Professional and Technological Education and Problem-Based Learning (Pbl) in Hybrid and Distance Education: a Systematic Review

A Educação Profissional e Tecnológica e a Aprendizagem Baseada em Problemas no Ensino Híbrido e a Distância: uma Revisão Sistemática o Contexto Pós-Moderno

Review

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Abstract

Information and Communication Technologies (ICT) have enabled improvements and an increase in the offer of Distance Education (DE). Problem-Based Learning (PBL) has been shown to be effective, mainly because it allows students to get closer to real situations experienced by professionals, an important characteristic for Professional and Technological Education (PTE). There is no data in the current literature on how much PBL has been applied to PTE whereby distance education or hybrid education. This research, through a systematic review, aims to fill this gap. It became evident that there are few publications on this topic, leaving the question open as to whether this is due to the low adherence to PBL or if the experiences and investigations in this field have not been widely disseminated.

Keywords: Problem-based learning. Distance learning. Hybrid teaching. Professional and technological education.

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Resumo

As Tecnologias Digitais de Informação e Comunicação (TDIC) têm oportunizado melhorias e aumento na oferta de Educação a Distância (EaD). A Aprendizagem Baseada em Problemas (PBL) vem se mostrando efetiva, principalmente por propiciar a aproximação do estudante com situações reais vividas por profissionais, característica importante para a Educação Profissional e Tecnológica (EPT). Na literatura vigente não há dados sobre o quanto a PBL tem sido aplicada à EPT por meio da EaD ou do ensino híbrido. Esta pesquisa, por meio de uma revisão sistemática, visa preencher esta lacuna. Evidenciou-se que há poucas publicações sobre este tema, deixando aberta a questão sobre se isso se deve à baixa adesão à PBL ou se as experiências e investigações neste campo não têm sido amplamente divulgadas.

Palavras-chave: *Aprendizagem baseada em problemas. Educação a distância. Ensino híbrido. Educação profissional e tecnológica.*

1. Introduction

Professional and technological education (PTE), more than just teaching the knowledge necessary for the exercise of technique or formalized by some science, should introduce students to the culture of communities of practice intrinsic to their work (BARATO, 2002). This complex responsibility requires different pedagogical and technological approaches to teaching and learning.

In this sense, efforts to build better teaching strategies have led to the creation of innovative alternatives for the teaching and learning process. This movement has benefited both digital information and communication technologies (ICT) and traditional technologies in the classroom, as will be shown throughout this work.

The virtual teaching and learning environments (VLE), for example, are tools capable of promoting inclusion and making distance, face-to-face or hybrid teaching more effective. Salvador et al. (2017) state, in this context, that research carried out in Brazil and in other countries shows the benefits of using this type of environment.

Active methodologies such as problem-based learning (PBL), on the other hand, have been contributing to the construction of increasingly meaningful, comprehensive and contextualized learning in different areas of knowledge (CORDOVA; BAADE; DOS SANTOS, 2020). For Junior et al. (2022), PBL enables learning that contextualizes the application of knowledge built in different areas of science in solving real problems, contributing to the development of critical thinking and problem-solving skills, skills necessary to deal with the challenges of the field. XXI century.

In this sense, due to its effectiveness, PBL has been successfully applied to the training process of different areas such as Medicine, Accounting, Administration, Software Engineering and Physiotherapy (DE LIMA, et al., 2022; ANDRADE, et al., 2022; NEGRO-DELLAACQUA, et al., 2020; CORDOVA, BAADE, DOS SANTOS, 2020). In all these cases, it contributed significantly to the training of students, as evidenced by the aforementioned studies.

Currently, there are VLEs capable of supporting education through PBL, helping to expand the benefits that this VLEs offers, making it available to a greater number of students. As an example of the use of AVEAs to support teaching through PBL, we can cite the works published in the form of the book "DE, PBL and the Challenge of Network Education" in 2018, where several authors dialogue on this topic (SPANHOL, 2018). In addition, it is also important to mention the work of Alexandre (2018), who proposed, in his doctoral thesis, the development of the PBL Planner Toolkit, a tool to assist in planning the PBL approach in computing teaching.

