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PAPER

Enhancing Informatics Teacher Training with Interactive Mobile Case Technologies

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ABSTRACT

The study explores the use of case-based methods to enhance the professional competencies of future computer science teachers, focusing on communication, creativity, and problem solving skills. Conducted at L.N. Gumilyov Eurasian National University, the research involved instructors and students in collaborative activities to evaluate these skills. The findings indicate that while communicative and creative approaches were commonly applied, interpersonal conflicts often emerged during problem solving exercises. Most participants emphasized the critical role of effective communication in succeeding within modern educational settings. The study underscores the potential of case-based technologies to develop essential teaching skills and adapt to the demands of contemporary education. The conclusions suggest strategies for improving teacher training, advancing adaptive pedagogy, and leveraging technology to transform education. These insights contribute to the broader academic discussion on incorporating innovative methods into teacher education, with implications for institutional policies and community advancement.

KEYWORDS

case technologies, creativity, education management, education quality, improving, interpersonal communication, professional skills

1 INTRODUCTION

Modern education demands a high level of professional preparation from teachers and the ability to adapt to dynamic changes in technologies and teaching methods, highlighting the importance of training future computer science teachers who not only possess deep subject knowledge but also effectively utilize innovative educational technologies [1]. In this context, case-based methods are one of the primary approaches to developing creativity, communication skills, and problem solving abilities. However, the effectiveness of case-based methods in higher education programs, particularly in the preparation of computer science teachers, remains insufficiently explored [2]. The key questions addressed in this study are 1) how does the case method influence the development of professional skills in students?

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Does it contribute to the development of communication and creativity, and to what extent can the case method be integrated into the curriculum? The aim of this study is to identify the potential of using case-based methods in the preparation of future teachers and provide recommendations for their implementation in the curriculum. Improving the quality of education for future teachers is a key task for pedagogical universities in different countries. A teacher plays a crucial role in determining the quality of education for the younger generation and, consequently, the overall quality of life in society [3]. Thus, investing in the professional development of educators is essential to achieving positive outcomes in both the academic and public spheres.

Today, the world is undergoing a rapid transformation that no one could have predicted. The development of technology, innovation, applied education, the widespread dissemination of knowledge, and its continuous improvement all contribute to this change. Changes can be observed in all aspects of human life. The spheres of education and knowledge are this evolving system's most vulnerable and important components. These changes help people become more aware of their needs, rights, and responsibilities. In addition, traditional approaches to improving and acquiring knowledge are becoming increasingly irrelevant [4], [5].

Education is the driving force behind citizen progress. In the current century, the ascendancy of digitization and innovation is progressively assuming a central position in societal progress. Education must align with these trends, equipping students with the knowledge necessary for active participation in the digital economy. Higher education should endow students with the skills required for success in the contemporary milieu, such as critical thinking, problem solving, and creativity [6].

The digitization of education provides impetus to the incorporation of diverse interactive modes of information sharing. Overall, in contemporary education, experiential learning, including projects or case studies, is gaining popularity [5]. The case-based method of instruction serves as a valuable resource for cultivating diverse proficiencies across various domains. This approach facilitates the development of critical thinking, creativity, and problem solving skills through experiential engagement with specific scenarios. Hands-on learning plays a pivotal role in refining the indispensable skills for achieving a prosperous professional path, especially in specialized or pioneering domains such as programming or informatics [7]. With the active integration of hybrid practical teaching techniques, students acquire capabilities in programming, problem solving, teamwork, idea presentation, and project management [8].

Cooperative learning continues to be a valuable tool in academic institutions today since it provides benefits for both students and teachers. A shift from a competitive to a collaborative learning approach can address the issue of sociocultural diversity in the classroom [9]. As an illustration, the advancement within innovative Education 4.0 accentuates the fostering of critical thinking, creativity, and problem solving proficiencies among student cohorts. In [10], the effectiveness of innovative instructional approaches, such as the case-based teaching method, is highlighted as being efficacious in augmenting the efficiency of both education and research. Given the above, there are several pedagogical approaches, both up-to-date and traditional, and the task is to choose the most effective ones to be used at the L.N. Gumilyov Eurasian National University and other universities.

The augmentation of the professional skills of young computer science educators through the utilization of case-based methodologies is a significant topic, as it implies the training of specialists who contribute to the digitization of education. However, there are several serious challenges in research within this field [11]. One of the challenges lies in the fact that case-based methodologies are a relatively novel approach to instruction. Accordingly, a limited body of research confirms

their efficacy. Moreover, the formulation and implementation of case-based methodologies can demand substantial labor and involve complex processes, which might hinder their seamless incorporation into the educational landscape [12].

Another issue pertains to the readiness of young computer science educators to embrace case-based methodologies. They may have insufficient knowledge and skills for creating and implementing cases or lack confidence in effectively leveraging case-based methodologies to enhance their professional competencies [13]. Hence, the research question is to ascertain the efficacy of this technology based on a localized group of respondents and specific educational topics within the local context. The conceptual framework guided the research by linking the implementation of case-based learning technologies with improvements in effectiveness, communication skills, and creativity. The following information will be presented in other sections of the article. The results of this study are important for the training of future computer science teachers, as they show that the use of case methods is effective for the development of key professional skills, such as communication, creativity, and problem solving, which are becoming important in the context of rapid changes in the modern educational environment and the digitalization of curricula. The identified difficulties indicate the need to improve the teamwork and emotional intelligence of future teachers, and the results of this study can be used to update curricula, adapt pedagogical methods, and implement technologies that contribute to qualitative changes in teaching and the development of learning communities.

