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Article

Interactive Peer Instruction Method Applied to Classroom Environments Considering a Learning Engineering Approach to Innovate the Teaching–Learning Process

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Abstract: Faced with the problem of a need for more student participation and motivation in the teaching–learning process (TLP) due to the persistence of traditional methods, peer instruction (PI) has emerged as an interactive teaching method. It is based on a dynamic of questions and answers to promote student reflection and discussion. Thus, this article shows the applicability of PI, considering a learning engineering approach to innovating the TLP. For this, the historical-descriptive method is used to conduct a literature review and a bibliometric study, evaluating scientific articles in Web of Science (WoS) and Scopus between 2018 and 2022. In addition, in the second stage, the experimental method is used to apply PI in two educational institutions and evaluate its applicability with Likert scales for teachers and students following a quantitative methodology. Consequently, following the analytical-synthetic method, the results indicate that PI the stages, the most relevant aspects, and the conditions to consider in a classroom environment are highly relevant to enhancing its effects. Thus, such applicability is reflected in its positive results in the TLP, considering the learning engineering, and its representation as a flexible and innovative alternative to traditional methods. This is because PI generated benefits for teachers and students, thus encouraging greater satisfaction, motivation, interest, understanding, and student participation.

Keywords: peer instruction; learning engineering; ICT; problem-based learning; project-based learning; education

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1. Introduction

The TLP is still characterized by the permanence of traditional methods in which the educator acts as the transmitter of information, and students limit their participation to receiving this passively [1]. It is evidenced that this master-class or lecture-type dynamic does not favor students' involvement in their learning, since interaction and commitment to class activities decrease in line with their motivation in the process [2,3].

Initially, inverted learning caused controversy among parents and students. Accelerated teacher self-learning during the pandemic has been of great importance for teachers' knowledge, skills, and abilities despite the stress caused. On the other hand, students could also identify that their gaming competencies were superior to teachers' in gamification issues; however, self-learning was not their forte. The important thing about this scenario is that, thanks to the confinement, many teachers were able to find a friend in ICT which allows, in many cases, optimization of the evaluation process and motivation to perform the tasks [4,5]. Databases such as the Web of Science and Scopus have significantly contributed to the state-of-art and given rise to the motivation for research due to the relevance and structure of their documents; however, other open-access sources are not to be discarded [6].

Due to this, changing the classroom environment's teaching practice and dynamics is necessary to give the students a leading role and actively participate in their learning. Studies have indicated how this improves their understanding, academic performance, and class development, while having increased effectiveness on the attitudes of students and increasing their level of knowledge, motivation, commitment, and satisfaction with their educational process compared to the results of the traditional teaching-learning approach [2,7–12].

Various teaching methods promote student participation and represent an innovative alternative to the traditional models that have endured over time. These participatory methods optimize educational results and form people with reflective, critical, analytical, and self-regulating learning skills [13–15].

In this sense, PI is a teaching method that effectively promotes participatory, active, and collaborative learning, a space for student interaction, and formative feedback [2,16–22]. Given its characteristics and didactic utilities, its application can be adapted to different contexts, levels, and classroom environments according to their educational objectives. PI is a learner-centered interactive method which uses questions and answers to determine the learner's understanding of a specific topic [19,22–24] and gives way to student debate and discussion. Before this, students should have an initial engagement with, and knowledge of, the content to be addressed in the class. Thus, the interaction is enriched with personal knowledge [25,26].

In this way, the benefits that inverted learning provides to the TLP are highlighted by making it possible to take advantage of class time, traditionally used for transmitting information, for knowledge assimilation activities where participation is guided, doubts are solved, and learning is consolidated [9,27]. On the other hand, knowledge transfer activities are left at home, where students can approach the subject matter with anticipation and the desired time for the individual learning that will serve as a basis for later participation in the class [21,22,28].

On the other hand, a relevant aspect to consider is that the path taken towards the new participative teaching methods is increasingly facilitated by technology to consider the interests and needs of students and today's society. Thus, information and communication technologies (ICT) have gained more space in the educational field and benefit increasing participation when applying these new teaching methods. PI is no exception since, although the ICT are optional, they enrich the process for the participants. However, this success of technology lies in the pedagogical knowledge behind digital knowledge and skills. These allow, in turn, the meeting of the educational objectives of the teacher's discipline [29,30].

Learning engineering is essential to innovating the TLP. It is based on engineering principles to use technology in harmony with the learning sciences to benefit education and its constantly changing reality. Thus, by combining the pedagogical, technological, and disciplinary knowledge a teacher requires, responding to current challenges and getting the most out of these methods is possible [27,31].

Consequently, the objective of this article is to show the applicability of the interactive method of teaching based on PI considering a learning engineering approach to innovate the TLP. This is in response to the problem raised in the present research related to the permanence of the traditional teaching methods that need more participation and motivation of students concerning their TLP. Thus, the importance of stimulating teaching ingenuity to develop educational innovation processes, where teachers use this knowledge to improve their classroom environment, is highlighted, as shown in Figure 1.

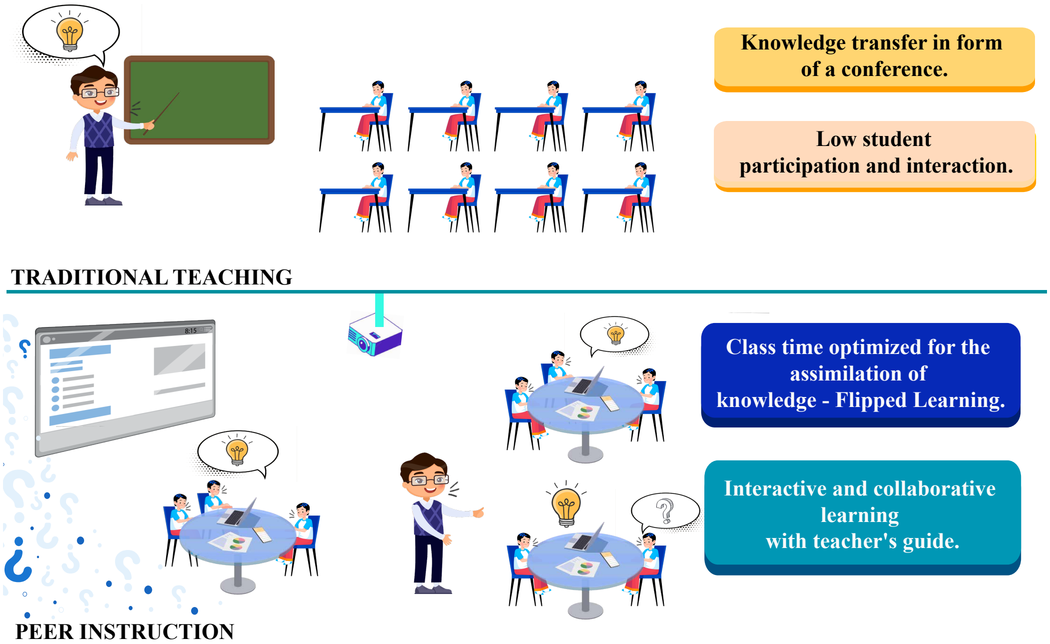


Figure 1. Peer instruction as an innovation to traditional teaching. Source: authors.

As for the organization of this article, the related work is presented in Section 2. The problem formulation and methodology are in Section 3, the results and analysis are in Section 4, and the conclusions are presented in Section 5.

2. Related Works

The research on PI demonstrates positive effects on various aspects of the educational process; consequently, the flexibility of the method is to be developed according to the context of education. Notably, in the present research, the method of carrying out PI was characterized by the complimentary use of the benefits of inverted learning. Consequently, three general stages were determined for their application: knowledge transfer, assimilation, and consolidation. The first is developed before the class, and the others are during the course.

Thus, PI takes advantage of class time to develop, in an appropriate setting, the stages of assimilation and consolidation in which students exercise comprehension skills, exposition and contrasting of ideas, problem-solving, critical thinking, argumentation, debate, and individual and group reflection [20,32,33]. In this sense, it also contributes to the social development of students since it promotes the use of social, collaborative, teamwork, and interpersonal skills.

Another relevant aspect and benefit of this method is that students can better understand the knowledge being discussed since, by arguing reflectively and thinking collaboratively, they can not only improve their representation of the concept but also take it to a level of social construction as a result of comparing their ideas with those of their peers [9,16,34].

This improvement in the understanding of the subject and the aforementioned skills facilitates, in turn, the long-term retention of knowledge. It is noted that this improvement is evidenced in studies which show how several students who initially answered incorrectly, after peer discussion, chose the correct answer, and their scores increased [2,10,16,35,36].