In addition, a systematic review study carried out by Car et al (2019), aiming to evaluate the effectiveness of DIDT-mediated PBL, identified and selected 22 publications focused on professional health education. This study revealed that PBL mediated by digital technologies is as effective as traditional PBL and more effective than traditional teaching techniques in terms of student gain in knowledge and suggested that it may also be better in developing new skills.

However, in the current literature, it is not possible to find information on how much, in fact, PBL has been promoted and practiced in Distance Education (DE) in the context of professional and technological education, nor if this combination has demonstrated effectiveness. There is also a lack of information about the possibilities offered, both quantitatively and qualitatively, by VLEs to support PBL.

In this sense, to start an investigation process in this regard, this research aims to answer the most basic question among those raised: considering the works whose results were published, it can be stated that problem-based learning has been practiced in distance education and blended learning in the context of PTE? To answer this question, a systematic review was carried out, the results of which will be presented in the following chapters.

2. Methodology

This research consists of a systematic review, which, according to Kitchenham (2004), consists of identifying, evaluating and interpreting primary studies relevant to a specific research question, area of study or phenomenon of interest.

The structure of the systematic review adopted in this work relied on the use of the parsif.al tool, available free of charge on the world wide web, and is composed of the steps of: (i) planning, in which the need for the review is analyzed and the research protocol; (ii) conduction, moment in which the search and selection of studies is carried out, the quality assessment and the extraction and analysis of the data found; and, finally, (iii) the systematization stage, in which the data obtained are interpreted, classified, described, organized and communicated. Therefore, to enable a better understanding of the process developed in this work, the above steps will be presented in more detail below.

2.1 Planning

At this stage, firstly, we sought to describe the need for carrying out this research, considering the related works. Then, the research protocol containing the procedures to be performed during the investigation process was organized and planned. The next topics will address more broadly the delimitations and methodological procedures carried out to obtain and analyze the data that underlie the findings of the present work.

2.1.1 Importance of research

This research is important for seeking information, in a broad way and not directed to a specific area, about the use of PBL in distance and hybrid education for professional and technological education courses. Some existing studies bring this information specifically to an area of study, such as health education (DE LIMA, et al., 2022) or do not delimit a specific context (ALVES, et al. 2020). In addition, the focus on PTE is also an innovative proposal, with no similar studies published so far..

2.1.2 Research protocol

In this topic, the processes for defining the research's guiding questions, the search strings, the selection criteria for primary studies and the databases selected for the search are presented. Thus, in order to meet the general objective of this investigation, three guiding questions were elaborated, as can be seen in Table 1.

Table 1: Research guiding questions

ID	Question
Q1	Can it be said that PBL has been widely used in DE and blended learning for PTE, considering the published studies??
Q2	What are the areas in which PBL is most often used in distance learning and hybrid modality for PTE?
Q3	What are the most used ICTs to conduct PBL in distance learning and hybrid modality for PTE?

Source: Designed by the author (2022)

The primary question (Q1) is more general and seeks to respond to the central problem of the present work, which is to know whether it is possible to say, considering the published studies, whether PBL has been widely applied in blended and distance learning in the context of PTE. The other questions (Q2 and Q3) seek complementary answers that will help to enrich the discussion on the topic.