Literature review: Examines contemporary approaches to enhancing education quality, including collaborative learning, gamification, automation, and emerging technologies, as theoretical foundations for the study.

Methods: Details the design, implementation, and validation of tools to assess the effectiveness of case technologies in developing professional skills among future informatics teachers.

Results and discussion: Presents findings on the impact of case technologies on communication, creativity, and problem solving, discussing their broader implications for educational practices and community engagement.

Conclusions: Summarizes key insights, highlights the study's contributions to teacher training, and outlines practical recommendations for improving educational quality through innovative methodologies.

2 LITERATURE REVIEW

This review explores contemporary approaches to enhancing the quality of higher education, with a focus on innovations and methodologies related to the preparation of future computer science teachers. The aim is to identify key theoretical and empirical findings that shape the research questions and objectives of the study.

2.1 Collaborative learning, traditional, and online pedagogy

Collaborative learning, which emphasizes active student participation and group problem solving, fosters critical thinking, communication, and teamwork skills [14]–[16]. This approach creates a conducive learning environment that supports interaction and mutual development in line with the skills required by modern educators. Traditional pedagogical models focus on teacher-led instruction, where students passively engage by absorbing information, primarily through lectures or Socratic

dialogue [9]. In contrast, the work [17] classifies contemporary pedagogical models into four types: fully online courses (80% or more content delivered online), face-to-face courses (completely in-person), hybrid courses (30–79% content delivered online), and facilitated online courses (1–29% content delivered online). Students increasingly prefer online or hybrid models due to their flexibility and accessibility.

2.2 Gamification, game-based learning tools, and quality assurance in higher education

The integration of tools such as Kahoot and EdPuzzle demonstrates the potential of gamification to enhance engagement and improve learning outcomes. Specifically, it has been proven that Kahoot improves preparation, communication, and collaboration skills across various subjects [18]–[21]. The work [22] developed a hierarchical model for assessing higher education quality, including dimensions such as administrative quality, infrastructure, and teaching standards. This comprehensive system provides valuable insights for enhancing institutional effectiveness and meeting students' expectations regarding employment and social integration.

2.3 Automation in education: new challenges and trends in programming languages development

Habib et al. [23] emphasize the role of automation in reducing the administrative burden on educators, enabling them to focus on creative teaching strategies. Automation also contributes to flexibility, providing students with personalized learning opportunities anytime and anywhere, which is especially beneficial in computer science education. As universities face increasing competition, accreditation requirements, and shifting student expectations, traditional quality control strategies must evolve [24]. Innovations such as virtual reality (VR) educational tools highlight both immersive technologies' opportunities and limitations, as examined by Jensen and Konradsen [25]. While VR contributes to the development of cognitive, psychomotor, and affective skills, issues such as digital dizziness and technological barriers remain problematic [26]. The work [27] found that Python is the most popular programming language in introductory courses at European universities due to its ease of use and versatility. Java, C/C++, and C# are also widely used, but their steeper learning curves present a drawback.

The reviewed studies emphasize the need for training in gamification and automation as an essential strategy for preparing future IT educators. At the same time, there are gaps in the current literature, highlighting the need for further research: in particular, there is a lack of attention to the interaction between pedagogical and socio-emotional skills, which are crucial for conflict resolution and maintaining effective communication in-group work. Contemporary studies often focus on a single method, such as gamification, without a proper analysis of adaptive and technologically integrated approaches to learning, ranging from mutual integration to holistic approaches. Research is also focused on theoretical aspects, with little practical guidance on the implementation of innovative methods in specific educational contexts. There is also a lack of empirical studies assessing the long-term impact of these approaches on the development of key competencies in future teachers. The theoretical findings from this literature form the basis of this study, which aims to fill these gaps by developing research questions and integrating innovative methods into teacher training programs.

2.4 Conceptual divergences and empirical gaps in case-based mobile learning: an epistemological analysis of educational digitalization

In the existing literature, the trajectory of pedagogical education digitalization is noted, revealing fundamental epistemological inconsistencies within the conceptual foundations of case-based mobile learning. The integration of case methodology with mobile learning—despite the apparent dynamism of pedagogy—raises concerns regarding its structural coherence: the pedagogical domain, enriched by diverse models, lacks a unified theoretical framework, as evidenced by discrepancies in Western implementations [28]. Empirical validation of mobile teacher training systems (exemplified by teachers in Melbourne, Australia) demonstrates increased flexibility and accessibility; however, the systematic integration of such models within formal computer science education remains insufficiently explored [29].

The intersection of interactive case technologies and cognitive assistive tools, as a component of the digital transformation of pedagogical strategies, remains conceptually fragmented. The study by Hyttinen and Suhonen [30] highlights the expansion potential of mobile learning but does not delineate its applicability to adaptive teacher development. The case-oriented learning paradigm, positioned as an instrument for enhancing contextual learning effectiveness, lacks consistency in its deployment within structured educational programs, a gap particularly evident in empirical models assessing its direct impact on computer science educators [31].

The constraints imposed by socio-cognitive factors—such as instructors' receptivity, engagement dynamics, and problem-setting heuristics—introduce additional complexities. The study by Wolak and Kim [32] illustrates a positive cognitive perception of technologically integrated methodologies; however, issues related to knowledge transferability remain unresolved. The educational paradigm reliant on interactive digital environments requires an ontological recalibration, while empirical data on its pedagogical sustainability, particularly in the domain of computer science didactics, remains limited [33].

