

SMARTPHONE-MEDIATED PROBLEM-BASED LEARNING IN STUDENTS AT A PERUVIAN UNIVERSITY

Wilfredo Carcausto¹, Silvia Del Pilar Alza-Salvatierra², María Patricia Cucho Leyva³,
Bertha Angélica León Tazza⁴, Vanessa Jocelyn Alza-Salvatierra⁵

¹Universidad César Vallejo, wcarcaustocalla@ucvvirtual.edu.pe, ORCID ID: 0000-0002-3218-871X

²Universidad César Vallejo, salzas@ucv.edu.pe, ORCID ID: 0000-0002-7075-6167

³Universidad César Vallejo, mariacuchol@ucvvirtual.edu.pe, ORCID ID: 0000-0002-4449-4909

⁴ Instituto de Educación Superior Pedagógico Público María Madre,

bleon@pedagogicomariamadre.edu.pe, ORCID ID: 0000-0002-6232-9990

⁵ Universidad Nacional de Trujillo, valza@unitru.edu.pe, ORCID ID: 0000-0003-4781-8646

ABSTRACT

The promotion of active undergraduate university teaching-learning is essential for future professionals who will contribute to the development of society. Therefore, this study determines and describes the effect of the Smartphone-mediated problem-based learning (PBL) methodology on the development of planning skills, teamwork and subject mastery in students at a university in northern Lima. An exploratory quali-quantitative study was conducted with a quasi-experimental post design in which 5 work teams participated in the experimental group and 5 in the control group. An interview rubric and an interview guide were used for data collection. Of the 5 work teams in the experimental group, 60.0% (n=3) showed good development of planning competence. In teamwork, 80% showed that interaction and communication was good. In relation to content, 60.0% showed excellent content knowledge and sufficient understanding of the problem, compared to the control group. The following categories emerged from the interviews: benefits of Smartphone with PBL, teacher's role and difficulties during sessions. In conclusion, the application of the PBL methodology mediated by a smartphone in the development of planning skills, teamwork and mastery of the subject was good, despite some drawbacks regarding the size of the classroom, limited internet connection and some non-operational electrical supports.

Keywords: problem-based learning, smartphone, higher education, ICT.

Resumen

El fomento de la enseñanza-aprendizaje activa universitaria en pregrado es fundamental para los futuros profesionales que contribuirán en el desarrollo de la sociedad. Por ello, el presente estudio determina y describe el efecto de la metodología de aprendizaje basado en problemas (ABP) mediado por Smartphone en el desarrollo de competencias de planificación, trabajo en equipo y dominio temático en estudiantes de una universidad de Lima Norte. Se realizó un estudio cuali-cuantitativo exploratorio con diseño cuasiexperimental post en donde participaron 5 equipos de trabajo en el grupo experimental y 5 en el grupo control. Para la recolección de los datos se utilizó la rúbrica y una guía de entrevista. De los 5 equipos de trabajo del grupo experimental, el 60,0 % (n=3) mostraron buen desarrollo de competencia de planificación. En el trabajo en equipo, el 80%

muestra que la interacción y comunicación fue buena. En relación al contenido, el 60,0% muestran un conocimiento excelente de contenido y comprensión suficiente del problema, en comparación con el grupo de control. De las entrevistas emergieron las categorías: beneficios del Smartphone con ABP, rol del docente y dificultades durante sesiones, En conclusión, la aplicación de la metodología de ABP mediado por un smartphone en el desarrollo de habilidades de planificación, trabajo en equipo y dominio del tema fue buena, pese algunos inconvenientes respecto al tamaño del aula, limitada conexión a internet y algunos soportes eléctricos no operativos.

Palabras clave: Aprendizaje basado en problemas, smartphone, educación superior, TIC.

Introduction

From different international organizations such as UNESCO and the OECD, the traditional teaching methodology that predominates in the university environment is being questioned, despite the existence of various methodologies and didactic tools for teaching and meaningful learning (UNESCO, 2019 ; OECD, 2019).

Currently, it is observed that technological devices, such as laptops, tablets, cell phones and digital whiteboards, have gone from professional or domestic use to become essential tools in education. However, disadvantages have arisen, such as the abuse in the use of cell phones and their ability to affect the classroom climate; the teacher, in addition, has to fight with the possible alterations of coexistence in the classroom resulting from misuse or abuse of these technologies by students (Reche et al., 2019).