As for the search strings, aiming to find studies that were capable of answering the aforementioned questions, after some tests in different databases, two proposals were defined, respectively for the English and Portuguese languages:

> ("*Professional Education*" *OR* "*Technological Education*" *OR* "*Technical Education*") *AND* ("*Problem-based Learning*" *OR* "*PBL*" *OR* "*Digital Problem-based Learning*" *OR* "*DPBL*") *AND* ("*blended learning*" *OR* "*eLearning*")

> ("Educação Profissional" *OR* "Educação Tecnológica") *AND* ("*Problem-based Learning*" *OR* "PBL" *OR* "Aprendizagem baseada em problemas" *OR* "ABP") *AND* ("ensino híbrido" *OR* "ensino a distância" *OR* "EaD")

With regard to the databases used as consultation sources, it was decided to explore the bases of Scopus (Elsevier), Springer Link (Springer InternationalPublishing), Web of Science (Thomson Reuters/Clarivate) and Google Scholar. Of the latter, due to its search mechanism returning a very large number of records, mainly because the search was not limited to the title, keywords and abstract of published studies, only a few articles were manually selected. For this, we considered primary publications that brought in the aforementioned metadata, the keywords explained in the search strings.

In addition, in order to provide greater traceability and an objective structure for selecting articles relevant to the interests of this research, inclusion and exclusion criteria were defined, as shown in Table 2.

Table 2: Inclusion and exclusion criteria

| ID	Inclusion criteria	ID	Exclution criteria
I1	The article is a primary study	E1	The article is before 2015
I2	It has been published in a journal or event	E2	It is duplicated
I3	It addresses PBL in de or blended learning	E3	It is not a primary study
I4	It was published between 2015 and 2021	E4	It does not address NLP in de or hybrid teaching
		E5	It addresses PBL in de or blended learning, but not for PTE
		E6	It has no free access

Source: Prepared by the author (2022)

The purpose of these criteria is to select primary studies (I1 and E3) published in journals or scientific events (I2) between 2015 and 2021 (I4 and E1), and that would bring results on the application of PBL in de or blended learning for PTE (I3, E4 and I5). Duplicate studies mapped in different databases or without free access (I6) were also excluded.

It is also important to mention that the criterion for E5, that is, defining whether or not a study is related to PTE, took into account the definitions contained in the law of Guidelines and Bases of National Education and in law 11,741, of July 16, 2008, which aims to change and complement the first. Therefore, those educational actions were considered with the purpose of preparing for the "exercise of the professions", covering initiation courses and professional qualification, technical and technological qualification of all levels of education (BRASIL, 1996; BRASIL, 2008).

2.2 Conducting, searching and selecting studies

After the planning phase, the effective conduction of this systematic review began following the protocol established in topic 2.1.2. The quantitative result of the searches carried out in the databases and using the strings defined in the protocol can be seen in Graph 1.

Graph 1: Quantitative result of studies found by database

Source: Research Data (2022)
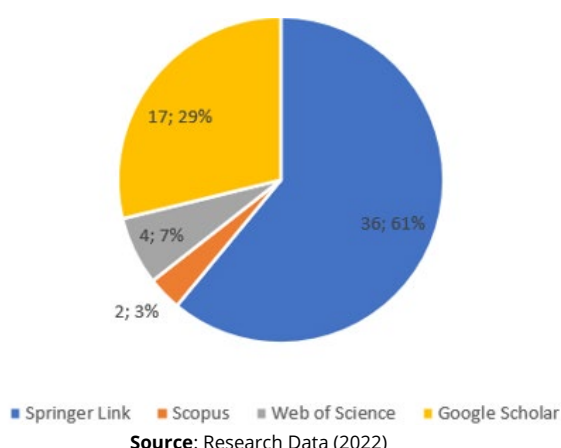
As can be seen, a total of 59 studies were found, among which there were no duplicates. Table 3 presents, from left to right, the databases where the searches were carried out, the number of articles found before filtering, the total number of articles between 2015 and 2021 (E1), the total number of articles after excluding duplicates (E2), the total number of articles after excluding those that were not primary studies (E3), the total number of articles after excluding those that did not address PBL in DE or blended learning (E4), the total number of articles after excluding those that did not address PBL in DE or hybrid education for PTE (E5) and those with free access (E6).