Instructors' technological literacy constrains the effectiveness of mobile case-based approaches. Gaps in digital competence among future educators hinder the seamless implementation of learning methodologies augmented by mobile devices [34]. While experiential learning has gained traction in STEM education, its intersection with mobile case-based strategies lacks sufficient theoretical substantiation, thereby creating an epistemic gap in teacher professionalization.

The impact of case-based mobile learning within the context of digital pedagogical transformation necessitates a reevaluation of its conceptual principles: without an integrated theoretical synthesis that bridges digital cognition and case-based epistemology, the structural foundations of computer science teacher training remain fragmented. This study aims to analyze the ontological disjunctions within the concept of mobile-integrated case pedagogy, positioning it within the broader discourse of educational digitalization and pedagogical sustainability.

2.5 Research objectives

An essential component of enhancing the IT educational infrastructure as a whole involves the establishment of a system to enhance the training of leading instructors in natural and technical disciplines. In this context, an analysis of the theoretical foundations of training computer science teachers highlighted the necessity to assess the efficacy of case-based technology in their instruction. The objective

of the research is to assess the effectiveness of utilizing case-based technologies at L.N. Gumilyov Eurasian National University based on the case-based method.

The study aims to accomplish the following objectives:

- To analyze traditional and contemporary teaching methods in universities to evaluate the effectiveness of their implementation in the professional activities of future computer science teachers.
- To develop a case-based learning program and test it on a sample of students from L.N. Gumilyov Eurasian National University.
- To conduct a survey to determine the effectiveness of the implemented case-based learning program.

3 METHOD

3.1 Sample

The experiment took place at L.N. Gumilyov Eurasian National University from January 18, 2021, to May 2021. Riza Suindikovna Akhitova, a doctoral student, under the guidance of the scientific consultant, Aytugan Kairzhanovich Alzhanov, conducted the study at the Department of Informatics. The experiment involved Group 5B011100–informatics. The study included a survey of 40 faculty members of the university (mean age 41.6, SD = 7) and 56 first-year and second-year students (mean age 19.4, SD = 15). The sample size for the study was determined based on the target population of faculty members and students at the university under investigation. A sampling error of no more than 4.77% was adopted for surveying computer science students and faculty at the university. Given that this falls below 5%, the sample can be deemed adequately representative of the research objectives [35].

3.2 Research design

The study employs the survey and focus group methods. After completing three case studies students and teachers were interviewed. The main variables of the study's conceptual framework are the following: case-based learning technologies (independent variable) learning effectiveness, communication skills, and creativity (dependent variables). This this study method is one of the most popular in the field of pedagogy. The authors of other studies [36] also use it. It ensures a more qualitative analysis compared to questionnaires. The interview makes it possible to find out in detail the opinions of the respondents, ask them about the reasons behind their decisions, and uncover the nuances of their judgments.

To conduct the focus group, students and educators were randomly divided into smaller groups. The teacher survey involved two groups (20 participants each), while the student survey encompassed three groups (18, 18, and 19 students). Each session lasted approximately 40 minutes.

The students were given three cases.

1. Comparison of software for statistical data analysis.
2. Calculation of variance in MS excel.
3. Creation of a lesson plan to review the basic concepts of data analysis for older students.

The learners worked on each case for three hours, with an interval of three weeks between sessions. After completing the case studies, the students and teachers were interviewed.

3.3 Research tools

The authors developed the questions.
Basic questions for teachers:

1. Was communication between students effective for solving the problem?
2. Did any disputes, conflicts, or disagreements arise?
3. Did the students consider each other's opinions?
4. Did the students apply a creative approach to problem solving (the one that they had not studied or used before in the classroom)?
5. If so, what approaches did they use?
6. How do you assess the quality of the assignments completed by students?
7. Was the task completed within the given period?

Basic questions for students:

1. Can you assess communication within the group in the process of solving problems?
2. Did any disputes, conflicts, or disagreements arise?
3. Did you and your peers consider the opinions of other students?
4. Did you apply a creative approach to problem solving (the one that you had not studied or used before in the classroom)?
5. If so, what approaches did you use?
6. Do you think the task was completed well?
7. Was the task completed within the given period? What was the teacher's assessment?

The questionnaire used in this study was meticulously designed to assess the effectiveness of the case-based learning method in fostering collaboration and creativity among students and teachers. The development process of the tool involved several stages to ensure its relevance, reliability, and validity. Initially, key themes were selected based on previous research on collaborative learning, problem solving, and creativity in educational settings. These themes focused on interpersonal communication, group dynamics, creative application, and outcome assessment.

Subsequently, questions were developed to address these themes, ensuring clarity, relevance, and conciseness. The instrument consisted of two sets of seven questions each, one for teachers and one for students, focusing on communication effectiveness, conflict resolution, consideration of opinions, creative problem solving, task quality, and time management.

An expert group in education reviewed the drafts to ensure that they aligned with the research objectives, and their feedback was incorporated to refine the wording and structure. A pilot test of the instrument was then conducted with a small sample of teachers and students who were not involved in the main study. This step provided additional insights into the clarity and relevance of the questions. To ensure reliability, the tool was evaluated using Cronbach's alpha, a statistical measure of internal consistency. The cumulative Cronbach's alpha value was 0.92,

indicating high reliability, with subsequent measurements yielding values of 0.95, 0.92, 0.93, 0.87, 0.96, and 0.94. These results confirmed the reliability and robustness of the questionnaire.