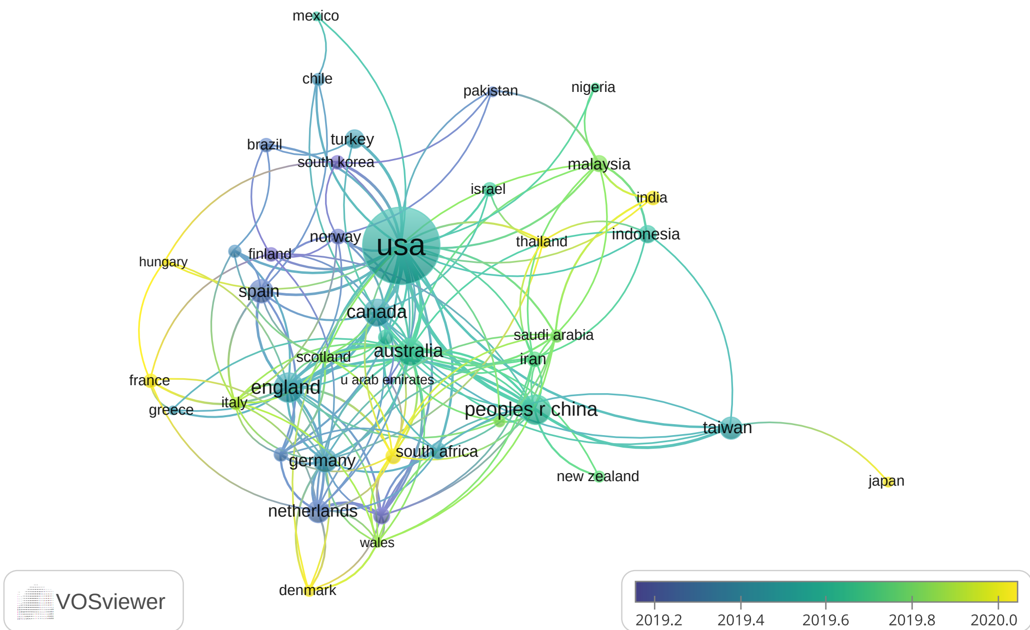
Additionally, PI increases levels of student satisfaction with the TLP since they are more interested in this active learning method as it represents a change in the classroom dynamics to which they are accustomed [16,37,38]. However, authors such as Alcalde and Nagel [37] indicates that this, together with the other benefits of the method, is separate from ensuring higher academic performance over extended periods due to the intervention of factors related to each learner.

It should be noted that, as part of the use of the benefits of ICT in education, several studies validate the usefulness of the "Student Response System" (SRS), also called "Instant Response System" or "clickers", in the application of PI. Through it, the teacher can generate the required questions and answer options; the students will answer them during the development of the method using a technological device and, in the end, an immediate report is obtained with the result of the automatic evaluation of the student answers [9,17,39].

Several SRS tools are chosen according to the teacher's needs and preferences, including Socrative, Quizizz, Classtime, ZUVIO, and Kahoot! [2,16]. Apart from the benefits already mentioned, studies have proven that their use enhances PI implementation and, when used together, improves the TLP and students' perception of it by integrating something of interest to them, such as ICT [9,17,40].

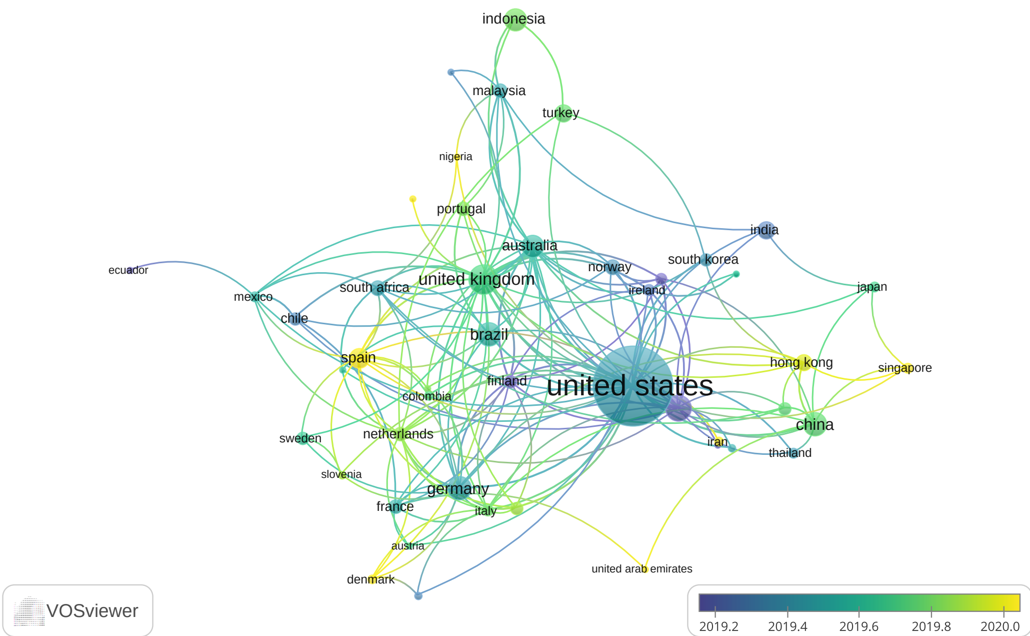
Related works affirm that PI is applied at teachers' discretion in diverse contexts and environments. For this purpose, they consider the beliefs and attitudes of a sample of secondary-school students and corroborate other studies' assertions about the benefits of the learning method. A relevant fact to consider in this regard is that, at the national level, the work of [41] stands out, where the results of applying PI in an Ecuadorian context are investigated. Here, it is found that the beliefs and attitudes of a sample of secondary-school students corroborate the assertions of the other studies mentioned above about the benefits of the learning method.

As indicated above, PI has been applied in different environments, as seen in Figure 2, which shows the countries highlighted according to the studies carried out on PI, together with the networks generated between them and a color scale which identifies which have the most recent publications. As a result, the United States is the leading country in both databases, considering that Eric Mazur developed the method at Harvard University in the 1990s. China, England, and Canada also stand out in the WoS, and the United Kingdom, Canada, and Germany in Scopus, data which show that none of the leading countries are Spanish-speaking.



(**a**)

Figure 2. *Cont.*



(**b**)

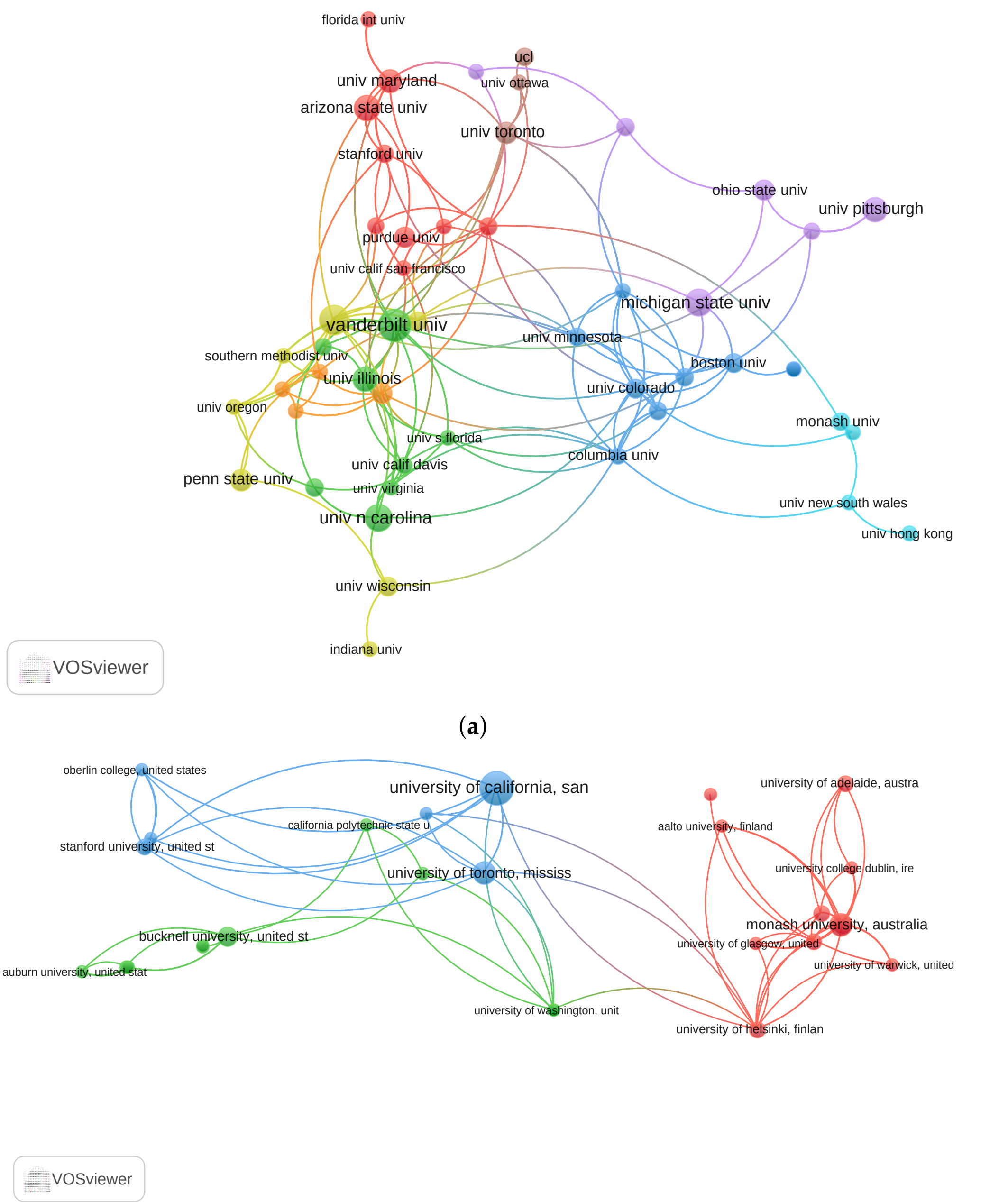
Figure 2. Bibliometric analysis: Leading countries in peer instruction according to research networks—(**a**) Web of Science (WoS). (**b**) Scopus. Source: authors.

