an incomplete description and does not provide an in-depth explanation of the pathophysiology of the health condition (causes, risk factors, signs, and symptoms). Explanations are given in 50% of the information provided, the pathophysiology of the condition is partially understood	The team provides erroneous, shallow explanations of the pathophysiology of the health condition (causes, risk factors, signs, and symptoms). There are errors in the explanation	The team is not able to explain the pathophysiology of the health condition (causes, risk factors, signs, and symptoms)
9	Explanation of functional structural impairments/activity limitation/restriction of participation	The team fully explains and describes in depth the user's functioning according to the criteria and dimensions proposed by the CIF (Functional structural impairments/activity limitation/participation restriction)	The team provides an explanation without thoroughly describing the user's functioning according to the criteria and dimensions proposed by the CIF (Functional structural impairments/activity limitation/participation restriction)	The team gives an incomplete explanation without thoroughly describing the user's functioning according to the criteria and dimensions proposed by the CIF (functional structural impairment/activity restriction/activity restriction)	The team poorly and inadequately explains the user's functioning according to the criteria and dimensions proposed by the CIF (functional structural impairment/activity restriction/restriction to participation)	The team is not able to explain the user's functioning according to the criteria and dimensions proposed by the CIF (functional structural impairment/activity restriction/participation restriction)

	Category	Excellent (4)	Good (3)	Fair (2)	Poor (1)	Failed (0)
10	Interpretation of complementary tests (biochemical profile, blood count, coagulation tests, spirometry, X-ray, CT, MRI, among others)	The team fully interprets the complementary tests relevant to the health condition studied (biochemical profile, blood count, coagulation tests, spirometry, radiography, CT, MRI, among others)	The team interprets at least 75% of the complementary tests relevant to the health condition studied (biochemical profile, blood count, coagulation tests, spirometry, radiography, CT, MRI, among others)	The team interprets at least 50% of the complementary tests relevant to the health condition studied (biochemical profile, blood count, coagulation tests, spirometry, radiography, CT, MRI, among others)	The team interprets at least 25% of the complementary tests relevant to the health condition studied (biochemical profile, blood count, coagulation tests, spirometry, radiography, CT, MRI, among others)	The team is not able to interpret the complementary tests relevant to the health condition studied (biochemical profile, blood count, coagulation tests, spirometry, radiography, CT, MRI, among others)
11	Explanation of pharmacological treatment depending on the health condition studied and its impact on functioning (mechanism of action, pharmacodynamics, pharmacokinetics, adverse reactions)	The team fully recognizes and correctly and thoroughly describes the pharmacology associated with the health condition studied (mechanism of action, route of administration, adverse reactions)	The team fully recognizes and correctly describes the pharmacology associated with the health condition studied (mechanism of action, route of administration, adverse reactions), but does not go into detail.	The team has incomplete knowledge of the pharmacology associated with the condition studied (mechanism of action, route of administration, adverse reactions) and describes it correctly only in some cases	The team partially recognizes and correctly describes only 1 drug in the pharmacology associated with the health condition studied (mechanism of action, route of administration, adverse reactions)	The team does not recognize nor correctly describe the pharmacology associated with the health condition studied (mechanism of action, route of administration, adverse reactions)