The final instrument included a set of questions for teachers assessing group interactions, creative problem solving skills, and task performance, as well as a set of interviews for students focusing on group dynamics, creative contributions, and perceptions of task outcomes. Through a thorough validation process, the tools reliably captured the dimensions of collaborative and creative processes in a case-based learning environment, enhancing the study's validity and providing a solid foundation for data analysis.

3.4 Data analysis and statistical processing

Students' answers were entered into MS Excel; next, they were analyzed in Statistica.

3.5 Ethical issues

The whole group participated in the survey; however, it was indicated that only those who agreed to take part in the experiment were interviewed. A similar approach was applied to teachers. All participants were informed about the study objectives and the peculiarities of collecting and analyzing information provided by them. The age of the students was 20–21 years.

3.6 Research limitations

The research results may not reflect the reality of applying case technologies at universities, as the number of participants in the interview was limited, and all respondents studied and worked at the same university.

4 RESULTS AND DISCUSSION

The analysis of sources showed that the case technologies can be implemented at the university and contribute to the improvement of training quality. As a result of the study, 40 teachers and 56 students were interviewed. The following results were obtained.

4.1 Collaboration and communication

In the context of the ability of students to work together on a problem, it was found that, from the point of view of the teachers, young people effectively solved problems without any conflicts or disagreements. From the student's perspective, cooperation appeared to be difficult as many learners insisted on their opinions and refused to take into account the opinions of others. Also, the students complained that some of them were too passive in solving problems (see Figure 1).

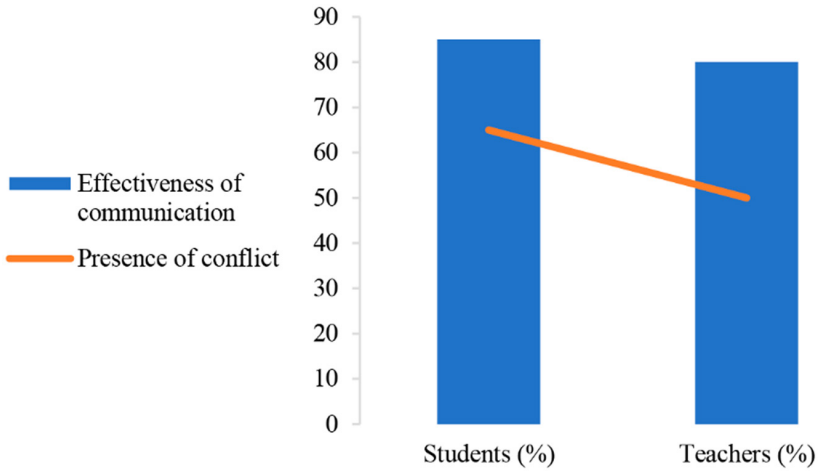

Fig. 1. Comparison of students' and teachers' perceptions on collaboration and communication
Source: author's development.

In particular, when asked about the effectiveness of communication, the majority of students answered: "satisfactory" (85%), while the majority of teachers assessed it as "good" (80%). When asked if there were disputes and conflicts, 65% of the students and 50% of the teachers said that there were. Sometimes, the only difference between good and bad schools is the level of qualification and skills among the staff. Human potential is often neglected. The study [5] looks at a methodology that refers to the human potential to ensure further improvement, higher education progress, and sustainability.

4.2 Creativity

From the perspective of both teachers and students, a creative approach was applied to solve the cases. In the classroom, students generated solutions that had not been previously explored. They also proposed the application of their prior work experiences, as depicted in Figure 2.

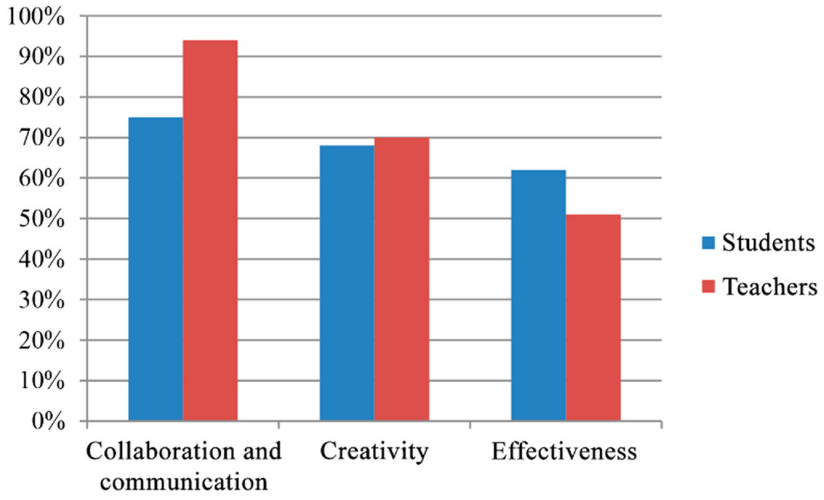

Fig. 2. A case study solution by students and teachers according to the three parameters

Among the students, 70% acknowledged their attentiveness to each other's viewpoints. However, 85% felt that their opinions were disregarded. In the realm of problem solving, approximately 40% of teachers and 75% of students indicated an inclination toward employing a creative approach. These findings underscore the divergence in perspectives between teachers and students regarding collaborative learning methods.

4.3 Effectiveness

The first and third tasks (comparing software for statistical data analysis and creating a lesson plan devoted to an overview of the basic concepts of data analysis for senior schoolchildren) were completed by students, the second (calculating variance in MS Excel) was partially solved. According to the students, the main reason for the failure was the lack of mutual understanding within the group. To eliminate this problem, students should be taught interpersonal communication and teamwork skills.