In this same context, it can be observed that Internet use has grown rapidly, in Europe and North America, 85% of the population are Internet users, the increase is 600% in Europe and 200% in North America, from 2000 to 2019. The increase is related to download speed. In areas of Asia such as Taiwan or Singapore, the speed is over 70 Mbps, and in many European countries the average speed is over 30 Mbps in countries such as Sweden, Denmark, Luxembourg, the Netherlands, Belgium or Spain (internetworldstats in Rodrigo-cano et al., 2020). In Peru, 85.4% of students accessing the Internet through the use of smartphones have higher university education and 89.9% of the population between 25 and 40 years old and 86.9% of those between 19 and 24 years old access the Internet through their cell phones. (INEI, 2018).

In addition to the implementation of ICT in education, methodologies have been proposed that promote cognitive, intrapersonal, interpersonal and technical skills development, such as the problem-based learning (PBL) methodology. The skills developed by this methodology have been defined as 21st century skills, and should therefore be included in the curricula, developed and evaluated in higher education (Geisinger in Carrió et al., 2022). PBL is a type of teaching-learning methodology with a constructivist approach based on using problems as a starting point to develop problem-solving skills and the construction and integration of new knowledge. (Alrahlah, 2016). PBL is based on solving real problems, using critical thinking, active learning, which is achieved through discussions and group collaboration. Students jointly create goals for their independent learning, investigate appropriate ways for solution, generate new ideas, evaluate them and employ them in practice. (Lytovchenko et al., 2022); It is a student-centered instructional approach that

aims to develop students' individual skills and collaborative problem solving skills. (Saleh et al., 2022)..

PBL is focused, experiential learning organized around inquiry, explanation, and meaningful problem solving, where students group together, collaborate, and learn what is required to solve a problem, (Hmelo-Silver in Carrió et al., 2022)In addition, it facilitates an encouraging learning environment for the development of cross-cutting thinking and inquiry skills. However, its execution is essential to achieve positive results. (Carrió et al., 2022)In PBL methodology, learners are responsible for monitoring the problem-solving process, determining the learning objectives, making a work plan, choosing and assessing learning resources, selecting the most relevant ideas and using them to provide solutions to the problem, and finally, reflecting on their results. (Carrió et al., 2022).

The problem stimulates learning, instead of lecturing, students are given a problem to solve, they form small groups, identify what they know and what they need to know, propose learning goals and make agreements with group members (Lytovchenko et al., 2022; Trullàs et al., 2022). PBL facilitates students' creativity and entrepreneurial skills, improves communication and collaboration. (Weng et al., 2022). improves communication and collaboration (Almulhem & Almulhem, 2022).

PBL methodology originated in the area of medical education in the United States to develop talents. Where, problems are used as instruments to motivate learning, and allows students to explore and learn with the objective of building a knowledge base. In this methodology, teachers guide students to form case studies based on real problems, discuss in groups and propose solutions. (Chang et al., 2022). PBA was initially developed by McMaster University, and is currently used in medical schools around the world, discussions can be conducted in person or virtually, through an online platform. (Pangastuti et al., 2022).

For Savery in (Carrió et al., 2022) PBL methodology, it motivates students to conduct research, integrate theory, practice, and employ knowledge and skills to provide a feasible solution to a concrete problem. Carrió et al. (2022) Savery affirms that social and cultural factors and peer interactions influence cognitive development and that learning develops with active participation in collaborative and purposeful activities.

Wang et al. (2021) defines PBL as a student-centered pedagogy, which can improve their mood and efficiency, however, it is time-consuming to find course materials, bring original learning initiatives and difficult problems can make them lose interest. Some studies have reported the effectiveness and feasibility of PBL integrated with flipped classroom in teaching medical students, which significantly improves their interest and self-learning ability. For Jong et al., (2022) The four key principles of PBL are that it should be constructive, self-regulated, collaborative, and contextual, which should optimize deep learning.

In PBL, students solve an open-ended problem with their peers. Tutors push toward a possible solution rather than impart knowledge. For medical students, PBL cases are comprised of clinical scenarios that address learning objectives (Tsai et al., 2021)The PBL case study provides scaffolding for the composition of ideas and allows for alteration of learning activities as needed.

It is focused on student learning, self-directed and job-embedded, supported by the use of technology. (Munawaroh et al., 2022). It reflects active learning and is considered a multi-methodological and multi-didactic pedagogical approach. (Hincapié et al., 2018)..

Despite the success of PBL in medical education, research on the method applied in engineering and architecture is limited and there are doubts about its viability in technical disciplines, mainly related to (a) the complexity and hierarchical structure of knowledge in these areas and (b) the prevailing pedagogical tradition. Walker and Leary concluded that engineering and science were two of the disciplines least conducive to the application of PBL. (Delgado and De Justo, 2018).