<p align="center">3.   PRESENTATION DEFENSE (50%)</p>

	Category	Excellent (4)	Good (3)	Fair (2)	Poor (1)	Failed (0)
12	Ability to integrate	The team is able to make complete and detailed deductions based on the cognitive, clinical, procedural, and experiential elements available to them, integrating them to answer the questions posed	The team makes complete but not detailed deductions based on the cognitive, clinical, procedural, and experiential elements available to them, integrating them to answer the questions posed	The team makes incomplete and unspecific deductions based on the cognitive, clinical, procedural, and experiential elements available to them and does not integrate them with each other	The team makes incorrect or misleading deductions based on the cognitive, clinical, procedural, and experiential elements available to them and does not integrate them with each other	The team makes deductions based on the cognitive, clinical, procedural, and experiential elements available to it and does not integrate them with each other
13	Ability to synthesize answers	The entire team is able to synthesize and to provide a complete and detailed argumentation of their answers to the questions posed by the professor	Only 4 students are able to synthesize and fully support and defend their answers to the questions posed by the professor	Students are redundant and unclear about the questions posed by the committee, but they manage to partially support and defend their answers to the questions posed by the professor	Students are redundant and unclear with the questions posed by the committee, but they manage to support and defend their answers to the questions posed by the professor with errors	Students are not clear when answering the questions posed by the committee and fail to support and defend their answers
14	Effectiveness in the presentation of ideas	The whole team thoroughly develops their ideas in detail, they are able to give coherent answers during the defense of their presentation.	Students fully develop their ideas, are able to give coherent answers during the defense of their presentation	Students partially develop their ideas, with little coherence in their answers during the defense of their presentation	Students fail to articulate ideas, lack coherence at times during the defense of their case	Students fail to develop their ideas
15	Background in pathophysiology	The team thoroughly supports and provides an in-depth justification of the pathophysiology of the health condition at the time of the defense	The team makes a description of the pathophysiology of the health condition at the time of the defense, but it is not detailed	The team provides an incomplete description but does not elaborate on the pathophysiology of the health condition at the time of the defense	The team poorly and insufficiently explains the pathophysiology of the health condition at the time of the defense	The team is not able to provide a description of the pathophysiology of the health condition at the time of the defense
16	Background in complementary tests	The team fully explains and elaborates on the justification of the complementary tests performed to assess the health condition at the time of the defense	The team provides an explanation but lack depth regarding the complementary tests of the health condition at the time of the defense	The team provides an incomplete explanation and does not give a thorough review of the complementary tests performed to assess the health condition at the time of the defense	The team poorly and inadequately explains the complementary tests performed to assess the health condition at the time of the defense	The team is not able to explain the complementary tests used to assess the health condition at the time of the defense
17	Background in pharmacology	The team fully explains and thoroughly supports the pharmacology associated with the condition at the time of the defense	The team is able to explain but not in depth the pharmacology associated with the condition at the time of the defense	The team provides an incomplete explanation of the pharmacology associated with the condition at the time of the defense and does not provide an in-depth understanding of the condition	The team poorly and inadequately explains the pharmacology associated with the condition at the time of the defense	The team is not able to explain the pharmacology associated with the condition at the time of the defense

	Category	Excellent (4)	Good (3)	Fair (2)	Poor (1)	Failed (0)
18	Background in impact on functioning	The team fully explains and thoroughly justifies the impact that the health condition has on functioning at the time of the defense	The team provides an explanation, but not in depth, of the impact that the health condition has on performance at the time of defense	The team provides an incomplete assessment and does not thoroughly consider the impact of the health condition on functioning at the time of the defense	The team provides an erroneous and superficial assessment of the impact that the health condition has on functioning at the time of defense	The team is unable to establish the impact on functioning caused by the health condition at the time of the defense

Annex 2. Co-evaluation rubric.