The relationships generated between countries and their relevance in several publications are of interest for analyzing the situation of the approach to the subject, as well as the search for research for future work and collaborations. However, the number of publications is lower in regional contexts; Brazil, Chile, and Mexico are found in WoS, and, in addition to these three countries, Colombia and Ecuador are included in Scopus, thus demonstrating the scarce production on the subject at the national level.

It is noted that the lines observed in the graph represent the collaboration in scientific production that has taken place between the countries described visually, since these lines connect the countries that have collaborated in production, making it possible to see the networks that have been generated concerning the topic. This is because several countries have carried out scientific productions on IP. Each line allows observation of those involved and how they connect to work together, produce and, as a result, build a research network around the topic. Thus, the lines make it possible to observe which countries are scientifically related and the IP research networks. In addition, the size of the circles makes it possible to differentiate each country's scientific production, since the more significant is the output of each country, the larger is the circumference.

Similarly, the networks generated between the universities that stand out in the approach to the topic in Figure 3 are evident. As can be seen, the data reflect more networks between countries than between universities, demonstrating a need to promote inter-institutional work to produce knowledge; this difference is also found between the databases since, in WoS, more networks are found between universities compared to Scopus. Additionally, it is shown that the leading institutions in both databases are from the United States, reflecting that the top country in this area has the most university networks.

An important fact is that in the databases used, no related works were found considering the method in light of learning engineering. Despite this, the importance of this approach is highlighted by considering the positive effects of generating and putting into practice the educator's creativity and innovative sense, to applying technology in educational environments.



(**a**)

(**b**)

Figure 3. Bibliometric analysis: Outstanding universities in peer instruction according to research networks—(**a**) Web of Science (WoS). (**b**) Scopus. Source: authors.

In this sense, we seek to use learning technology to promote a kind of "reengineering" applied to education to satisfy needs and solve problems that arise in everyday pedagogical life. Therefore, the analysis of the educational situation seeks to draw on the ingenuity of teachers to make decisions that consider the current reality and improve the TLP for the benefit of the academic community and students [31,42–45].

It is important to remember that more than the simple use of technology is needed; technology encompasses all the information, data, and knowledge resulting from it to improve education and the quality of learning. At the same time, it seeks to generate experiences that make it possible to obtain the data required to understand and report on students, knowledge processes, and future solutions and implement improvements in educational practices [46].

Thus, learning sciences and engineering design are combined to systematically apply interdisciplinary methodologies, knowledge, and tools which consider data to make decisions and are person-centered, to respond to educational needs.

It is known that the human way of learning is considered to contribute to the approach of solutions in response to the current challenges of teachers. Thus, as part of the approach, more than having expertise in a discipline is needed, it is also necessary to know how the student learns the discipline [46].

Consequently, to effectively implement this approach, it is necessary to start from the knowledge that teachers have to face a constantly changing reality; this is an essential aspect of their technological expertise and how they apply it pedagogically to benefit from ICT in the activities in the TLP of their discipline. With this aspect in mind, data from the Organization for Economic Cooperation and Development (OECD) is brought to the analysis, which indicates that the number of teachers who have prior knowledge learned in their formal training of the use of ICT in teaching is low in most of the countries considered, as shown in blue in Figure 4 [47].

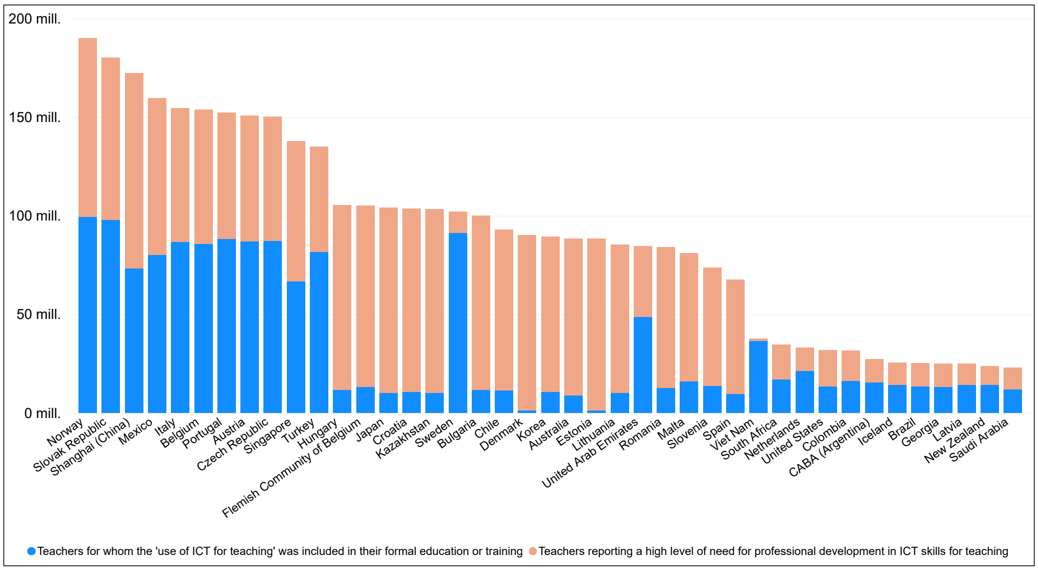


Figure 4. Previous and required knowledge in ICT for teaching—based on OECD data. Source: authors.

As a consequence of this lack of professional training, as shown in orange, the number of educators who affirm that technology is necessary to face the challenges of today's educational reality, where ICT skills are becoming more and more fundamental, is increasing. Accordingly, this considers the relatively recent positioning of technology as valuable and essential in the educational field. As for Latin American countries, the situation is the same, since the less prior knowledge exists, the greater is the need for training; Chile is the country that stands out for the high number of teachers who indicate this need.

It is said that the importance of teachers having ICT skills lies in their increasing use in the educational environment. In addition, in this particular case, in the application of methods such as IP, the use of ICT can increase student participation and enable the development of IP in online environments.

Concerning Ecuador, despite not being among the countries analyzed in these data, this need for specialized training is highlighted in the Multipurpose Survey of the National Institute of Statistics and Census, which addresses ICT indicators since it reflects a percentage of 10.2 of people with digital illiteracy in the country in 2020, especially in rural areas. These data consider educators and all people between 15 and 49 years of age who do not have an activated cell phone and have not used a computer or the Internet in the last year.

To conclude this section, Table 1 presents the most relevant studies on the subject, which justifies the relevance of this research in relation to those already carried out.

Table 1. Summary of works related to peer instruction and learning engineering.

Work	**Problem**			**Constraint**				**Proposal**		
Author	**Student dissatisfaction**	**Student participation**	**Traditional teaching**	**Scenario**	**Disciplinary knowledge**	**Technological knowledge**	**Pedagogical knowledge**	**Learning engineering approach**	**Interactive learning**	**Flipped learning**
Vallarino, 2022 [22]	✠	✠	✠						✠	✠
Lee, 2022 [46]					✠	✠	✠	✠		
Ruiz de Miras, 2022 [21]		✠	✠						✠	✠
Zhong, 2022 [12]			✠	✠		✠	✠		✠	
Hernández-Guerra, 2021 [1]	✠		✠	✠					✠	✠
Englund, 2021 [34]						✠	✠		✠	
González, 2021 [9]		✠	✠						✠	✠
Carstensen, 2020 [2]		✠	✠		✠	✠	✠		✠	
Tullis, 2020 [36]		✠					✠		✠	
Goodell, 2020 [31]					✠	✠	✠	✠		
Budini, 2019 [16]	✠	✠	✠				✠		✠	
Alcalde, 2019 [37]	✠	✠								
Present work	✠	✠	✠	✠	✠	✠	✠	✠	✠	✠

3. Problem Formulation and Methodology

Education, at present, reflects the problem of failing to meet the requirements of modern society by maintaining teaching methods with an effectiveness that has been widely questioned. It wastes not only the benefits of strategies that promote interactive and collaborative learning and have proven positive results but also the utilities of ICT as a critical element in today's daily life [7–9,14,22]. Based on the main related works that were analyzed [12,21,36,37], the following problems and methodology were formulated. Thus, the elements determined in these studies are backed up by the proposals of the authors taken into consideration for PI [1,2,16].

In line with this, this research answers the main problem of the need to provide an alternative that responds to the low student participation caused by a master-class dynamic based on the passive transmission of information from the teacher to the students.

On the other hand, part of the problem also lies in how these methods are carried out, as in the case of sound and aeration; consequently, they represent a drawback of Ecuadorian education. It, together with overcrowding, means that the classrooms need the relevant space according to the number of students. Insufficient space, along with an unflattering infrastructure, cause them not to receive enough air at the appropriate temperature for an adequate oxygenation process. The sound projection must be sufficient for all students to hear and interact without representing an auditory inconvenience.

Faced with this problem, PI emerges as an alternative method that starts from invested learning to maximize the use of class time with participatory and interactive activities that achieve the assimilation of knowledge, thus leaving the transfer of knowledge to before the class so that students attend with previous knowledge of the course and consolidate learning.

As mentioned above, PI has several benefits, particularly that it also achieves participation and cooperative learning when students discuss their ideas, defend them to try to convince their classmates, and question them to analyze whether the chosen answer is correct. To apply this method, it is necessary to initially consider the characteristics of the space and environment where the process is used to maximize the results. These will be detailed later.

In this sense, it would be convenient to have ample space suitable for the number of students and a soundproofing mechanism so that external noise does not interfere with the TLP or vice versa. A classroom where aeration is appropriate and its infrastructure allows the regulated entry and exit of air is also necessary so that, based on the principles of neuroeducation, adequate oxygenation contributes to brain processes related to learning.