Smartphone use in education

Information and Communication Technologies (ICT) have opened new scenarios in all areas. In education, it provides multiple alternatives for generating and transmitting knowledge, and has also influenced education professionals to adapt to a new context in which ICTs play a significant role in the formation of citizenship. (Matosas-López et al., 2020). However, not all its effects are positive. Bossolasco, Chiecher and Dos Santos in (Matosas-López et al., 2020) mention that the actions of young people in the digital environment do not always involve the development of educational competencies. For Linne in (Matosas-López et al., 2020), indicates that it generates a certain dispersion of the students' attention in the university context.

Because of this context, new teaching methodologies emerge, where mobile devices play an important role in the learning process. (Rodrigo-cano et al., 2020). Also, the use of cell phones intervenes in the teaching-learning process, the starting age of use is increasingly lower and as a result of this, variables that can influence the educational environment arise. (Reche et al., 2019). In recent years, the smartphone and tablet are the devices that have experienced the greatest expansion. These have Internet access and a relatively high battery usage/charge, where numerous applications can be used and have multiple functions that allow them to perform any task. (Rodrigo-cano et al., 2020). These technologies can also be used to develop skills for learning, analyzing and interpreting information, not only for their fields of study, but also for obtaining basic competencies (Paramio et al. in (Rodrigo-cano et al., 2020)..

Internet access from mobile technology allows learning in informal spaces, it is individualized and localized, this learning is known as mobile learning. Its great expansion allows most of the population to have in their Smartphones some of the 100 best tools for learning, such as YouTube, the Google browser and Google Drive, all of which facilitate mobile and collaborative learning. (Hart in Rodrigo-cano et al., 2020).

ICTs allow flexible, ubiquitous and collaborative learning methodologies, and communication with experts in specific fields, immediate connection with other peers or teachers, allows education in informal or non-habitual spaces. M-learning can provide support mechanisms for teachers, such as online surveys and text messages with immediate feedback, allowing teachers and students to participate freely and opportunistically. (Rodrigo-cano et al., 2020)..

For Rodrigo-cano et al. (2020). Mobile-learning, has gained prominence in current training methods. Online virtual courses through mobile devices have generated unprecedented significant advances. Thus, the business sector instructs its employees in this way.

Therefore, the objective of this study is to describe the effect of the ABP methodology mediated by Smartphone in the development of planning skills, teamwork and thematic mastery in university students at a university in northern Lima. The result of the study is relevant for the structuring of the contents and design of teaching strategies in their subjects by teachers to consider technology and the ABP methodology as a didactic support for the search, construction, integration of information and achievement of the didactic objectives set.

Methodology

An exploratory qualitative-quantitative study with a quasi-experimental post design was developed. In the quantitative phase, the measurements of the groups were taken only in the post, then the scores of the experimental group were compared with those of the control group. In the qualitative phase, the work teams of the experimental group were interviewed. Of the 10 work teams, formed by three and/or four university students of the 2019-II semester of a University of North Lima, 5 work teams participated in the experimental group and 5 teams in the control group. Third cycle nursing students who signed the informed consent form were included. Students who did not attend any of the sessions were excluded. Numerical data collection was done with a rubric with three indicators: Planning (P), Teamwork (TE) and Content (C) and 4 response options, which was adapted from Toledo and Sanchez (2018). The same that was validated by five experts linked to the subject and had a reliability of Cronbrach's Alpha 0.82. Likewise, the collection of verbal information was done through a guide of open questions about the use of Smartphones by students and the role of the teacher, which was given to each team for their response.

Permission to conduct the study was requested from the authorities of the Faculty of Health Sciences of the University. Once the authorization was granted, we chose to apply the PBA methodology and the research was conducted during the months of September to December 2019.

The work was carried out during four sessions, each session was developed in 4 academic hours. In the first session, the teams analyzed and described the problem based on their experience; the teacher and the student teams indicated the objectives and contents to be learned and provided information on PBL. In the second session, the necessary information search was carried out. In the third session, each team prepared the work report and in the last session the teams delivered and presented the final report.

The following is an explanation of how the PBL methodology was applied in this study: (1) *Presentation of the problem or problems*. In this step, the teacher, after explaining and illustrating what a problem is, then the representatives of each team randomly choose a problem to read, describe and analyze, about the teaching problem that they experience daily in the classroom, also, they point out the characteristics, cause, consequences and investigate and

describe the active methodology that could remedy. (2) *Identification of learning needs*. In this part, the teacher identifies the students' learning needs. (3) *Setting objectives*. From this, the teacher encourages them to set the objectives and content they intend to address and learn according to the following sequence: (a) Describes the academic experiences they have had with traditional teaching. (b) Studies the different innovative teaching methodologies. (c) Applies the selected innovative teaching methodology with the intention of solving the real problem identified and described in the classroom. (4) *Information search*. In this part, the groups of students search for information. The control group, which was composed of five teams, used the documents prepared for the development of the subject: slides, handouts and printed books provided by the library for the search and collection of information. The experimental group, i.e. five other teams used the smartphone and the documents mentioned in the previous group. (5) *Evaluation*. The teacher assessed developed competencies of the students: planning, teamwork and content.