Name of co-evaluated student: _____

Category	Excellent (4)	Good (3)	Poor (1)	Fail (0)
Commitment	My teammate was always responsible and committed to the activity, consciously taking advantage of the time allotted in class to review material, do research and generate new contributions, which made it possible to balance group work and make it more efficient	My teammate, most of the time, was responsible and committed to the activity, consciously taking advantage of the time allotted in class to review material, do research and generate new contributions; however, their attitude prevented us from balancing group work and making it more efficient	My teammate was sometimes responsible and committed but was not aware of the time allotted in class to review material, do research and generate new contributions, making it difficult to balance group work and make it more efficient	My teammate was never responsible nor committed to the activity, was not aware of the time allotted in class to review material, do research and generate new contributions, and did not allow to balance group work and make it more efficient
Responsibility and concern	My teammate was responsible and concerned about the development of the activity; they timely complied with the commitments made, schedules, delivery of products, review of materials, among others, in accordance with the corresponding progress process	My teammate was responsible and concerned about the development of the activity, fulfilled most of the times with the commitments made, schedules, delivery of products, review of material, among others, in accordance with the corresponding progress process	My teammate was responsible and concerned about the development of the activity, occasionally fulfilled the commitments made, schedules, delivery of products, review of material, among others, in accordance with the corresponding progress process	My teammate did not timely comply with the commitments made during the case building process
Leadership	My teammate consistently led and/or enhanced the team's proactivity, effectively influencing the order and structure needed to achieve the final product. My teammate promoted a climate of partnership among the team	My teammate led and/or enhanced the team's proactivity constantly, but without effectively impacting the order and structure needed to achieve the final product. My teammate promoted a climate of partnership among the team	My teammate did not lead but occasionally enhanced the team's proactivity without being an effective influence on the order and structure needed to achieve the final product. My teammate did not promote a climate of partnership among the team	My teammate did not lead or enhance the team's proactivity and did not promote a climate of partnership among the team
Contributions during the process	My teammate reviewed the product developed during the week's work sessions, gave feedback to the group in order to correct errors and provide solutions as a team, which allowed for a better work process	My teammate reviewed the product developed during the week's work sessions; however, they occasionally gave feedback to the group in order to correct errors and provide solutions as a team that allowed for a better work process	My teammate occasionally reviewed the product produced that week, but did not give feedback to the team	My teammate never reviewed the product produced that week, so he was unable to give any feedback
Review of the final product	My teammate reviewed the final work product, gave feedback to the group to fix possible errors and/or provide feedback on ideas that led to consensual team solutions that made it possible to generate a more developed product	My teammate reviewed the final product, gave feedback to the group to fix possible mistakes and/or provide feedback on ideas, but failed to reach consensual team solutions that allowed for a more developed product	My teammate occasionally reviewed the product produced that week, but did not give feedback to the team	My teammate never reviewed the product produced that week, so he was unable to give any feedback.
Fulfilled the assigned role	My teammate fulfilled the assigned role each week, contributing to the achievement of the activity's objectives	My teammate occasionally fulfilled the assigned role, contributing to the achievement of the activity's objectives, as well as to the mood within the work team	My teammate occasionally fulfilled the assigned role, but did not contribute to achieving the activity's objectives or to the mood within the work team	My teammate did not fulfill the assigned role in each work week
Participation was proactive and innovative	My teammate gave original suggestions and opinions. They were decisive and innovative, contributing to the resolution of the case	My teammate gave suggestions and opinions, was decisive, although not innovative, but still contributed to the resolution of the case	My teammate gave suggestions and opinions, was not decisive and innovative, but still contributed to the resolution of the case	My teammate did not contribute to the resolution of the case
Effective communication	My teammate communicated effectively, respectfully and appropriately with all team members during all work sessions and was willing to listen to the recommendations made	My teammate communicated effectively, respectfully and appropriately with all team members during all work sessions but was not available to listen to the recommendations made	My teammate communicated effectively, respectfully and appropriately with all team members during some work sessions, but was not willing to listen to the recommendations made	My teammate did not communicate effectively, respectfully and appropriately with team members and was also not willing to listen to the recommendations made
Teamwork	My teammate contributed to the working environment, working collaboratively to achieve the objectives of each work week	My teammate contributed to the working environment, but occasionally worked collaboratively to achieve the objectives each work week	My teammate contributed sporadically to the working environment, but did not work collaboratively to achieve the objectives in each work week	My teammate did not contribute to the working environment and did not work collaboratively