Examples of the teachers' answers:

1. "Yes, the guys worked together", "the whole group solved the problem," "some students were more active."
2. "No disputes were observed," "there was a peaceful discussion," "actively, but without conflicts."
3. "Yes, they did," "I think, partially," "basically, everyone insisted on their own opinion."
4. "Partially." "Most of the students suggested creative ideas," "rather, yes."
5. "Those that were previously seen," "comparison of the basic concepts of data analysis with the concepts the students know (in the context of case study 3)."
6. "Above average," "quite good," "in general, they coped."
7. "Yes," "partially."

Examples of student answers:

1. "Negatively," "they did not listen to me," "very loudly," and "positively, but my opinion was not taken into account."
2. "Almost not", "no."
3. "Partially," "everyone insisted on their opinion."
4. "Yes."
5. "The one that I learned in the video tutorials."
6. "Perhaps," "it could have been better," "yes, qualitatively."
7. "It took us more time to solve problem 2," "we did it on time," and "we solved it in 2 hours (case study 1)."

4.4 General assessment of the work with cases

In general, teachers and students positively assess the application of case technology. An alternative to the traditional approach to education makes it possible to apply skills that were hardly used before (teamwork, collaborative learning, solving non-standard problems, and simulation of real activities by working on a single project). The alternative approach develops the creative thinking of students, as well

as thinking aimed at solving problems, since the related tasks are difficult and differ from standard tasks in the textbook. In this study, the tasks were more difficult compared to those that the students had to solve earlier. The results showed that using case studies in the learning process helps to form students' skills necessary for their work and personal life.

Thus, 90% of the students and 85% of the teachers reported that collaboration and communication skills are extremely important in the modern world. Additionally, 80% of the students noted their intention to develop. Thirty-five percent of the students who took part in the interview had already worked for various organizations, and 20% of them reported that this experience helped them to solve a case study; 25% of the students answered that they had not worked before and believed that they did not have enough practical experience to solve the tasks (see Figure 3).

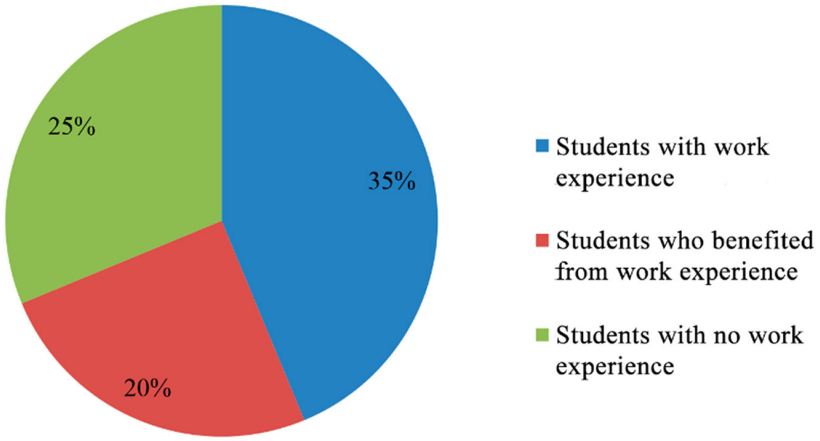

Fig. 3. Impact of student work experience on the solution of the case study

All interview participants had positive opinions about the effectiveness of this approach to solving problems and about conducting similar case studies. It is important to understand the difference between "employability" and "work readiness." According to Budd et al. [7], employability refers to the acquisition of knowledge of a specific subject and general social practices (or skills), metacognition (reflection or strategic thinking), and complementary theories. Whereas, work readiness is defined as the degree to which graduates are perceived as having the approach and qualities that make them ready to succeed in the work environment. To clarify, employability encompasses technical knowledge and the personal and interpersonal competencies necessary for employment. On the other hand, work readiness places a greater emphasis on the personal and interpersonal attributes esteemed by employers. Work readiness can be seen as part of employability. The results showed that the ability to learn together is important. Collaborative learning has five important components: positive interdependence in pursuit of a common goal, social and individual responsibility, personal interaction, teamwork skills, and interpersonal skills [9].

In general, according to the results of this study, the case technologies can deliver positive results when teaching students. This was reported by most of the students (85%) and teachers (90%) who took part in the interview. In particular, according to the students, their communication skills improved; they could apply theoretical knowledge and previous work experience and develop a creative approach to problem solving. The teachers believed that their students also developed both teamwork skills and a sense of personal responsibility for the project's results. Some results were seen after the completion of the three case studies. In particular, the

students identified problems that arose when solving tasks; 75% of students and 67% of teachers believed that the use of 15–20 case studies during each academic year could improve interpersonal communication skills, a creative approach, and, in general, the results of the projects (see Figure 4). This study tested the basic principles of improving the quality of training for informatics teachers using the method of case technologies, as well as the academic conditions that enhance informatics teacher training at universities. The study examined various aspects of the training process, such as the creation of a supportive learning environment, the use of information technologies, and other factors that contribute to effective informatics teacher education.