After data collection, the quantitative part, the findings were processed and analyzed with the 2016 version of the Excel program. Applying descriptive statistics to establish the absolute and relative frequencies of the control and experimental groups. In the qualitative part, the relevant information extracted from the interviews was transcribed, read, analyzed and converged.

RESULTS

Quantitative phase

According to table 1, work planning, of the 5 teams of students 60.00 % (n=3) showed identification and analysis skills on the order of activities in order to evaluate and execute a good level of development of competencies. In comparison with the control group, 40% (n=2) were found to be in the regular and low level, which indicates that more interest is needed to achieve common work goals and to continue improving their planning skills. In the teamwork indicator, 80% (n=4 teams) of the members of the experimental group communicate and interact well or adequately with each other, compared to the control group which was regular with 80% (n=4 teams).

In relation to the content, 60.0% (n=3 teams) showed excellent knowledge of the topics and understanding of the problems, compared to the control group, which was average.

Table 1

Level of development of competencies according to the studied components

| Level of competencies developed | Aspects evaluated | | | | | |
|---------------------------------|-------------------|---------|----------|----------|---------|---------|
| | Planning | | Teamwork | | Content | |
| | GE | GC | GE | GC | GE | GC |
| | N=5 (%) | N=5 (%) | N=5 (%) | N= 5 (%) | N= 5(%) | N=5 (%) |
| Excellent | 1 (20) | 0 (0,0) | 0 (0,0) | 0 (0,0) | 3 (60) | 0 (0,0) |
| Good | 3 (60) | 1 (20) | 4 (80) | 0 (0,0) | 2 (40) | 0 (0,0) |
| Regular | 1 (20) | 2 (40) | 1 (20) | 4 (80) | 0 (0,0) | 4 (80) |

| | | | | | | |
|-------|---------|--------|---------|--------|---------|--------|
| Under | 0 (0,0) | 2 (40) | 0 (0,0) | 1 (20) | 0 (0,0) | 1 (20) |
|-------|---------|--------|---------|--------|---------|--------|

Qualitative phase

Before the intervention to the experimental group, the student teams were interviewed so that they could relate their perceptions about the teaching they received from their teachers. Four problems related to teacher-student communication, management of didactic resources, use of active teaching-learning methods and evaluation of tasks were found and identified, as shown in the quotations from the interviews, which were summarized below:

"Their ways of teaching should improve, they derive be more dynamic and practical" (Interview team 1, September 10, 2019).

"We have some teachers who know a lot about the subject, but they have a hard time communicating in a simple way with us" (Interview team 4, September 13, 2019).

"...teachers in their slides put a lot of information, only sometimes they comment a little, as there is a lot of material, the student gets distracted or tired" (Interview team 2, September 13, 2019).

"The problem of most teachers is that their classes are more expository, when you want to ask them questions, they mention that for the end. But that end, sometimes it does not come because there is not enough time for everyone to intervene" (Interview team 3, September 13, 2019).

"They do not evaluate us in all classes, only in the partial and final, although they do ask us questions, but they do not take notes, it may be because of the number of female students we are" (Interview team 5, September 12, 2019).

Table 2

Distribution of the problem identified in the classrooms

| Open issues identified by students in the classroom |
|---|
| -Poor didactic communication |
| -Deficient management of didactic resources. |
| -Lack of use of active teaching-learning methods located at the site. |
| -Poor task evaluation. |

Source: own elaboration.