In addition, the natural and artificial light available in the classroom must be taken into consideration so that it contributes to various aspects of the TLP, such as the attention of students or the use of multiple resources; an example of this is the use of digital boards or projectors on which, if there is no adequate light regulation, the results of the answers given in PI cannot be visualized.

Additionally, the classroom layout is an essential aspect; a traditional organization is not the right environment for the application of the method, and a change in it will even allow a change in the mentality of the subjects of education. Thus, a circular organization enables better interaction, where the groups for discussion among peers are located at round tables which allow them to dialogue and work efficiently, and, in turn, the teacher can move around the space to guide the process, as shown in Figure 1.

These and other conditions characterize the classroom environment where the method would be applied. This is also a problem since these conditions should be considered, as they should be appropriate for the Ecuadorian context and would, thus, require several changes. Among these, the small size of the classrooms, the investment in resources and infrastructure, and the costs they would need are taken into account.

As part of academic management, sustainability of income, competitiveness, quality, and warmth, as the case may be, are noted, considering equipment, maintenance, and, mainly, teacher training. It is believed that an important aspect is technology and that, as previously mentioned, not all educators have the required knowledge. If they do, they only sometimes use it, combining it with the pedagogical and disciplinary knowledge necessary to meet their educational objectives, as stated in learning engineering.

Given the national and educational reality, the abovementioned conditions are generally not found, so it is necessary that teachers be flexible, adaptable, and resilient to adjust planning to the context and apply the method in the best possible way. Once the scenario characteristics were considered, the steps were presented according to Eric Mazur's theory, detailing the activities divided into the three main stages of inverted learning and PI.

The information they wish to approach should be made available to the students, with the resources that the teacher considers pertinent according to the topic addressed. For the transfer stage, the audiovisual contents are presented to the students precisely and briefly in a didactic way after establishing the objectives regarding the expected learning outcomes. It is recommended to propose interactive activities that allow checking and monitoring, including the help of the ICT, so that students are prepared for the assimilation phase since, to achieve the purposes of invested learning, a percentage of at least 80 must comply with this asynchronous approach to knowledge.

Based on this, the teacher should design the crucial question(s), generally multiple-choice questions, to demonstrate the understanding of the essential concepts, which then triggers the interaction. Consequently, to achieve the desired effects of PI, this conceptual test must be carefully and strategically planned considering the subject matter, level of complexity, and classroom environment, avoiding the generation of student confusion when answering and focusing on posing questions that encourage reflective and argumentative reasoning.

For the assimilation stage, in the synchronous meeting with the students, the teacher should briefly introduce the class topic and continue with the presentation of the question so that the students can reflect and respond individually (voting). With the benefits of ICT, various tools allow this process to be developed and facilitate the evaluation of the results through an SRS; in this case, the device used was "Wooclap".

To complement the assimilation with the consolidation stage, the teacher must review the answers and make decisions, depending on the evaluation results. When the question results reflect a percentage lower than 30 in terms of correct answers, the educator should briefly explain the concept due to the poor understanding or provide students with a conceptual aid. When the percentage is higher than 70, a description of the correct answer is given to provide feedback, review the concept, and the class can continue to the next question. After the review, the voting is repeated to continue onto the subsequent step, as explained below.

If the percentage is between 30 and 70, we move directly to the next step, which consists of discussion, where groups of students should be formed in which each one should argue to convince their classmate(s) that their answer is correct. Therefore, it is convenient for students with different solutions to be grouped together, to generate the desired debate and reflection to enrich the process results. In addition, the composition should be in-line with the context and classroom environment and the objectives and interests of the teachers.

As previously mentioned, the setting is a fundamental element to consider for the application of the method since, for example, in this step, the ideal would be to give ample freedom for students to move around the classroom without restriction to discuss with any group or pair, which is complicated when the space is minimal, or the classroom layout does not make this possible. Therefore, the teacher must consider all the characteristics of the context to be used to plan the application based on the possibilities, time, number of students, arrangement and type of tables, spatial conditions, and other criteria that the educator must consider strategically, according to the learning engineering approach, to achieve the desired objectives.

The number of members of the groups formed should be in tune with the number of students in the class and facilitate the contentious debate of each of them. In this case, a number between 3 and 4 was chosen so that everyone could participate extensively in the discussion. However, this number is flexible and depends on the conditions and the teacher's judgment of pedagogical, technological, and disciplinary aspects, remembering that they must accompany and guide the whole process.

Likewise, the educator must provide the necessary freedom and time to the students so that they can express themselves, argue and discuss; make sure that everyone participates; clarify doubts in required cases; and monitor the progress to continue with the next step. This consists of a new vote where the learner again answers the same question posed in the SRS, and they decide whether to keep their initial answer or change it after the discussion is developed. Together with the results, the teacher indicates the correct answer, explains it in greater depth, and provides feedback to consolidate what was understood. The teacher can then address a new topic or move on to the next question and repeat the same process as shown in Figure 5 and, in more detail, in Figure 6.

To research the method explained above, the historical-descriptive method was first used to contextualize and conceptualize the topic at the international level, determine the stages required to apply peer interaction, and describe the relevant aspects of this method based on the search, selection, and analysis of scientific articles.

For this literature review, 30 articles were considered and selected from the most relevant results found in WoS and Scopus using "peer instruction" as the search term.

The selected articles were organized in a matrix in an Excel spreadsheet to develop the state of the art, taking into account the issues, problems, and solutions raised in them. For this purpose, it was established as a criterion of selection the year of publication between 2018 and 2022. The time mentioned was in the title or the keywords.

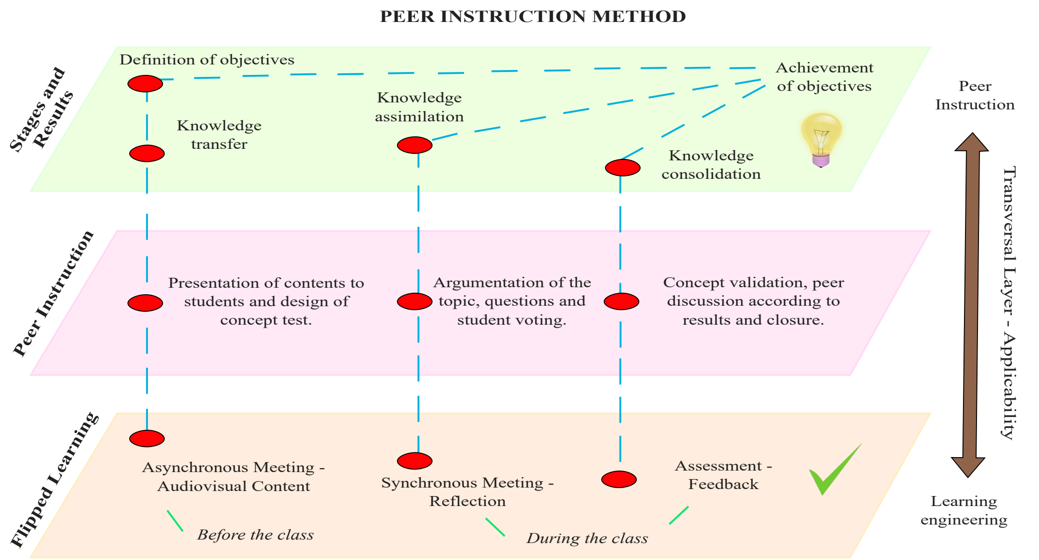


Figure 5. Interactive method of peer instruction applied to classroom environments. Source: authors.

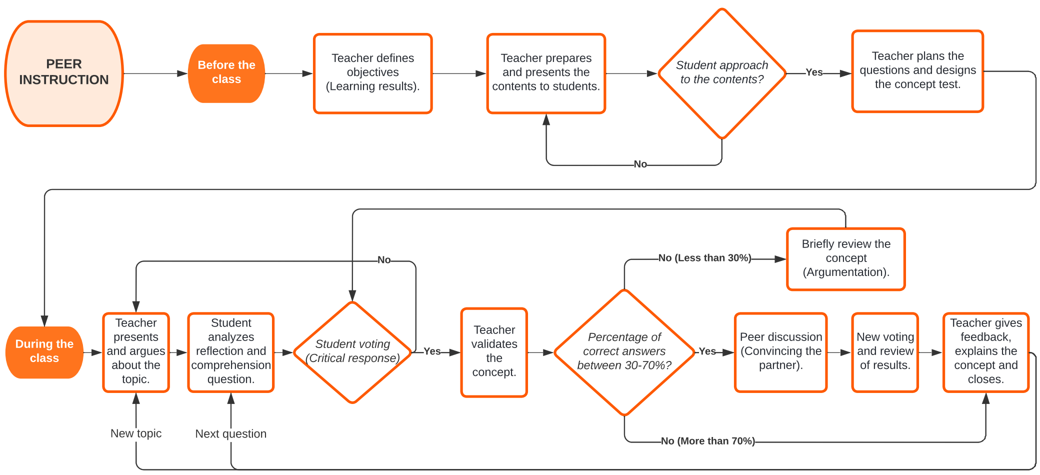


Figure 6. Peer instruction method process. Source: authors.

The review is complemented with a bibliometric study to show the universities and countries that have mainly dealt with PI, its application in different contexts, and the networks generated among them. This way, it was possible to approximate the subject's state regarding scientific production and how PI has been treated in the academic environment. The study was carried out using the VosViewer tool with the scientific articles published in the five previous years and the same databases, resulting in 1718 documents in WoS and 1694 in Scopus. In addition, for the analysis, data from the open-access OECD on knowledge and teacher training in ICT for education were considered.