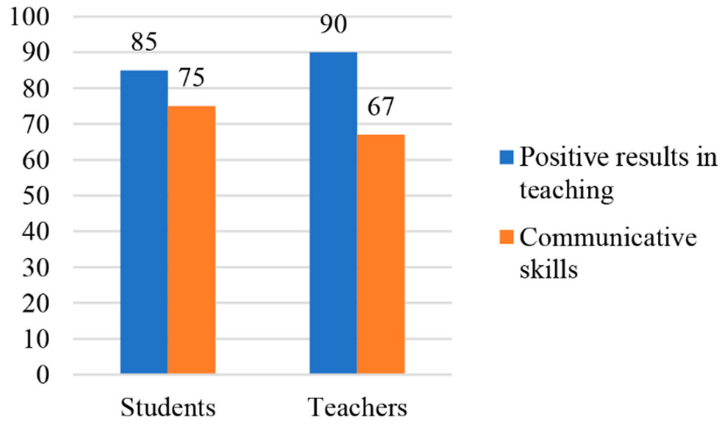

Fig. 4. Impact of case-based learning on results in teaching and communicative skills

According to Khaydarova [37], learning can be characterized as the process of creating knowledge. Good teaching is seeing learning through the eyes of the learner. To follow this philosophy and find the right ways to measure quality, it is necessary to analyze customer feedback. The goal is to find ways to improve regardless of hierarchy and to create development projects. The author studied the possibility of applying this philosophy to universities. The results of the present study confirm the opinion of the scientist.

Ten teachers and eight students took part in the cases and the interviews. Based on the interview results, several aspects of students' work, such as efficiency, creativity, collaboration, and communication, were analyzed. Some aspects of the study are consistent with the findings of [36]. Teachers reported certain barriers to effective teaching, including those listed below:

- A well-defined curriculum and teaching resources, a large number of students in the classroom, and several theoretical principles;
- Problem-based learning and student-centered learning are not considered in the assessment as a teacher bonus;
- There are no assistants;
- Lack of student interest and motivation.

The qualities of successful teachers are as follows:

- Consistency with organizational strategies;
- Interest in students and belief in their abilities;
- Systems approach in higher education; and
- Interest in the field of science that is being taught.

The following functional requirements for teaching in higher educational institutions are proposed:

- Availability of a course plan and the use of appropriate teaching strategies;
- Development of metacognition and self-assessment of students during training [38];
- The use of a concept map and a preliminary organizational plan in training.
- Promotion of creativity during classes;
- Explanation and knowledge development to solve problems in further career activities through discussions in the classroom;
- Experience with documents [26].

The study confirmed that contests with the use of case technology could be a type of effective work with students [39]. According to [24], Bebras (an international computer science competition) has been conducted for 20 years. Each year, an increasing number of countries participate in the competition. The research aims to describe the Bebras model by analyzing 10 years of data from different countries' participation in the competition. The model is based on democratic and inclusive values in education. Another study investigated computer-aided design, which typically involves hands-on computer-based lessons on how to use software [40]. The study found that software packages suitable for training should be user-friendly, accessible, and reasonably priced. However, the freeware and proprietary case technology programs available in the market are relatively difficult for novices.

The analysis of 56 sources devoted to Bebras showed the impact of this competition on national programs, especially on computer science education. Learning by solving small examples of conceptual problems and flipped learning are perfect options for the society of the digital age. There is evidence that Bebras is an effective tool for developing problem solving skills and computational thinking [24]. Computational thinking has also been explored in the context of skills that children develop by practicing programming and algorithms. Computational thinking contributes to the development of qualities such as abstract thinking, problem solving, pattern recognition, and logical reasoning [41]. Current educational and infrastructural developments make computational thinking a promising area to support these learning competencies. In the current study, the students (65%) and teachers (50%) reported that arguments and conflicts occurred between students when solving tasks. In the context of creativity in problem solving, 40% of the teachers and 75% of the students believed that creativity was actively used in problem solving.

The students and teachers who took part in this study demonstrated an interest in-group work. Likewise, a study by [42] shows that students' and teachers' perceptions of the assessment system share many similarities, but there are also important differences. Practical implementation of case-oriented learning involves creating an environment and context for deeper and more effective communication between teachers and students. This could be collaboration groups, longer-term joint work of students with a specific teacher on one product, or the use of practical psychologists and social communication specialists in the classroom [30]. In addition, the university community where the study was implemented recognizes the importance of creating collaborative processes, such as working groups, to address specific problems. These working groups provide an excellent opportunity for the continuous improvement of university processes and relations with society. The use of online collaborative learning is strongly supported by cloud computing. Thus, the results of another study revealed a range of evidence supporting the use of cloud computing

tools for certain collaborative learning activities categorized as sharing, editing, communicating, and discussing [43].

In addition, other factors influence the learning process and are rarely taken into account when preparing groups of students for training. The study conducted by [6] demonstrates that elements including student circumstances such as scholarships, extracurricular activities, parental education, age, prior performance, and the university they attend significantly affect their perception of the quality of higher education. Part-time employment has a moderate impact on student perception. Parental income does not affect student perceptions. Mobile digital technologies, together with case-based learning, create an environment for facilitating the exchange of opinions, support, and sharing of knowledge in a group and with a teacher [17]. This facilitates coping with socio-demographic differences and differences in the social and educational background of students [16]. As previously mentioned, the integration of collaborative learning methods and digital tools, such as cloud technologies, not only facilitates access to materials but also enhances student collaboration, providing a more interactive learning environment [44]. At the same time, other studies indicate that students have a positive attitude toward these tools but face difficulties in adapting to new technologies due to unreliable internet access and technical issues. These challenges can affect the overall success of these methods, highlighting the need for implementing flexible technical support and infrastructure in universities to ensure the stable operation of digital platforms [45], [46].