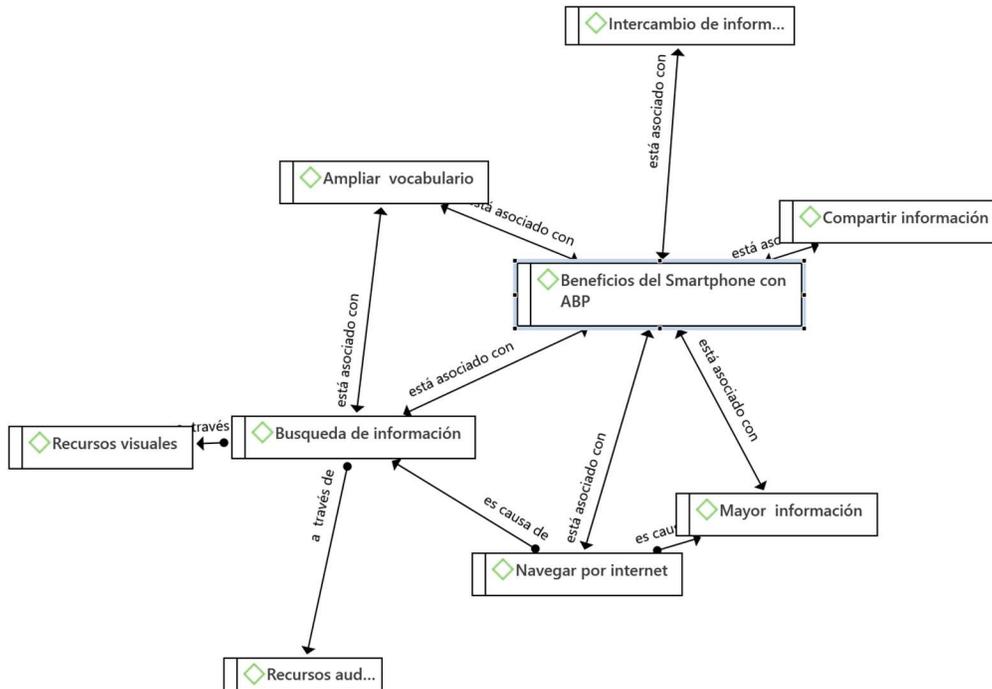
After the intervention, interviews were conducted with the student teams of the experimental group. Three categories emerged from the stories: benefits of using the Smartphone, the teaching role and the difficulties during the sessions, which are presented below.

In relation to the emerging category benefits of the use of the Smartphone. From the interviews conducted with the students, it can be noted that the application of the PBL methodology with the support of a smartphone connected to the Internet was a learning experience, since it facilitated

the search for information through the use of visual and auditory resources and the exchange of information as shown in Figure 1 and the units of meaning that are expressed in the brief quotations reported by the teams.

Figure 1. Benefits of the smartphone with ABP

Own



Source:

elaboration

"Using smartphone with internet was wonderful, since, it helped us to have diverse information at any time on topic. For example, we were able to watch video, lectures and read documents related to the topic, then prepare our report (Interview team 2, December 13, 2019).

"Normally our cell phone we use it for other purposes, now we understood that we can use it to look up information, as an aid to expand my vocabulary and share information with my group mates" (Interview team 3, December 13, 2019).

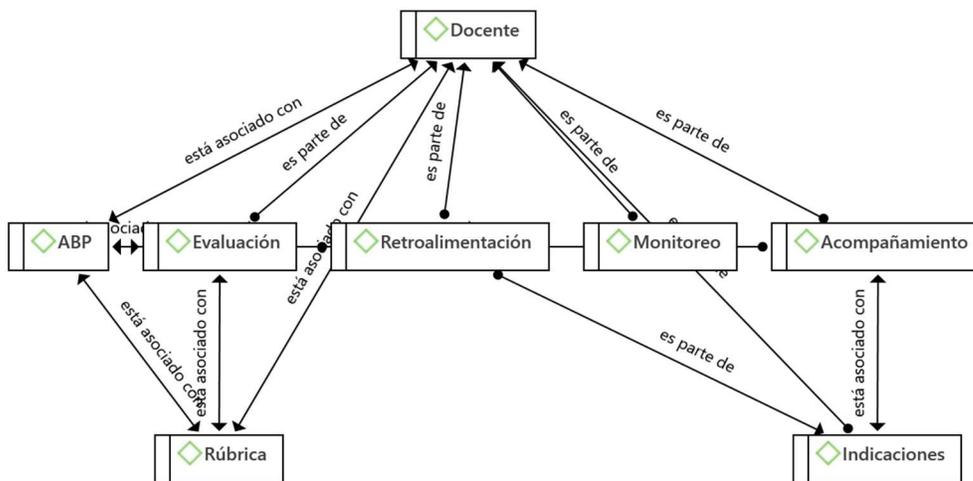
From this account and from Figure 1, it can be understood that the smartphone, which also serves as a search engine, was used to communicate and exchange information for the academic report.

"Thanks to the realization of this work in the classroom we learned to make better use of our cell phone. In our team, we use it to surf the internet and

search for information, send messages and exchange documents to gradually do the work" (Interview team 4, December 13, 2019).

Regarding the category: Teacher's role in the classroom, the participants of the study show the teacher's practices during the development of the class sessions, in which the indications, accompaniment, feedback, monitoring and evaluation (rubric) through the use of PBL stand out.