Table 3: Number of articles after sorting

Data base	Before the selection	Selected by Exclusion Criteria					
		(E1)	(E2)	(E3)	(E4)	(E5)	(E6)
Springer Link	36	19	19	12	5	4	3
Scopus	2	1	1	1	1	1	1
ISI Web of Science	4	4	4	3	1	1	1
Google Scholar	17	9	9	7	4	4	4
Total	59	33	33	22	11	10	9

Source: Research Data (2022)

2.3 Systematization

After applying the inclusion and exclusion criteria, 9 studies were selected. Table 4 presents them listing their identification ID for mention purposes throughout this work and the complete reference of each study.

Table 4: classified articles

ID	Reference
A1	FERNANDES, R.A.M.L.; OLIVEIRA LIMA, J.T.; Da SILVA, B.H..Development, implementation and evaluation of a management specialization course in oncology using blended learning. BMC Med Educ. v.20, n.37, 2020.
A2	BLACKBURN, G.. Innovative eLearning: Technology shaping contemporary problem based learning: a cross-case analysis. JournalofUniversityTeaching& Learning Practice. v.12, n.2, 2015.
A3	LOPES, A., M.. O Uso das TDIC para Resolução De Situações-Problema no ensino de Enfermagem. In: Congresso Internacional de Educação e Tecnologias. Anais... São Carlos, UFSCAR, 2018.
A4	MACEDO, J. G.. O Desafio Da Formação Continuada On-line Dos Professores Na Educação Profissional E Tecnológica Do Senai. In: Congresso Internacional de Educação e Tecnologias. Anais... São Carlos, UFSCAR, 2018.
A5	RESENDE, M., D.. PBL Em Cursos A Distância: Aproximando Teoria E Prática. In: Congresso Internacional ABED de Educação a Distância 25. Anais... Poços de Caldas, ABED, 2019.
A6	SAMPAIO, P., R., C.. Compartilhando Experiências Na Construção De Soluções Para Uma Indústria 4.0. In: Congresso Internacional ABED de Educação a Distância (CIAED) 24. Anais... Florianópolis: ABED, 2018.

A7	HINNEBURG, J., LÜHNEN, J., STECKELBERG, A. et al. A blended learning training programme for health information providers to enhance implementation of the Guideline Evidence-based Health Information: development and qualitative pilot study. BMC MedEduc, v. 20, n.77, 2020.
A8	CONCEIÇÃO, D., L., G., UMYLDER, C., F., SILVA, E., M., R. A Utilização De Problem-Based Learning Em Cursos De Graduação Em Administração A Distância. In: Congresso Internacional de Educação e Tecnologias. Anais... São Carlos, UFSCAR, 2018.
A9	BLACKBURN, G. A university's strategic adoption process of an PBL-aligned eLearning environment: an exploratory case study. Educational Technology Research&Development, [s. l.], v. 65, n. 1, p. 147–176, 2017.

Source: Research Data (2020)

Among the nine selected studies, six present processes and results of the application of PBL in hybrid teaching and DE for PTE for a course or specific curricular units (A1, A3, A5, A6, A7 and A8), another of these studies (A2) presents results of this experience in three different universities, while A4 reports the use of a Virtual Teaching and Learning Environment (VLE) for the continuing education of teachers and A9 presents the effort of a group composed of seven colleges and three university campuses to determine how best to use digital technologies to drive PBL usage. Twenty actions were evidenced in five countries - which were identified in the studies - six in Brazil, one in Germany, one in New Zealand, one in Australia, one in the United Kingdom, in addition to ten others that did not mention the country.

Regarding the areas of application, actions were found that use PBL in the axes of Management and Business, Environment and Health, Educational and Social Development and some studies that did not mention its area of application. And, finally, three different PBL support tools were identified and applied throughout the selected actions, such as Scenario Based Learning Interactive (SBLi)[1], Integriertes Lern-, Informations- und Arbeitskooperations-System (ILIAS)[2], Schoology[3]. Some studies did not mention tools or technological resources used to support their actions. The next chapter brings more details about the findings, as well as discussions that allow further reflection on the use of PBL for PTE through Distance Education or blended learning.