When considering factors influencing perceptions of education quality, it has been found that academic success is closely related to students' socio-economic status and access to external resources, such as mentorship and additional courses [47], [48]. This supports findings that factors associated with extracurricular activities and financial support play a significant role in students' perceptions of the overall quality of their education. Taking these additional factors into account can greatly enhance our understanding of various aspects of the learning process and enable the development of more effective strategies for improving the quality of higher education.

The study identified several issues in the application of case-based methods for training future computer science teachers. One of the main problems is the discrepancy in the perception of communication and creativity between students and instructors: students rated their communication skills below average, while instructors assessed their communication skills as well developed. Furthermore, 65% of students and 50% of instructors reported encountering conflicts during problem solving, highlighting the need for improved teamwork and conflict resolution training. Differences in views on the role of creativity indicate the need to formulate clear criteria and guidelines for students and teachers regarding these innovative approaches in advance during the practical implementation of case-based learning. Finally, the fact that 20% of students stated that they rely on prior work experience to solve problems effectively underscores the need to provide equal opportunities for practical learning. Maximizing the benefits of case-based methods in training IT teachers obviously requires prior training of participants or some experience in collaboration and project interaction. Perhaps using simple cases at the beginning of training will prepare teachers and students and will help to bring their understanding, positions, and experiences closer together during the training [43]. Addressing these issues is crucial for maximizing the benefits of case-based methods in the preparation of IT educators.

One of the key conclusions of this study is the identification of case-based methods as a viable tool for enhancing teacher preparation programs. The implementation of these methods can help bridge the gap between theoretical knowledge and

practical application, enabling teachers to meet the diverse needs of their students. By developing essential skills such as teamwork, innovation, and adaptability, they contribute to creating a more dynamic and flexible learning environment. This, in turn, fosters improvements in the overall quality of education within society, laying the foundation for long-term societal benefits. Emphasizing creativity and effective problem solving also aligns with the needs of the rapidly evolving labor market. Teachers who possess these skills are more likely to inspire lifelong learning in students and adaptability to future challenges. This multiplicative effect extends beyond the classroom, promoting the formation of a societal culture that values innovation and critical thinking.

The study highlights the importance of interpersonal communication and collaboration not only among students but also within the broader educational community. Teachers trained in case-based methods are better equipped for communication with parents, administration, and community stakeholders. Enhanced communication fosters the establishment of strong partnerships, which are essential for addressing systemic issues and implementing meaningful reforms. The research also emphasizes the potential of case-based methods to address educational inequality. These methods can help create inclusive classrooms by providing teachers with tools to adapt curricula to diverse learning needs. This is particularly crucial for communities with historically marginalized groups, as it ensures that all students have access to quality education and the opportunity to succeed.

In a broader sense, the application of innovative teaching strategies, such as case-based methods, can strengthen the socio-economic structure of a community. Well-prepared teachers produce a skilled workforce that contributes to economic development and reduces social inequality. This study, with its focus on creativity and problem solving, equips students with the skills necessary for success in a knowledge-based economy. To maximize the societal impact of this study, educational institutions and policymakers should consider expanding the use of case-based methods in teacher preparation programs. Workshops, seminars, and community projects could serve as platforms for disseminating research findings and encouraging collaboration among teachers, students, and community members. Partnerships with local businesses and organizations could also provide real-world contexts for case-based learning, allowing the direct application of acquired skills to meet community needs. By emphasizing the broader social implications of case-based methods, this study positions itself as a catalyst for transformational changes with the potential to improve not only the quality of teacher education but also the well-being and prosperity of communities.

Differences in the perception of communication—an interactive process shaped by individual engagement, interpretative alignment, and response modulation—became evident in the discourse of students and instructors, revealing a fundamental divergence in evaluative criteria. Instructors' assessments emphasized the structured nature of dialogue, whereas students perceived communicative asymmetry, characterized by the dominance of authoritative positions and the suppression of alternative viewpoints. This implicit discursive hierarchization generated an imbalance in argumentation strategies. The divergence in creativity—an analytical construct reflecting generative cognitive processes—stemmed from differing conceptions of novelty. Instructors valued methodological innovation, viewing creativity as the systematic application of prior knowledge in unfamiliar contexts, while students associated creativity with spontaneous, unstructured ideas resistant to standardization. This epistemic contrast—between procedural ingenuity and intuitive experimentation—further reinforced disparities in pedagogical expectations.

Expanding representativeness—addressing selection bias through stratified sampling—requires the integration of heterogeneous demographic clusters (institutional affiliation, socio-economic status, digital competence) to enhance statistical generalizability. Optimizing recruitment methodology necessitates multistage randomization, ensuring equitable representation of respondents across pedagogical ecosystems (public/private universities, rural/urban institutions). Mitigating response distortions is essential to triangulate data collection instruments—integrating surveys and interviews—to minimize the subjective overrepresentation of dominant viewpoints. The incorporation of longitudinal tracking mechanisms strengthens empirical reliability by capturing diachronic changes in receptivity to case-based learning. The implementation of adaptive weighting models within analytical frameworks balances underrepresented cohorts, ensuring the validity of conclusions across cognitive-affective engagement variables. The recalibration of evaluative criteria standardizes cross-sectional comparability, eliminating methodological asymmetry in interpretative paradigms.

Potential biases can be eliminated by supplementing further research with alternative data collection methods. A controlled experiment will allow for more accurate determination of changes in individual significant variables in the learning process and quantitative assessment of individual characteristics of the learning process based on cases involving mobile learning. Observational studies improve the quality of objective observation of students and teachers' behavior during communication and search for non-standard solutions, which is the most important factor in the effectiveness of case solving, as shown in the study.