Figure 2. Teaching role in the classroom



Source:
Own

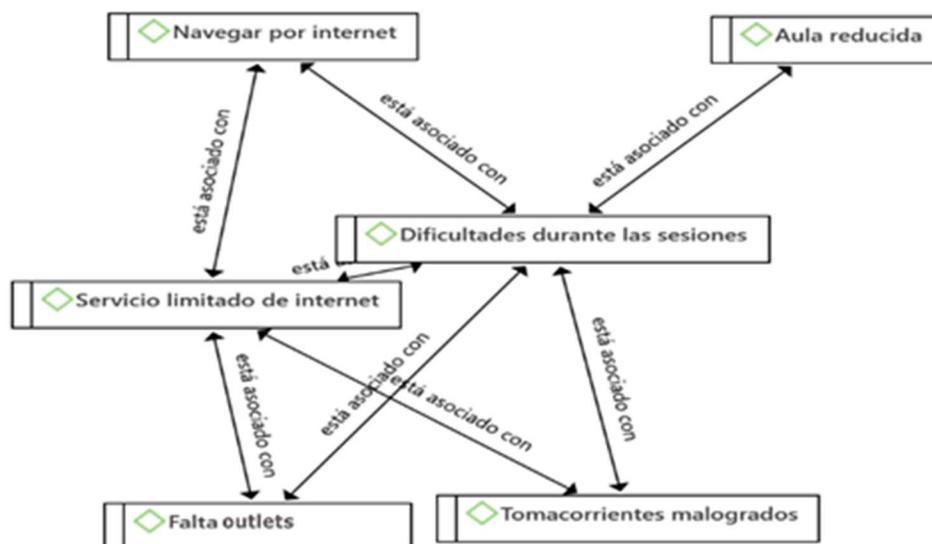
elaboration.

"We explained briefly and directly the topic, then clarified our doubts through examples team by team [...], before finishing the class we were evaluated with the rubric provided to us prior to the start of classes" (Interview team 1, December 13, 2019).

"[...]to start working in teams, the teacher explained the applications and multiple educational uses of the cell phone [...]. Then we would go group by group to observe and comment on what we were doing well and indicate what we should continue to improve" (Interview team 5, December 13, 2019).

In the category of difficulties during the sessions, some difficulties emerged from the participants' speeches that are related to some services provided by the university in the classroom.

Figure 3. Difficulties during sessions



Source: Own elaboration

"Lack of more electrical outlets in the classroom" (Interview team 1, December 13, 2019).

"There are outlets, but some are broken [...]" (Interview team 2, October 13, 2019).

"[...]limited internet service by the university" (Interview team 3, December 13, 2019).

"Since we do the classes in teams, the environment should be broader" (Interview team 5, December 13, 2019).

DISCUSSION

This study aimed to describe the effect of the Smartphone-mediated PBL methodology on the development of planning skills, teamwork and thematic mastery in university students, according to the findings after the post-test, it was found that planning was a key element of student work teams, of which 5 teams of the experimental group obtained higher scores, i.e. showed better development of skills to identify and analyze the sequence of activities to be performed in order to execute and evaluate what was planned.

In the study, the level of learning with smartphone-mediated PBL was good, this explains that the highest percentage of university students adequately learned to communicate, interact and describe the problematic reality. This finding was similar to that of Hincapié et al. (2018). in his research where he compared the working group with the control group in terms of performance and their levels of achievement of critical thinking competence, confirming the benefits that student-centered, active and participatory methodologies, especially PBL, have on the working team, since the results found were superior, showing greater reflection in their training process and greater competence in making judgments.

Regarding the assessment on the use of the smartphone for information construction and search, it was favorable, in that sense, for the teams that used the mentioned resource it was an important support in the integration and construction of new knowledge in a pleasant learning environment, which is similar to what was found by Kim (2020) where the favorable effect of the positive environment on communication and the teaching and learning process in the classroom stands out.

The perception about the teacher's accompaniment and feedback was positive. This means that the pedagogical practices implemented during the class sessions contributed to the development of students' competencies. Furthermore, that teachers need to be involved in reviewing, evaluating and updating their own pedagogical-professional activity. In this sense, Girma et al. (2022). The authors propose to implement the ABP method in their research, which resulted in higher academic satisfaction among ABP students than LBL (Lecture Based Learning) students. The authors propose implementing the PBL method to ensure quality education in higher education and to have qualified professionals. For Ko (2022) Problem-based learning (PBL) provides a new way of learning, where students cooperate in small groups to identify a problem and, after discussion, share their experiences and solve the problems. Students will feel the benefits of teamwork and optimize their learning.

On the other hand, Trullàs et al, Trullàs et al. (2022) states that, if the PBL methodology is properly applied, the degree of satisfaction is high, mainly for students. Moreover, PBL is more effective than traditional methods, it improves social and communication skills, problem solving and self-learning skills, and in many studies it has achieved good results in improving academic performance.