Subsequently, the experimental method was used to apply PI in classroom environments to evaluate a learning engineering approach according to the context and its applicability through Likert scales, following a quantitative methodology. In addition, the analytical-synthetic method was applied to assess and present the results in consideration of fulfilling the research objectives.

At this point, for the application of the method, two surveys of 22 questions each were designed, for teachers and students, respectively. The population consisted of 89 students between 8 and 11 years of age and two 31-year-old educators from two Salesian educational institutions in Quito, Ecuador; one of a fiscomisional type and the other of a private nature. In the first institution, the survey was applied to 48 students and their language and literature teacher in the fifth year of General Basic Education, and the second to 41 students and their teacher of Mathematics in the sixth year of General Basic Education.

The method was applied in virtual classroom environments in both institutions through the Zoom tool for online video conferences and Microsoft Forms for the surveys. These surveys contained questions related to the stages, relevant aspects, and other elements of the applicability of PI considering a learning engineering approach; this is in-line with the fulfillment of the objectives set out in the research and taking into account the theoretical and empirical contributions of research related to the topic.

The Likert scale used for the surveys was based on five items as response options to determine the perception of students and teachers, with these being: Strongly Agree (P1), Agree (P2), Undecided (P3), Disagree (P4), Strongly Disagree (P5). Table 2 shows the survey questions to students and the number of responses obtained in each of the five items; likewise, Table 3 reflects the questions and answers of the survey addressed to teachers.

Table 2. Survey based on five points Likert scale—Students.

Survey	**P1**	**P2**	**P3**	**P4**	**P5**
1. Did you review all the material your teacher shared before class?	57	20	7	2	3
2. Was the technology application easy to use, and did it increase your active class participation?	53	23	7	2	4
3. Did visualizing the immediate results of the questions help you reflect on your answer?	55	23	8	0	3
4. Do you think the teacher's guidance and explanation improved your understanding of the topic and clarified your doubts?	68	14	3	1	3
5. Did you participate more in today's class activities than in traditional classes?	53	17	10	3	6
6. Do you think today's class contributed to the interaction with your classmates and your teacher?	60	21	6	0	2
7. Did the reflection with your peers and the collaborative work help you to understand the topic better?	60	21	6	1	1
8. Did you find it exciting to interact and answer questions using the technology application?	56	20	10	2	1
9. Did your answer being anonymous make you answer the questions more honestly and confidently?	64	13	6	1	5
10. Does reviewing the material before class using technological tools give you more time to understand the subject at your own pace?	63	15	6	3	2
11. Did answering individually at the beginning help you reflect and question yourself about the material you reviewed before class?	57	20	9	2	1
12. Did you better understand the material the teacher shared before class when you discussed it with your classmates?	57	22	6	2	2
13. Did the reflection with your peers make you feel more confident to answer the second time correctly?	56	23	6	2	2
14. Have your doubts about the subject been clarified?	69	16	3	0	1
15. Did you enjoy participating in the reflections and discussions in your peer group?	59	24	5	0	1
16. Did you feel satisfied or motivated with today's class?	65	19	4	0	1
17. Did the Peer Instruction method applied today help you better understand the subject?	62	21	4	1	1
18. Did today's class keep your attention, interest, and concentration more than traditional classes?	65	12	8	1	3

Table 2. *Cont.*

Survey	P1	P2	P3	P4	P5
19. Did you like your teacher's use of technology in the classroom?	74	12	2	0	1
20. Would you like your teacher to use more technological tools in their classes?	61	13	8	3	4
21. Would you like to learn how to use more technological tools that contribute to your learning?	74	11	1	2	1
22. Would you like your teacher to use this and other non-traditional methods more often?	62	16	5	2	4

Table 3. Survey based on five points Likert scale—Teachers.

Survey	P1	P2	P3	P4	P5
1. Was the case where the Peer Instruction Method was applied optimal?	0	2	0	0	0
2. Did the Peer Instruction Method allow for formative evaluation?	1	1	0	0	0
3. Did immediately seeing the results of the responses allow you to assess the student's level of understanding, provide feedback and reinforce the topic?	1	1	0	0	0
4. Made the technological application used to contribute to the development of the Peer Instruction Method?	2	0	0	0	0
5. Did the students show more interaction, motivation, and dynamism during the class compared to traditional classes?	1	1	0	0	0
6. Did students participate more in class activities?	2	0	0	0	0
7. Does the Peer Instruction Method favor social skills by promoting student interaction and collaborative work?	1	1	0	0	0
8. Do apply the Peer Instruction Method in light of Flipped Learning contribute to students' self-learning and self-discipline?	1	1	0	0	0
9. Do you think the experience with the use of the Peer Instruction Method and ICT was positive and conducive to student learning and satisfaction?	2	0	0	0	0
10. Did the establishment of interactive resources made with ICT (Wordwall and EdPuzzle) for the transfer stage contribute to the students have reviewed the material?	2	0	0	0	0
11. Did the review of the content before class allows students to participate more actively in the assimilation and consolidation stage with questions and reflections?	0	2	0	0	0
12. Do you think that the Peer Instruction Method allows students who did not understand the topic in the transfer stage to do so after the peer interaction?	2	0	0	0	0
13. Would better educational results be obtained if the resources and conditions of the classroom setting and space are improved?	1	1	0	0	0
14. Do you consider that students have a positive perception of the application of the Peer Instruction Method?	2	0	0	0	0
15. Do you consider Peer Instruction to be an applicable method?	2	0	0	0	0
16. Do you consider the method flexible enough to be applicable in different classroom environments?	1	1	0	0	0
17. Would you recommend another teacher to apply the Peer Instruction Method in their classroom?	2	0	0	0	0
18. Do you consider Peer Instruction to be a method that innovates the teaching-learning process?	2	0	0	0	0
19. Do you think it is essential for a teacher to have the technical knowledge to apply it in a pedagogically appropriate way in their discipline or subject?	2	0	0	0	0
20. Do you consider that you received sufficient training in innovation and technology for education during your university preparation as a teacher?	0	2	0	0	0
21. Do you think it is necessary to train teachers in ICT, innovative approaches, and methods to stimulate their ingenuity in their pedagogical practice?	2	0	0	0	0
22. Do you think that the consideration of learning engineering is important to innovate the teaching-learning process and contribute to the application of the Peer Instruction Method?	2	0	0	0	0

To conclude this section, it should be noted that, in response to the problem mentioned above, the main research question is the applicability of PI considering a learning engineering approach to innovate the TLP. For this purpose, it is specifically questioned which stages are required for applying this method and which are its relevant aspects considering the approach above.

Thus, in methodological terms, this article is the result of quantitative research of the experimental type that shows the applicability of the method in classroom environments. Its empirical results are also based on a literature review and a bibliometric study carried out at the beginning of the research to answer the questions posed.

4. Analysis of Results

After applying the surveys to the teachers and students of the groups and institutions previously described, the results obtained were analyzed. In this sense, Table 4 shows the answers in percentages of each question asked to the students according to the Likert scale. As can be seen, the option that prevails in the responses is "Strongly agree", followed by "Agree", showing the acceptance of the application of PI method.

Table 4. Survey score: peer instruction—students.

	P1	P2	P3	P4	P5
Questions	**Strongly Agree Survey %**	**Agree %**	**Undecided %**	**In Disagreement %**	**Strongly Disagree %**
1	64%	22.5%	7.9%	2.2%	3.4%
2	59.6%	25.8%	7.9%	2.2%	4.5%
3	61.8%	25.8%	9%	0%	3.4%
4	76.4%	15.7%	3.4%	1.1%	3.4%
5	59.6%	19.1%	11.2%	3.4%	6.7%
6	67.4%	23.6%	6.7%	0%	2.2%
7	67.4%	23.6%	6.7%	1.1%	1.1%
8	62.9%	22.5%	11.2%	2.2%	1.1%
9	71.9%	14.6%	6.7%	1.1%	5.6%
10	70.8%	16.9%	6.7%	3.4%	2.2%
11	64%	22.5%	10.1%	2.2%	1.1%
12	64%	24.7%	6.7%	2.2%	2.2%
13	62.9%	25.8%	6.7%	2.2%	2.2%
14	77.5%	18%	3.4%	0%	1.1%
15	66.3%	27%	5.6%	0%	1.1%
16	73%	21.3%	4.5%	0%	1.1%
17	69.7%	23.6%	4.5%	1.1%	1.1%
18	73%	13.5%	9%	1.1%	3.4%
19	83.1%	13.5%	2.2%	0%	1.1%
20	68.5%	14.6%	9%	3.4%	4.5%
21	83.1%	12.4%	1.1%	2.2%	1.1%
22	69.7%	18%	5.6%	2.2%	4.5%

Questions 19 and 21 have the highest value, reflecting the students' preference for technology in classroom environments. It is based on the fact that 83.1% of the students liked that their teacher used technology in the classroom and, in turn, the same number would like to learn to use more tools of this type, which contribute to their learning.

On the other hand, Table 5 shows the percentage values of the answers given by the teachers. These indicate that the respondents fully agree with the proposed in 12 of the 22 questions related to the method's applicability. Likewise, said totality agrees with what is indicated in three questions and, in the remaining questions, one of them chose the option "Strongly agree" and the other chose "Agree"; thus, the items "Undecided", "Disagree" and "Strongly disagree" of the Likert scale were not selected by the respondents in any question.

Table 5. Survey score: peer instruction—teachers.