3. Results and Discussion

In order to better organize the results, found, the extraction and systematic mapping of information, as well as its interpretation and categorization, presented below, will be carried out taking into account the guiding questions of the research. For this reason, the next topics aim to answer these questions directly.

3.1 Considering the published studies, can it be said that PBL has been widely applied in distance learning or hybrid teaching for PET? (Q1)

Answering this question is a big challenge. Firstly, because it is necessary to make it clear that the question explicitly brings an important delimiter: that the answer considers only the practices that had their results published. This is a very relevant point, as one can hypothesize that most of the PBL practices in DE or blended learning for PET are not published in journals, events or indexed books.

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1   Available at: https://www.sblinteractive.org/Home.aspx

2   Available at: https://www.ilias.de/en/

3   Available at: https://www.schoology.com/

Secondly, it is important to remember that this research, in order to investigate its central question, considering information that can provide the most up-to-date answer possible, sought to select publications from the last six years – between 2015 and 2021 –, which also comprises the most recent period. of the COVID-19 pandemic, in which there may have been an increase in the use of DE practices. For this reason, despite having found, in a significant amount, studies dating from 2002 to 2014, understanding that such studies would not express the state of the art of the question investigated, it was decided to suppress them from the present analysis by applying the criterion of specific deletion.

That said, as already mentioned, nine publications that met all the selection criteria of this review were selected. Six of them, the majority, therefore, deal with the publication of the processes and results of the application of PBL in DE or blended learning for a specific course or curricular unit (A1, A3, A5, A6, A7 and A8). These studies show five experiences with the application of PBL in DE or blended learning in five years. Of the other articles, A2 presents results of this experience in three universities: University of Queensland, in Australia; Massey University, New Zealand; University of Manchester in the UK.

Article A4, in turn, reports the use of a Virtual Teaching and Learning Environment (VLE) for the continuing education of teachers in the National Industrial Learning System (SENAI), through problem-based learning. This publication does not mention the scope of this continuing professional training program; for this reason, it is not possible to infer whether it has a national or regional character.

The results found in A9 demonstrate the effort of a group composed of seven colleges and three university campuses to determine the best way to use digital technologies to boost the use of PBL and, therefore, improve the quality of teaching. The nationality of the institutions participating in the research was not mentioned in the publication.

Table 5 presents a summary of the number of initiatives using PBL in DE or blended learning, considering their respective related articles.

Table 5: Actions using PBL in DE or hybrid teaching

Country	Number of actions	Article
Brazil	6	A1, A3, A4, A5, A6 e A8
Germany	1	A7
New Zealand	1	A2
Australia	1	A2
United Kingdom	1	A2
Not mentioned	10	A9

Source: Research Data (2022)

As can be seen, twenty actions were evidenced in five countries – which were identified in the studies – directly involving PBL for DE or blended learning in professional and technological education in publications of the last six years. Analyzing the absolute numbers, it is not possible to state whether this practice has been widely applied in the context investigated by the present study.

However, when considering the number of professional and technological education institutions, including Higher Education Institutions (HEIs), in Brazil and abroad, which offer distance or hybrid courses, it becomes clearer how little effort has been directed towards the application of PBL in these modalities, or at least to publish the results of these efforts. The dissemination of these practices could contribute, in general, at least in two ways to the improvement of teaching and learning processes mediated by ICT.

One of them concerns the recording of evidence related to the effectiveness of PBL in this context - which would provide elements for more comprehensive and well-founded discussions. The other is related to the dissemination of techniques, tools and models used to make it feasible, which could contribute to the popularization of PBL and, consequently, encourage its adherence in hybrid and distance modalities.