Rodrigo-cano et al. (2020) in their article where they analyzed the digital competencies of workers, skills, knowledge and training on the use of Smartphone for their training. According to the results obtained, 65% of the respondents use the smartphone more than 2 hours a day, they also use it frequently for the performance of their profession, although the correct use of these technologies as learning tools is lacking. It also affirms that there is a digital divide.

According to Fielden and Rico (2022) students need to develop critical thinking, linguistic development and problem-based learning is an excellent methodology to do so. Through this methodology, which focuses on student autonomy and constructivist learning, language skills are also optimized. For Munawaroh et al. (2022) problem-based e-learning significantly affected students' achievement motivation and interest in learning in the entrepreneurship course. Teachers are recommended to implement the E-PBL Model because it can enhance motivation and interest in learning that ultimately increase learning achievement.

CONCLUSIONS

In conclusion, the effect of the application of the PBL methodology mediated by a smartphone in the development of planning skills, teamwork and mastery of the subject was good, despite some

drawbacks regarding the size of the classroom, limited internet connection and some non-operational electrical supports.

Regarding the difficulties for an adequate classroom formation, the interviewees showed a certain negative perception and attitude. From this, it can be inferred that the admission offices are not adequately distributing the designation of classrooms by section; likewise, the university should improve the quality of internet service for the university community and change the electrical supports that are in disuse to avoid the downloading of cell phones.

One of the limitations of the study was that the PBA methodology was applied to a purposively selected group, which does not allow extrapolation of the findings. However, it is an approach that serves to explore with another approach and study design. Likewise, it is an advance in topics associated with university didactics.

REFERENCES

- Almulhem, M. A., & Almulhem, J. A. (2022). Evaluation of Problem-Based Learning implementation in a College of Medicine, Kingdom of Saudi Arabia: a cross sectional comparative study. *BMC Medical Education*, 22, 311. <https://doi.org/10.1186/s12909-022-03347-1>. <https://doi.org/10.1186/s12909-022-03347-1>.
- Ahrahlah, A. (2016). How effective the problem-based learning (PBL) in dental education. A critical review. In *Saudi Dental Journal* (Vol. 28, Issue 4, pp. 155-161). <https://doi.org/10.1016/j.sdentj.2016.08.003>
- Carrió, M., Baños, J. E., & Rodríguez, G. (2022). Comparison of the Effect of Two Hybrid Models of Problem-Based Learning Implementation on the Development of Transversal and Research Skills and the Learning Experience. *Frontiers in Education*, 7. <https://doi.org/10.3389/FEDUC.2022.875860>. <https://doi.org/10.3389/FEDUC.2022.875860>
- Chang, Y.-H., Yan, Y.-C., & Lu, Y.-T. (2022). Effects of Combining Different Collaborative Learning Strategies with Problem-Based Learning in a Flipped Classroom on Program Language Learning. *Sustainability*, 14(9), 5282. <https://doi.org/10.3390/su14095282>.
- de Jong, N., van Rosmalen, P., Brancaccio, M. T., Bleijlevens, M. H. C., Verbeek, H., & Peeters, I. G. P. (2022). Flipped Classroom Formats in a Problem-Based Learning Course: Experiences of First-Year Bachelor European Public Health Students. *Public Health Reviews*, 43(August), 1-9. <https://doi.org/10.3389/phrs.2022.1604795>
- Delgado, A., & De Justo, E. (2018). Evaluation of the design, process and outcomes of a technical subject with problem-based learning. *Education XX1*, 21(2), 179-203. <https://doi.org/10.5944/educxx1.19415>
- Fielden, L., & Rico, M. (2022). Intercultural and linguistic competences for engineering ESP classes: A didactic framework proposal through problem-based learning. *International Journal of Applied Linguistics*, 32(1), 3-24. <https://doi.org/10.1111/ijal.12370>. <https://doi.org/10.1111/ijal.12370>
- Girma, S., Girma, D., & Habtie, E. (2022). Problem based learning approach increases the