	P1	P2	P3	P4	P5
Questions	**Strongly Agree Survey %**	**Agree %**	**Undecided %**	**In Disagreement %**	**Strongly Disagree %**
1	0%	100%	0%	0%	0%
2	50%	50%	0%	0%	0%
3	50%	50%	0%	0%	0%
4	100%	0%	0%	0%	0%
5	50%	50%	0%	0%	0%
6	100%	0%	0%	0%	0%
7	50%	50%	0%	0%	0%
8	50%	50%	0%	0%	0%
9	100%	0%	0%	0%	0%
10	100%	0%	0%	0%	0%
11	0%	100%	0%	0%	0%
12	100%	0%	0%	0%	0%
13	50%	50%	0%	0%	0%
14	100%	0%	0%	0%	0%
15	100%	0%	0%	0%	0%
16	50%	50%	0%	0%	0%
17	100%	0%	0%	0%	0%
18	100%	0%	0%	0%	0%
19	100%	0%	0%	0%	0%
20	0%	100%	0%	0%	0%
21	100%	0%	0%	0%	0%
22	100%	0%	0%	0%	0%

At this point, questions 9, 18, and 22 stand out because they indicate the benefits of the application of the method since both teachers fully agree that the experience of application together with ICT was positive and favored student learning and satisfaction, which is why they consider it as a method that innovates the TLP. Furthermore, they affirm that taking into account the learning engineering is essential for such innovation and, thus, contributes to the application of PI.

At the same time, questions 14, 15, and 17 stand out for showing the applicability of PI more directly by showing that the two teachers agree that the students have a positive perception of the method. Hence, they affirm that they consider it applicable and would even recommend its application in class to another educator.

Concerning the stages previously explained for applying the method, question 10 was analyzed. Both educators fully agree that the use of interactive resources including ICT for the knowledge transfer stage contributed to the students having reviewed the material. This is not only because of the ability of ICTs to generate attractive, interactive, and didactic resources but also because of the option to review the number of students who studied them, as is the case with "Wordwall" and "EdPuzzle", which were the ICTs used in this case.

Similarly, questions 11 and 12 were considered, where the two teachers agree that reviewing the content before class allowed more active student participation in the assimilation and consolidation of knowledge with questions and reflections. In turn, the educators fully agreed that the method allowed learners who did not understand the topic during the transfer stage to do so after the peer interaction. Although the previous review of the content is fundamental for the development of the method, the interaction among peers is of great importance to achieve the fulfillment of the objectives.

According to the percentages in Table 4, Figure 7 shows that 64% and 22.5% of the students agree and agree. Therefore, they reviewed the material shared by the teacher before the class. However, reaching a higher value, 70.8% of them agree that such a review using technological tools gave them more time to understand the subject at their own pace, which shows that, like the teachers, the students highlight the importance of the review and its benefits for learning according to their time needs, even though some of them did not review all the material.

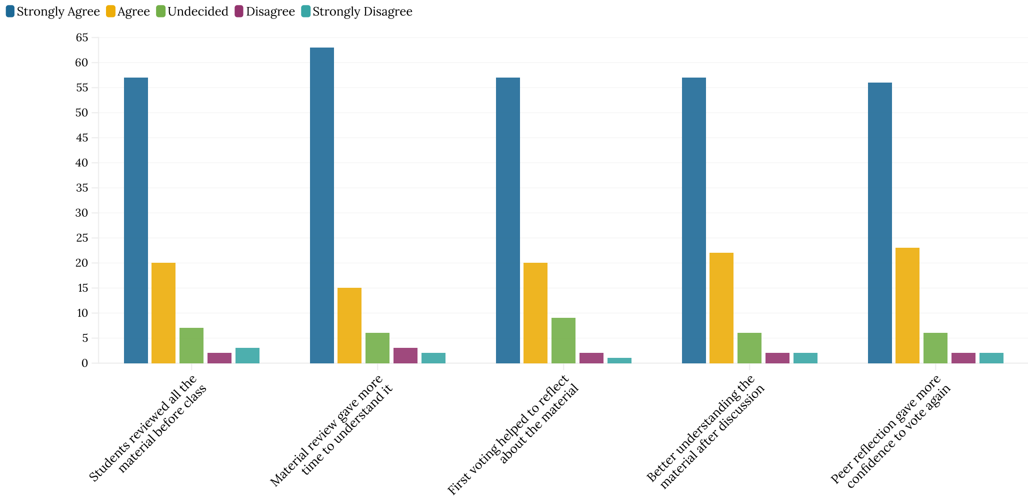


Figure 7. Students survey: application of peer-instruction method process. Source: Authors.

In the figure, the relevance of the assimilation and consolidation stages is observed since the student option of "Strongly agree" prevails at a percentage higher than 60%, considering the fact that answering individually at the beginning helped them to reflect and question themselves about what they had reviewed before class. This result was repeated when they affirmed that they understood the material reviewed better when they discussed it with their classmates and that the reflection between them made them feel more confident to answer correctly in the second ballot. What has been said up to this point implies that the moments of interaction and discussion are significant to achieving the proposed method, as the teachers surveyed affirm.

Regarding the relevant aspects of the method, considering questions 2, 3, 5, 7, and 8 of the teachers' survey, they agree that it allows a formative evaluation since, thanks to the fact that the teacher can see the results of the students' voting immediately, they can evaluate their level of understanding, give feedback and reinforce the topic, as the case may be. These answers are maintained to affirm that the method made the students present more significant interaction, motivation, and dynamism compared to traditional classes; that it favored their social skills by promoting student interaction and collaborative work; and that it contributed to their self-learning and self-discipline when applied in the context of inverted learning.

Considering questions 4 and 6, both teachers fully agree that another important aspect is that the method made students participate more in class activities. Following the same answer option, the educators affirm that the technological application used called "Wooclap" contributed to the development of the method, highlighting the benefits of the mentioned application by allowing participation in real-time, anonymous voting, immediate visualization of results, and other aspects according to the teaching needs, among them, the option of using it for free.

These aspects are found in the student survey results since, as can be identified in Figure 8, the "Strongly agree" option prevails, with 59.6% being the lowest value and 73% the highest. Thus, it is possible to describe, as relevant aspects of the method, the effects and benefits that it brings to the TLP; among these and sharing the highest value, is that they felt greater satisfaction or motivation along with more attention, interest, and concentration in the class in which PI is applied compared to traditional courses. Next to these, with 69.7%, is that the method helped them better understand the subject.

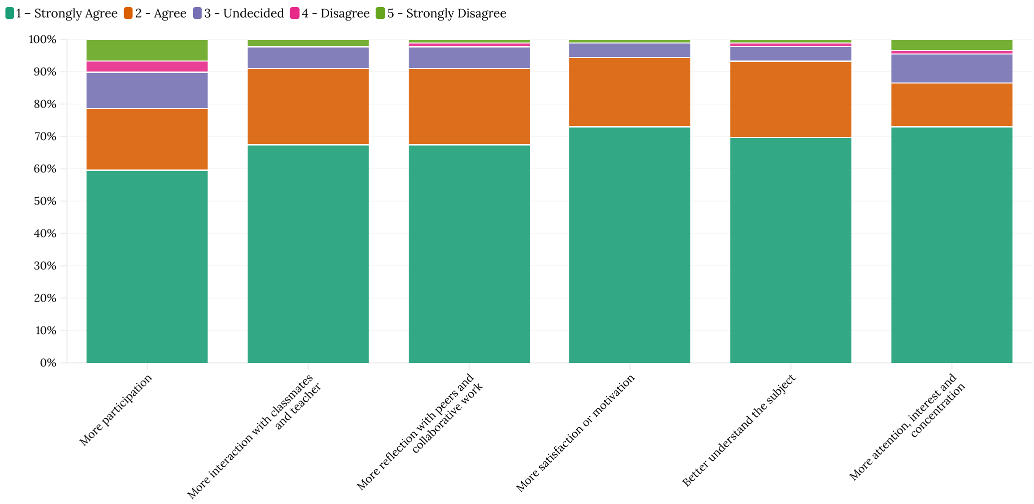


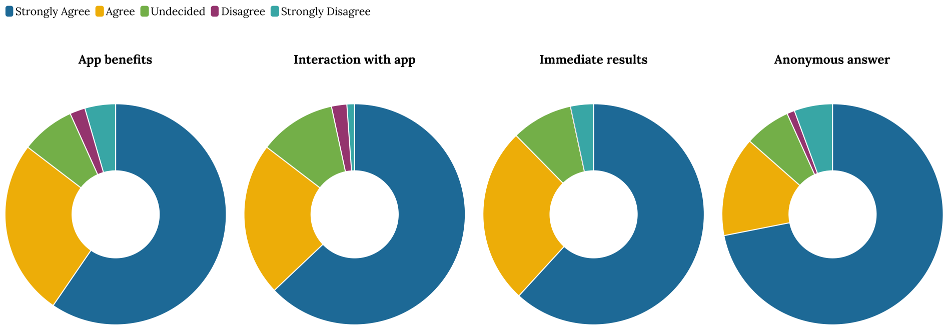
Figure 8. Students survey: relevant aspects and benefits of peer instruction method. Source: authors.

Subsequently, the contribution of PI to interaction among peers and with the teacher shares the exact value of 67.4%, with the fact that the reflection among peers and collaborative work embedded in the method are essential elements that also help to understand what was discussed in class. Finally, with the lowest value, the student perception indicates that there was more significant participation in the activities of the course in question than in traditional classes.