According to the DE Census Analytical report on distance learning in Brazil (2018), among vocational technical courses, sequential specific training courses and technological graduation, in 2018 there were 1,132 (one thousand one hundred and thirty-two) courses offered in the DE modality or blended, only in Brazil. From this number, stricto sensu and lato sensu postgraduate courses were removed, as there is no clear separation between professional and academic training courses in the aforementioned report.

If only this source is considered when comparing with the number of actions published in studies in Brazil on the use of PBL, a percentage of 0.53% of the courses offered adopting this teaching and learning technique is obtained. A notoriously low number. No sources were found that report this information at an international level.

This evidence suggests the need for greater promotion of actions or scientific dissemination of actions in order to popularize PBL in distance learning modality. Therefore, the answer to the first guiding question, given the results raised by the present research, is that, considering the studies published within the established period, PBL has not been widely applied for DE or hybrid teaching in professional and technological education.

3.2 What are the areas in which PBL is most often applied in distance learning or hybrid mode for PTE? (Q2)

In order to better organize the answer to this question, the areas identified during the present investigation were classified within the technological axes foreseen in the National Catalog of Technical Courses, also mentioned in the National Catalog of Higher Technology Courses, namely: environment and health, control and industrial processes, educational and social development, management and business, information and communication, infrastructure, food production, cultural production and design, industrial production, natural resources, tourism and hospitality and leisure.

Thus, even though, mainly in the international scenario, the surveyed courses are not always identified within these areas, the present work presents them that way, given their proximity or similarity with the other courses classified within each axis. Table 6 shows the number of courses by technological axis.

Table 6: Number of courses by technological axis

Country	Number	(%)
Management and Business	4	20%
Environment and Health	5	25%
Educational and Social Development	1	5%
Not mentioned	10	50%

Source: Research data (2022)

The environment and health axis, as can be seen, has the largest number of courses with PBL practices in the hybrid or distance mode. It is an area in which this teaching and learning technique was created and developed. This may be a factor that influences the maturity of this type of practice and, consequently, its

application in the contemporary context, in which ICT have been used in the most diverse dimensions of human relationships (CORDOVA; BAADE; DOS SANTOS, 2020).

In second place, the management and business axis appears, with four initiatives using PBL in distance learning or hybrid mode, according to the survey results. It is not possible to develop an explanation for the result found from the data available in this work. However, at this moment, considering the available information, it can be stated that the area where PBL practices in Distance Learning or blended learning are more recurrent, as is the case with PBL in face-to-face modality, are concentrated in the axis of environment and health, more specifically in health education courses.

3.3 What are the most used ICTs to conduct PBL in distance learning or hybrid mode for PTE? (Q3)

According to the data found, the use of TDIC to conduct parts or stages of the PBL process for DE or hybrid teaching in professional and technological training courses was restricted to virtual teaching and learning environments or Learning Management System (LMS).). In this context, the use of these technologies was observed, most of the time, for the creation of scenarios that represented problem situations, communication between teachers and students and between students and students, sharing of learning outcomes and repository of materials made available by the teacher. for studies. Table 7 presents the technological resources used, the number of occurrences of their use among the analyzed articles and the articles in which they were cited.

Table 7: Most used ICTS

VLE	Number	Article
Scenario Based Learning Interactive (SBLi)	13	A2 e A9
Integriertes Lern-, Informations-und Arbeitskooperations-System (ILIAS)	1	A7
Schoology	1	A3
Not informed		
	5	
		A1, A4, A5, A6 e A8

Source: Reseacrh data (2022)

The most used VLE for the implementation of PBL in DE, as can be seen in Table 7, is the Scenario Based Learning Interactive (SBLi), an environment that allows the creation of scenarios as support for techniques such as problem-based learning and inquiry-based learning. It is a paid software, which has a free license for non-commercial use. The articles that mention the use of this resource were published based on studies carried out in Germany (A9), citing ten European educational institutions, and in Australia (A2), citing two institutions in Oceania and one in Europe. No Brazilian publications with reports or studies based on SBLi were found.