Annex 3. Self-evaluation rubric

Student's name: _____ Date: _____

Category	Excellent (4)	Good (3)	Poor (1)	Fail (0)
Attendance and punctuality	I attended all the workshops. I was always on time, five minutes before the class started. I was late on one occasion	I missed 1 or 2 workshops I was late for 2 classes	I missed 3 classes I was late for 3 classes	I missed 4 classes I was always late
Listening attitude	I was always willing to listen to the professor and my teammates during all the work sessions	Overall, I was usually willing to listen to the professor and my teammates	Sometimes I chatted with teammates, but I tried to avoid doing other activities	I find it hard to stay focused. Most of the time I tend to chat with my teammates or do other activities
Work attitude	My work attitude always contributed to maintain a cooperative work environment in all the work sessions	Most of the time, I showed a good work attitude	My attitude sometimes disturbs the work environment	I tend to disturb the work environment with my actions
Participation in the synchronous activity	In all the work sessions I participated, made comments, provided examples, gave my opinion, and/or reported on the work done by my team in the synchronous activity	On several occasions, I made contributions, examples, or opinions in the synchronous activity	I participated in the general discussion only on a few occasions. Most of the time my participation was limited to the group work	I participated very little or not at all in class
Performance of asynchronous autonomous activities	I completed all the proposed activities in all the work sessions, following the instructions and sticking to the topic and context of the work	I carried out most of the proposed activities, with a high level of commitment	I carried out some of the proposed activities in full and stayed on topic	I avoided doing the activities proposed in class
Respect	I maintained a respectful attitude towards the professor and teammates during all the work sessions	On several occasions, I maintained a respectful attitude towards the professor and teammates in all the activities carried out in all the work sessions	I sometimes maintained a respectful attitude towards the professor and teammates in all activities carried out	I did not maintain a respectful attitude towards the professor and teammates
Use of cell phone during the synchronous activity	I used my cell phone or notebook for academic purposes during all the work sessions. I never checked social networks during the synchronous activity	I almost always used my cell phone or notebook for academic purposes. Sometimes I checked social networks during the synchronous activity	I sometimes used my cell phone or notebook for academic purposes and checked social networks during the synchronous activity	I never used my cell phone or notebook for academic purposes. I only checked social networks during the synchronous activity.
Participation in the PBL process	My contributions or suggestions were original in all the work sessions. I was decisive and innovative and contributed to the resolution of the case	My contributions or suggestions were almost always original. Sometimes, I was decisive and innovative and contributed to the resolution of the case	My contributions or suggestions were sometimes original. I was sometimes decisive and innovative and contributed to the resolution of the case	I did not make original contributions or suggestions. I was not decisive and innovative
Effective communication	I was able to communicate effectively, respectfully and appropriately with all team members and professors in all work sessions	I was able to communicate effectively, respectfully and appropriately with all team members in only 3 work sessions	I was able to communicate effectively, respectfully and appropriately with all team members in only 2 work sessions	I was able to communicate effectively, respectfully and appropriately with all team members in only 1 work session
Fulfillment of the assigned role	I fulfilled my assigned role in all the work sessions, contributing to the achievement of the activity's objectives, as well as to the team's work environment	I fulfilled my assigned role in only 3 work sessions, contributing to the achievement of the activity's objectives, as well as to the working atmosphere within the team	I fulfilled my assigned role in only 2 work sessions, contributing to the achievement of the activity's objectives, as well as to the working atmosphere within the team	I fulfilled my assigned role in only 1 work session, contributing to the achievement of the activity's objectives, as well as to the working atmosphere within the team

Annex 4. General evaluation of the "Problem Based Learning" (PBL) methodology.

Please evaluate the "Problem-Based Learning" (PBL) methodology used for the pathophysiology course.
Read each statement and mark with a "x" the option that most accurately reflects your opinion about the PBL activity.

	Strongly disagree	Disagree	Indifferent	Agree	Strongly agree
I was well informed about the PBL methodology (personal benefit)					
The activities developed during the PBL were carried out as instructed					
The facilitator (professor) guided the teams well					
The facilitator (professor) helped to promote our discussions					
The PBL allowed us to achieve the learning objectives of the course					
PBL is a good method to apply knowledge					
The clinical cases encouraged me to use additional learning resources (concept maps, videos, team meetings, literature search)					
The team's presentation of the PBL helped with our understanding and use of appropriate terminology					
The PBL allowed me to learn from other students and my teammates					
My work in the PBL involved teamwork, mutual respect, and cooperation					
The PBL allowed me to improve my communication skills					
The PBL is an effective learning tool					
I recommend the PBL to other students					

Comments:

Name: _____ ID: _____
Thank you for sharing with us your answers.