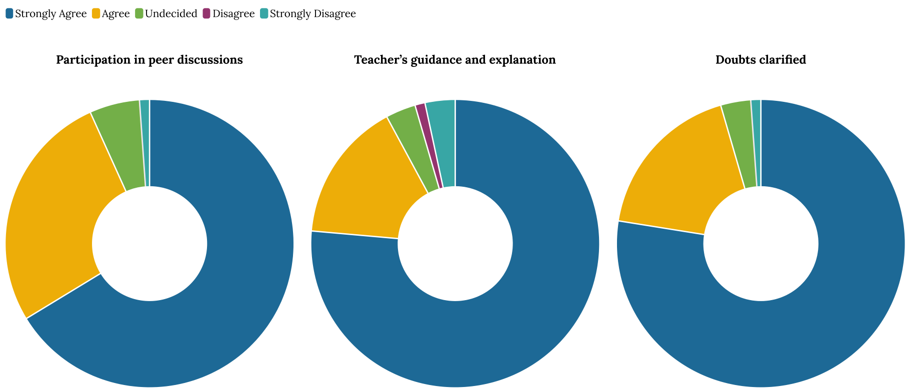
As mentioned theoretically, the scenario is another essential element to consider when applying the method. In this sense, when analyzing questions 1, 13, and 16 of the teacher survey, it was found that the two educators agreed that the scenario in which it was applied was optimal. However, it was also evident that they agreed that improving the resources and conditions of the classroom setting and space would favor better educational results. At the same time, it is worth comparing the teachers' responses of strongly agree and agree when asked if they believe the method is flexible to be applied in different classroom environments.

This leads us to say that, although the method can be flexible to be applied in different contexts and with other characteristics, it is essential that the setting has the necessary conditions for it to be applicable and to seek the optimal ones that could enhance the results. While it is true that teaching ingenuity adapts the context to carry out the different methods, it is also vital to have the required elements for PI to meet its objectives.

Other elements considered in the application of the method are the facilities it offers, which favor didactic management in the classroom environments in which it is applied. In Figure 9a, it is observed that 71.9% of students agree that answering anonymously during the voting made them feel more confident to do so honestly. Following this element, with percentages higher than 60%, the students agree that they found the interaction with the technological application to respond during the voting exciting and that the visualization of immediate results during the voting helped them to reflect on the answer they chose. Finally, they state that the application was easy-to-use and benefited their increased active participation in class.



(**a**)



(**b**)

Figure 9. Students survey: a comparative analysis of results—learning engineering approach. (**a**) Facilities for didactic management in classroom environments; (**b**) motivation, accompaniment and feedback. Source: authors.

The facilities described and presented in Figure 9 must be complemented with an exemplary process of motivation, accompaniment, and feedback to enhance the achievement of the objectives of the method based on learning engineering. This is evidenced in Figure 9b, where the option "Strongly agree" predominates and indicates that thanks to its development, 77.5% of the students clarified the doubts they had about the topic, 76.4% believe that the teacher's guidance and explanation improved the understanding of the topic and clarification, and 66.3% felt motivated and liked to participate in the reflections and debates that occurred in the group with their classmates.

Thus, in Figure 9 is analyzed how technological, pedagogical, and disciplinary aspects are strategically combined to implement PI according to a learning engineering approach in which all elements must be well thought out to enhance academic results and achieve the objectives. At the same time, the results highlight the primacy of the pedagogical component to carry out the method, recalling that without it, the benefits that technological tools may have are not enough to achieve the objectives.

On the other hand, considering the learning engineering pointed out in questions 19, 20, and 21 of the educators' survey, both fully agree that it is essential for a teacher to have the technological knowledge to be able to apply the approach in a pedagogically acceptable way in his subject or discipline. Therefore, they maintain the same response to affirm that teacher training in ICT, innovative approaches, and methods are necessary to stimulate their ingenuity in their pedagogical practice; in this way, they will be able to apply what they know better and enhance educational results.

An important aspect is that teachers chose the option "Agree" when asked if they consider that they received sufficient training in innovation and technology for education during their university preparation as teachers. The age of the respondents can explain this because the mentioned training is relatively current in the Ecuadorian context; they are part of the cohort of teachers who did receive it, as opposed to the majority of those with an older age. However, the preparation of an educator in this sense must be constant to respond to society's changes, needs, and advances, so that training that is only considered partially sufficient by teachers can be strengthened.

Concerning this technological use, Figure 10 compares the answer students gave when asked if they liked that the teacher used technology in class versus the answer they shared about their desire to learn to use more technological tools for their learning. This aims to show how each student's response changes or remains the same from one question to the other. In addition, results are divided into two columns to separate data for students in the subject of Language and Literature from those in Mathematics.

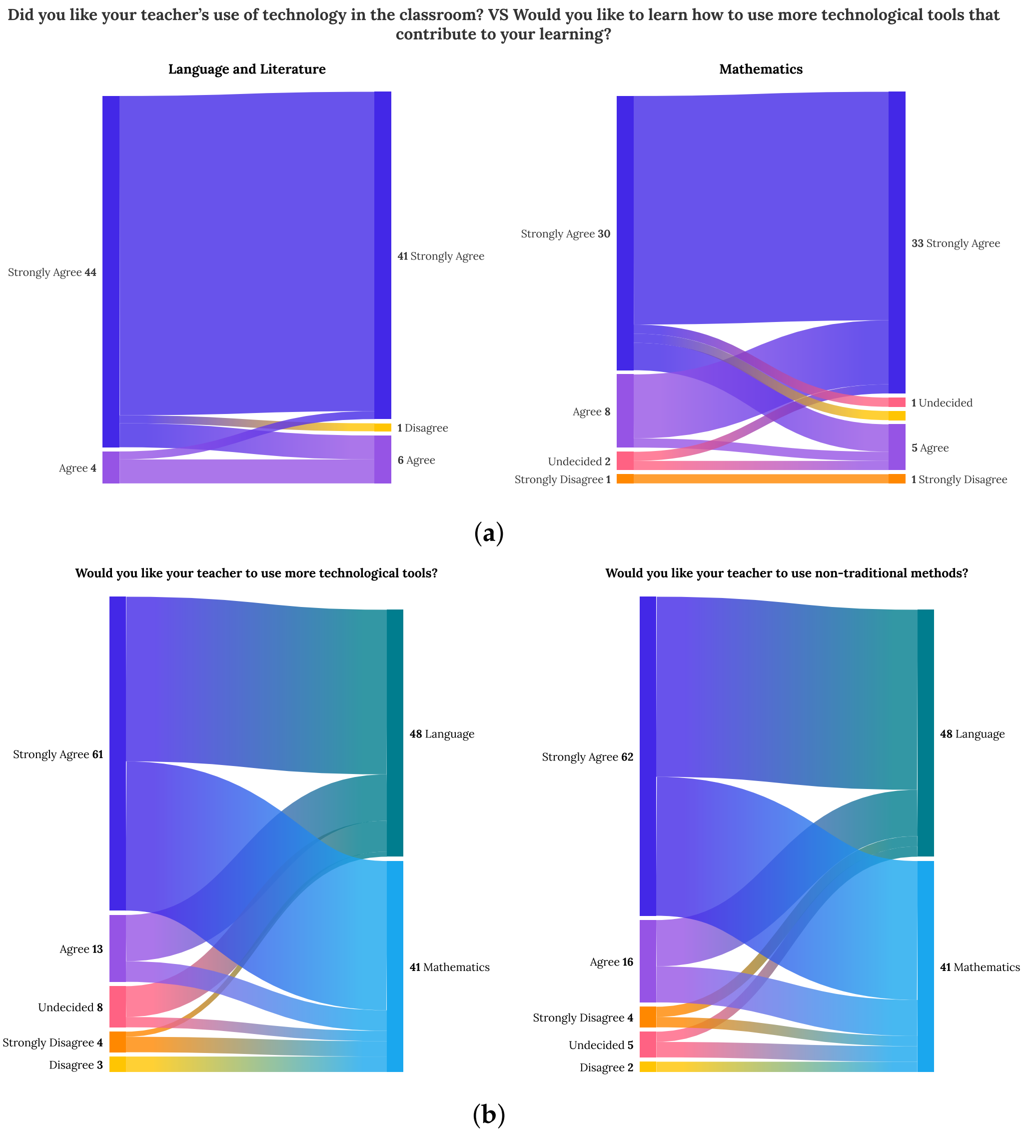


Figure 10. Students survey: a comparative analysis of results—subject vs. (**a**) use of technology to learning in classroom, (**b**) use of technological tools and non-traditional methods. Source: authors.

Many students favored both the use and knowledge of ICT in a classroom environment. As can be observed, in the case of Language and Literature, all students agree with both questions, with the first answer option being the most chosen and represented in blue; this is except one student who, despite strongly agreeing that he liked the teacher's use of technology in the classroom, disagrees with wanting to learn more tools that contribute to his learning. Minor changes are evidenced in the answers to the questions.

In contrast, in the case of Mathematics, there are more changes between the answers to each question and one student who disagrees with the two questions asked. Despite this, 38 votes stand out, distributed between the options "Strongly agree" and "Agree" in both queries, and, likewise, the majority of the former is maintained in blue.

As can be seen, the Language and Literature students show a greater preference for the use of technology in class and for the desire to learn to use it more in comparison to the Mathematics group; it is noteworthy that 40 out of 48 students in the first group mentioned chose the option "Strongly agree" in both questions, while this situation is reflected in 25 out of 41 students in the second group.