The use of SBLi for the implementation of PBL, in general, was not described in detail by any article found. However, the creation of scenarios containing problem situations to be solved by the students was mentioned.

The Integriertes Lern-, Informations-und Arbeitskooperations-System (ILIAS), in turn, is an open source German AVEA. Its translation into English means Integrated Learning, Information and Work Cooperation System, or, in free translation, Integrated Learning, Information and Work Cooperation System. Its use was cited by a study carried out in Germany (A7). Regarding its use for the implementation of PBL, it was only mentioned that during a hybrid teaching process, the ILIAS was used for the online stage of the studies, for the provision of problem situations, teaching materials, online tasks and tutorial videos. In addition to enabling communication between students.

Schoology is a paid LMS that offers a free version to be used by individual teachers. It is cited by a Brazilian study (A3), but the details of its use are also not described. It is only mentioned that problem situations were made available on the online platform, which also had forum resources for interaction between students and availability of didactic materials.

The other studies did not mention which learning resource using TDIC were used in their practical experiences. However, the answer to the guiding question (Q3) is quite clear. The most used ICT for the implementation of PBL in DE or hybrid teaching for PTE are the virtual teaching and learning environments and, among them, the SBLi was the most used.

In studies prior to 2015, it is possible to find the application of intelligent agents (DE AZEVEDO et al., 2002) and the game Second Life (JONG et al., 2014) for conducting PBL tutorials in distance or hybrid learning. However, these technologies have not appeared in more recent studies, as evidenced by this research. In this sense, it is worth mentioning the fact that, despite being widespread and used in different contexts of contemporary society, it was not possible to find in records of the last six years, the use of artificial intelligence (AI) to support PBL mediated by digital information and communication technologies. It is not possible to identify a reason for this, but given the versatility of AI, it can be said that there is an open space for research and future practices in the context that presents itself.

4. Conclusion

The results presented in the present work show that PBL has been little explored in distance learning for professional and technological education, considering the results of experiences that were published in the form of articles in magazines or scientific events in the last 6 years.

We are not suggesting that the practice of PBL is not widely applied in DE and blended learning for PTE, as other studies would be needed, involving other investigation methods to obtain a more assertive answer in this regard. However, it is possible to state that there should be greater scientific dissemination in relation to the work carried out, if that is the case, as this is a question that remains unanswered.

This is because, while reading some of the analyzed publications, it is perceived that there are several benefits for students when using PBL as a teaching technique, among which the development of social communication skills stands out more recurrently. (A4, A8 and A9), better general understanding of the subject taught (A3, A8, A7 and A9), development of practical problem-solving skills (A1, A6, A7 and A9). In addition, studies revealed that students felt more challenged and motivated when they had to seek solutions to real problems (A2, A7 and A9).

In this sense, making the results of these works public, informing the benefits, difficulties and solutions found, could encourage greater adherence by institutions and teachers who work in DE, to the use of PBL. Although this is a technique applied since the 1960s and considering all the progress made in the field of ICT, the studies found show difficulties in the implementation of PBL when mediated by such technologies, limiting the practices adopted to the provision of problem situations, teaching materials and media.

In this context, a study carried out by Cal (2019) showed that the digital technologies most used in this segment were online search engines for research, meetings through web conferences, chats and forums for discussions, collaborative tools, podcasts and serious games. This study did not specify, however, if these resources would be organized in a VLE or if they would be used in an isolated and fragmented way.

None of the articles analyzed by this review address the technological possibilities to facilitate cooperative work or the use of artificial intelligence to recommend educational content or maintain team cohesion, for example. And these are technological resources already widely used in other contexts. Finally, it is suggested that further research be carried out, in order to confirm whether there are in fact few initiatives in the use of PBL in DE and blended learning for PTE or if there is just no effective dissemination of these initiatives.

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