- academic satisfaction of health science students in Ethiopian universities: a comparative cross sectional study. *BMC Medical Education*, 22(334). <https://doi.org/10.1186/s12909-022-03397-5>. <https://doi.org/10.1186/s12909-022-03397-5>
- Hincapié, D., Ramos, A., & Chrino-Barceló, V. (2018). Problem-Based Learning as an Active Learning strategy and its incidence on academic performance and Critical Thinking of Medical students. *Revista Complutense de Educación*, 29(3), 665-681. <https://doi.org/10.5209/RCED.53581>
- INEI. (2018). *Estadísticas de las Tecnologías de Información y Comunicación en los Hogares* (Issue 2).
- Kim, J. (2020). Learning and Teaching Online During Covid-19: Experiences of Student Teachers in an Early Childhood Education Practicum. *International Journal of Early Childhood*, 52(2), 145-158. <https://doi.org/10.1007/s13158-020-00272-6>
- Ko, C.-H. (2022). Studying on Learning Satisfaction in Teaching Keyboard Courses With Problem-Based Learning Teaching Mode. *Front. Psychol*, 13, 884311. <https://doi.org/10.3389/fpsyg.2022.884311>.
- Lytovchenko, I., Ogienko, O., Kriukova, Y., Meleshko, I., Yamshinska, N., Voronina, H., & Kutsenok, N. (2022). Online Problem-Based Learning: Possibilities for Engineering Vocabulary Acquisition in ESP Course at Technical University. *International Journal of Information and Education Technology*, 12(9), 905-911. <https://doi.org/10.18178/ijiet.2022.12.9.1700>. <https://doi.org/10.18178/ijiet.2022.12.9.1700>
- Matosas-López, L., Luzardo-Briceño, M., Aguilar-Jiménez, A.-S., & Jaimes-Carrillo, L. (2020). Relationships between social networks and digital instructional resources at university: comparative Spain - Colombia. *Pixel-Bit. Journal of Media and Education PIXEL-BIT*. <https://revistapixelbit.com>. <https://revistapixelbit.com>
- Morales, Purificación Toledo, J. M. S. G. (2018). Project-based learning : A university experience. *Revista de Curriculum y Formación Del Profesorado*, 22(2), 471-492.
- Munawaroh, Sri, N., Susilowati, L., & Rukminingsih. (2022). The Effect of E-Problem Based Learning on Students' Interest, Motivation and Achievement. *International Journal of Instruction*, 15(3), 503-518. <https://doi.org/10.29333/iji.2022.15328a>.
- OECD (2019). *OECD Skills Strategy 2019*.
- Pangastuti, D., Widiastih, N., & Soemantri, D. (2022). Piloting a constructive feedback model for problem-based learning in medical education. *Korean Journal of Medical Education*, 34(2), 131-143. <https://doi.org/10.3946/kjme.2022.225>.
- Reche, J. M. S., García, M., & Ortega, M. del C. (2019). The implications of the use of mobile devices in the teaching-learning process in 5º and 6º primary school students. *Pixel-BIT Revista de Medios y Educación*, 55. <https://recyt.fecyt.es/index.php/pixel/index>
- Rodrigo-cano, D., De-casas-moreno, P., & Aguaded, I. (2020). Mobile learning (m-learning) as a training resource for companies. *Revista Mediterránea de Comunicación*, 11.
- Saleh, A., Phillips, T., Hmelo-Silver, C., Glazewski, K., Bradford, M., & Lester, J. (2022). A learning analytics approach towards understanding collaborative inquiry in a problem-based

- learning environment. *British Journal of Educational Technology*, 53, 1321-1342. <https://doi.org/10.1111/bjet.13198>.
- Trullàs, J., Blay, C., Sarri, E., & Pujol, R. (2022). Effectiveness of problem-based learning methodology in undergraduate medical education: a scoping review. *BMC Medical Education*, 22(1), 104. <https://doi.org/10.1186/s12909-022-03154-8>. <https://doi.org/10.1186/s12909-022-03154-8>
- Tsai, C., Chiu, Y., Chao, C., Lin, M., Ho, C., Chen, H., Sheu, B., Hsu, C., & Yang, C. (2021). Effectiveness of tutor shadowing on faculty development in problem-based learning. *BMC Medical Education*, 22, 564. <https://doi.org/10.1186/s12909-022-03615-0>.
- UNESCO (2019). *World declaration on higher education in the twenty-first century: vision and action*. 1-20.
- Wang, A., Xiao, R., Zhang, C., Yuan, L., Lin, N., Yan, L., Wang, Y., Yu, J., Huang, Q., Gan, P., Xiong, C., Xu, Q., & Liao, H. (2021). Effectiveness of a combined problem-based learning and flipped classroom teaching method in ophthalmic clinical skill training. *BMC Medical Education*, 22, 487. <https://doi.org/10.1186/s12909-022-03538-w>. <https://doi.org/10.1186/s12909-022-03538-w>
- Weng, X., Chiu, T. K. F., & Chun, C. (2022). Promoting student creativity and entrepreneurship through real-world problem-world problem-based maker-based education. *Thinking Skills and Creativity*, 45. <https://doi.org/10.1016/J.TSC.2022.101046>. <https://doi.org/10.1016/J.TSC.2022.101046>