On the other hand, in Figure 10b, the data obtained with the questions on the desire for teachers to use more technological tools in their classes are presented divided into one column and to use PI and other methods different from the traditional ones more often in the other. The results are further divided by subject to compare the perception of each group of students according to questions.

At the question level, it is found that the most significant number of students agree that the use of technology and different methods in a class should be increased; in the same way, the first option is the most chosen and is represented in blue. In this regard, it should be said that there is a greater acceptance of the second question, showing that students are more interested in an increase in the use of methods that innovate the TLP in comparison to the greater use of technology, thus reinforcing the primacy of the importance of the pedagogical component.

Considering the data of the first two response options indicates a perception in favor of the question is possible to identify in the first question the response of 41 out of 48 students of Language and Literature and 33 out of 41 students of Mathematics. For the second question, 44 out of 48 students of the first subject were mentioned, and 34 out of 41 students of the second subject responded. As can be seen, higher results were obtained in the Language and Literature group, demonstrating a greater desire for greater use of technology and methods other than the traditional ones.

This comparison between subjects shows the applicability of the method and technology in subjects such as Language and Literature since, even though they were initially designed to be applied to the exact sciences, higher acceptance values were obtained in comparison with the Mathematics group. In this sense, the Language and Literature students were more motivated by the application in question, data which should be considered to improve the learning of the subject. Thus, the positive effects of this and other methods, together with technology, can be observed in innovating the TLP in various areas and classroom environments.

What has been said up to this point shows that PI has positive effects under previously indicated conditions. However, an end to keep in mind is that, as with other methods, it is essential to consider the importance of interdisciplinary work and the benefits of using a variety of procedures according to the needs of the context and classroom environment. It is its generation of a manageable amount of work for teachers and students, or an impertinent use of the method, which could make it unfruitful.

Finally, Figure 11 shows the respondents' perception of the applicability of PI to innovate the TLP; thus, teachers consider the method to be 95% applicable, while students believe it to be 87% useful. It is explained in the results previously analyzed and, based on this, the conditions under which the method would or would not be applicable are shown in Table 6.

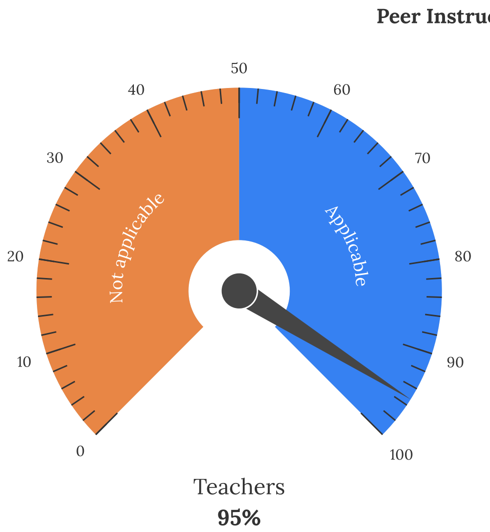


Figure 11. Teachers and students survey: peer-instruction applicability to innovate the teaching–learning process. Source: authors.

Table 6. Conditions of peer-instruction applicability.

Not Applicable	Applicable
Vague or undefined objectives.	Adequately defined objectives (learning outcomes).
Lack of planning of the activities of each stage of the method.	Clear and specific content to be reviewed before class.
Absence of student review of submitted content before class.	Student approach to content before class.
Pervasive concept test or with confusing questions.	Planning, design, and timely presentation of the proof of concept.
Disorganization or inflexibility in the times assigned to each stage.	Stage with the necessary conditions for the presence and participation of all students.
Difficulties in student access to tools, resources, and activities.	Access to tools, resources, and activities for all students.
Lack of teacher or students' knowledge of using the selected technological tools.	Teacher and student knowledge on using the selected technological tools (easy-to-use tools).
Unsuccessful use of technological tools due to a weak pedagogical base.	Technology tools with the option to set up anonymous responses, immediate results, and real-time interaction.
Very complex or straightforward proof of concept (no room for debate).	Student vote that gives way to critical responses.
lack of constant evaluation for concept validation.	Guidance and teacher accompaniment in the discussion among peers in each group.
Insufficient or impertinent feedback.	Adequate teaching feedback.
Emphasis on the methodological development of PI with a weak or forced approach to content.	Selection and pertinent approach to disciplinary content with pedagogical use of technological tools.

5. Conclusions

Previous research on PI has highlighted its benefits for enriching learning outcomes and improving the educational process. Thus, it was explained how to carry it out and its positive effects from a theoretical point of view. In line with this, the present research demonstrates how the interactive method of teaching based on PI, considering learning engineering, is applicable to innovating the TLP if it is carried out under the appropriate conditions.

Here, we highlight that it is more widely used in Language and Literature despite being a method initially designed for the exact sciences. It is necessary to plan the elements involved in the application at the technological, pedagogical, disciplinary, infrastructure, access, and other components of didactic management levels. For this purpose, after analyzing results, some conditions should be considered before applying PI to enhance its benefits. Among these conditions, a suitable scenario is essential according to the classroom environment because, although in this case the method was applied virtually and in two subjects, PI offers the flexibility required to be used in various classroom environments with other modalities and areas of knowledge.

The high applicability of this interactive method, reflected with higher values in the teachers' perception, is also due to the knowledge and adequate management that the educator must have on how to carry it out and to the development of the method in the light of the utilities of inverted learning; this uses the class time more productively by using it for activities other than the presentation of contents. Thus, three general stages are required to apply it, the transfer, assimilation, and consolidation of knowledge; at this point, it is worth mentioning that it is essential to define the objectives before the whole process and verify their achievement at the end.

After a clear and precise establishment of the learning results is achieved, the transfer stage involves the asynchronous meeting where the contents are presented clearly, specifically, and interactively to the students before the class, and the proof of concept is designed. Subsequently, synchronously, in the assimilation stage during the course, the argumentation of the topic, questions, reflection, and student voting occurs. These are complemented by the consolidation stage, where the concept is validated during the discussion among peers which takes place according to the vote results. Thus, the class closes after the evaluation, feedback, and final verification of the fulfillment of objectives.

After applying the method, it is possible to describe its relevant aspects from the viewpoint of learning engineering, which characterizes it as an interactive method involving active participation, reflection, debate, criticality, and collaborative work. In addition, PI favors dynamism, clarification of doubts, and understanding of the subject by requiring of students an autonomous approach, analysis, and explanation of the content. Likewise, among these aspects, the satisfaction, motivation, attention, interest, and concentration generated in comparison to traditional methods, according to the student's perception, stand out.

A relevant aspect is self-learning that this method promotes with a view to self-regulation, together with the contribution it makes to the students' social skills due to the interaction, which, in turn, benefits the understanding of a subject. The horizontal explanation that arises among peers facilitates such knowledge by taking place in a similar learning situation, among peers.

In addition, another aspect to be taken into account is the formative evaluation that enables the teacher to monitor, accompany and provide feedback in the process so that students can learn from their mistakes and value their achievements. Therefore, together with including the teacher's guidance and explanation as a fundamental element, the primacy of the pedagogical component is emphasized by affirming that without it, technology would not achieve the objectives and even highlighting the possibility of applying the method without using ICT in the case of not having technological availability, while emphasizing that its use enriches the results of its application.

For this reason, technology is also an aspect to consider when positioning PI in accordance with students' interests since they enjoy its use and are motivated to learn more about it and its use for their education. In addition, there are the fruits that such learning would bring to students' preparation for a life where technology occupies an ever-increasing space and where ignorance of technology represents, at present, a form of illiteracy and inequality of opportunities. Along the same lines, constant training in ICT, innovative approaches, and methods are required in the face of an educational reality which is constantly changing along with the needs and interests of the academic community and society itself.

This requirement is accentuated in the Ecuadorian context to motivate self-training and its promotion at the institutional and national levels. Teacher training must constantly include technological aspects and training which allows educators to use their ingenuity as an essential characteristic of learning engineering and apply technology in a pedagogically appropriate way. Therefore, they are expected to put engineering principles into practice to generate resources, improve their technique, and carry out pedagogical processes that make interdisciplinary use of this knowledge to obtain better learning results. Thus, thanks to the development of PI and other methods, they can approach the content of their discipline or subject strategically, achieve the educational objectives and innovate the TLP.

In addition, some elements are considered that, although not strictly necessary, enriched the method results and are proposed as facilitating its management. Among these is that the student responses are anonymous, the voting results are visualized immediately, and the technological tools are easy to use and make it possible to follow an SRS dynamic for real-time interaction.

A limitation of this research is that results were based on applying the method in one class per subject and considering the perception of two groups of students with their respective teachers. For this reason, a future lines of research would be a longitudinal analysis of the application of IEP over a more extended period, together with consideration of the results obtained if they are applied to more than one subject at a time.

Given this, if a repetitive and prolonged application is considered, other forms of active participation can be combined and based on teachers' experience and ingenuity according to the classroom environment's needs; since not all methods can be applicable in all situations. Therefore, the pertinent use of various existing ways is considered adequate, which can be enhanced from an interdisciplinary perspective.

Finally, the high applicability of the method is shown as a response to the problems evidenced regarding the students' lack of participation and motivation, which is strengthened by the students' desire that this and other methods different from the traditional ones be used more often in the classes. Thus, the positive effects of applying techniques that innovate tge TLP, such as PI, and the importance of doing so under the consideration of more aspects than just pedagogical ones, as is the case with learning engineering, are demonstrated. Due to this, it is recalled that little research into method has be performed in Ecuador; it is hoped that this paper will contribute to disseminating its benefits and its application in a society that still reflects resistance to innovate its teaching methods.

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