The use of case-based learning is possible in educational institutions with different practices, pedagogical cultures, and different infrastructures since effective implementation requires communication, space for creativity of participants, and connection with real experience (cases). The use of mobile technologies makes the learning process independent of the conditions, time, and space of learning, which simplifies the implementation of the program in existing conditions [5]. Cases are selected by the teachers based on student's level of knowledge and skills, and one should be prepared for the fact that as a result of solving the case, students in collaboration will improve their level ahead of the training program [18]. An important element of the practical implementation of the method can be the involvement of facilitators, who can be psychologists and communication specialists, as well as practitioners in the field of study. The latter can stimulate students' creativity by introducing interesting knowledge from real cases and a sense of connection between what is happening and real-world problems [26].

The practical value of this study lies in the potential implementation of a similar case-based program for computer science students. From a theoretical perspective, this study contributes to the understanding of how case-based learning can affect the development of interpersonal communication skills and creativity in problem solving among students. The reliability of the results obtained is satisfactory for a specific university. The results of this study might differ in the context of other universities. This study is a contribution to the application of case technologies in higher education to improve its quality.

The adaptation of research methodology to diverse educational contexts necessitates the reconfiguration of its core structure. Case methodology, inherently flexible yet context-dependent, must be continuously reshaped in response to institutional, cultural, and disciplinary variables. Pedagogical environments differ in their epistemic foundations, necessitating methodological plasticity. The conceptual principles underlying interactive learning through concrete situations undergo

modifications based on technological infrastructure, pedagogical objectives, and instructor qualifications.

The interaction between digital didactics and empirical cognition serves as a critical determinant of adaptive effectiveness. The calibration of assessment instruments—including surveys, interviews, and statistical models—ensures alignment with local educational goals, with each parameter (validity, reliability) undergoing iterative refinements to account for disciplinary requirements. The structural integrity of data collection methods—balancing quantitative rigor and qualitative depth—preserves methodological coherence, maintaining both analytical precision and contextual relevance.

5 CONCLUSION

The study made a significant contribution to educational research and practice by demonstrating the feasibility and effectiveness of using case-based methods to enhance the professional skills of computer science teachers in future. The key findings of the research indicated that interpersonal communication, creativity, and problem solving skills are critical factors in student success. While 85% of students assessed their communication skills as below average, 80% of instructors reported these skills as well developed, suggesting the need for more specialized training in-group dynamics. Furthermore, 75% of students stated that they effectively use creativity in problem solving, but only 40% of instructors recognized this, highlighting the need for further research into fostering innovation.

The analysis of previous laboratory work conducted in this study revealed the impact of lab work on problem solving skills, with 20% of students using them effectively. Students also demonstrated good results in problem solving, successfully completing two out of three case studies, despite the problems going beyond traditional textbook issues. These results deepen our understanding by demonstrating the practical application of case-based methods in preparing students for real-life scenarios and developing essential skills such as communication, creativity, and adaptability.

They also lay a strong foundation for future research incorporating additional technologies, such as artificial intelligence or VR, to improve teacher preparation programs. Moreover, educational administrators can use these insights to optimize curricula, implement adaptive teaching strategies, and develop tools for monitoring and evaluating teaching quality. These findings provide a basis for interdisciplinary research on curriculum design and offer a roadmap for expanding case methodology across diverse educational contexts.

5.1 Limitations

While the findings of this study provide valuable insights, it has its limitations too. The study, conducted within a single university, may limit the generalizability of the results to other institutions or educational contexts. Additionally, the relatively small size of the focus groups may affect the representativeness of the data. Relying on self-reports to assess communication and creativity could introduce subjectivity and bias into the results. Future research should consider expanding the sample to include a variety of educational environments and employing more objective methods to verify the findings. Nevertheless, these limitations do not diminish the

contribution of the study; rather, these preliminary results point to directions for further investigation.

5.2 Recommendations

We recommend that future researchers explore a range of new technologies with the potential to enhance computer science teacher training. In addition to case-based technologies, VR and artificial intelligence present promising research directions. For instance, VR can be used to simulate real-world teaching environments, allowing teachers to practice and optimize their teaching methods in an engaging and controlled setting. This approach may also help develop problem-solving skills by presenting complex scenarios that require creative solutions. AI offers extensive opportunities for personalized learning. AI platforms can adapt to individual learning styles and provide real-time feedback to create a customized learning experience. Researchers could explore the integration of AI tools, such as chatbots, automated assessment systems, or intelligent tutoring systems, into the teacher training process for civic education. These tools can reduce administrative burden, promote adaptive learning, and encourage the acquisition of advanced skills. Future studies could also examine the effectiveness of gamification strategies in teacher education. By using interactive learning platforms and game-based methods, researchers can assess how these approaches enhance motivation, engagement, and retention among future teachers. Investigating the long-term impact of these tools on teaching effectiveness and student outcomes would make a valuable contribution to this field. Another potential area of research is the use of big data analytics in teacher education. By analyzing patterns of teaching effectiveness and feedback, researchers can gain insights into the effectiveness of various teaching styles and identify opportunities for improvement. It would be particularly beneficial to explore how big data can influence decision-making in curriculum development and program evaluation. Finally, we recommend conducting comparative studies to assess the impact of different technologies on teacher education in various cultural and organizational contexts. Understanding how these tools function in different settings can support the scaling and adaptation of innovative teaching strategies. Researchers should also pay attention to ethical considerations associated with these technologies, such as data privacy, accessibility, and inclusivity, to ensure their fair application in teacher training programs.

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