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ORIGINAL

Ready to Master Data Structures? Discover How Eduplay and Problem-Based Learning Elevate Computational Thinking and Real-World Problem Solving

¿Está listo para dominar las estructuras de datos? Descubra cómo Eduplay y el aprendizaje basado en problemas mejoran el pensamiento computacional y la resolución de problemas del mundo real

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ABSTRACT

Data structures therefore should be conquered for optimal development of computational thinking and general problem solving prowess. Nevertheless, traditional classroom approaches can hardly meet learners' interest and enlighten them on how the acquired knowledge could be applied in practice. This paper aims to analyze how the introduced Eduplay, an application that comprises educational games and interactive exercises, can be applied to Problem-Based Learning, focusing on problem-solving. The purpose of the study is to determine the extent to which active learning methods contribute to the improvement of students' interest, comprehension and skill in data structures. This methodology comprised pre- and post-tests with regard to CT and qualitative approach employed in observing the learning participants' engagement and interactions. The study also shows that with the integration of Eduplay and PBL, students become more engaged effectively and independently, they think critically, and effectively and independently apply the learnt concepts. The above results imply that combining Eduplay and PBL offers not only the transition from classroom knowledge to working experience but also learning in its entirety. This approach presents educators with a new direction that they can use to enhance the learning outcomes of their students in data structures and other computational fields.

Keywords: Computational Thinking; Data Structures; Eduplay; Engagement; Problem-Based Learning (PBL); Problem-Solving Skills.

RESUMEN

En el panorama de la educación, en constante evolución, dominar las estructuras de datos es una habilidad fundamental que mejora el pensamiento computacional y las capacidades de resolución de problemas. Este artículo explora la integración de Eduplay y el aprendizaje basado en problemas (PBL) como enfoques pedagógicos eficaces para la enseñanza de las estructuras de datos. Eduplay, una combinación de juegos educativos y actividades interactivas, fomenta la participación y profundiza la comprensión, mientras que PBL alienta a los estudiantes a abordar problemas del mundo real, aplicando el conocimiento teórico en contextos prácticos. La sinergia entre estas metodologías cultiva el pensamiento crítico, la innovación y las habilidades colaborativas en los estudiantes, preparándolos para la resolución de problemas complejos en los campos computacionales. Al combinar los fundamentos teóricos de las estructuras de datos con experiencias de aprendizaje prácticas, este enfoque no solo hace que el aprendizaje sea más atractivo, sino que también cierra la brecha entre el conocimiento académico y la aplicación en la industria. El artículo analiza las ventajas de utilizar Eduplay y PBL en el desarrollo del pensamiento computacional, proporcionando una vía para que los educadores mejoren los resultados de aprendizaje de los estudiantes en el estudio de las estructuras de datos y más allá.

Palabras clave: Estructuras de Datos; Eduplay; Aprendizaje Basado en Problemas; Pensamiento Computacional; Resolución de Problemas; Aprendizaje Interactivo; Juegos Educativos.

INTRODUCTION

All computer science and related field students should be able to learn data structures and should be proficient in them. Since one of the main problems in programming is data organization and manipulation, data structures give the means for solving it (T. Liu & Israel, 2022). The use of an array, linked list, tree, and graph forms an essential concept in solving interspersed computational issues. But the thing is that those conceptions are essential, and though a student tries to understand them, he usually fails to apply them when solving problems. There remains a chasm between the conceptual theory of knowledge and its application in formulating enhanced thought and actuality for UIL students desiring to continue to advanced courses, as well as for professional positions in the technology industry (C. Sun et al., 2022). It's quite expected that traditional lectures with data structures, clear explanations, and problem-solving in textbooks can hardly help achieve a profound understanding or even problem-solving skills based on the knowledge acquired.

These methods are good for preparing the students with basic concepts of the specific area, but they are not effective in developing the skills of critical thinking, problem-solving, and stepping up to apply the concepts – all essential characteristics in today's technological world. It allows students to memorize algorithms and data structures without being aware of how and when they are implemented or when they are to be applied to a particular problem. Therefore, they encounter some challenges, especially when it comes to developing a solution to issues in software development and that of the other technical disciplines. This problem is reinforced by the growing need for computational thinking – an important academic and career concept (Taub et al., 2020). Computing thinking means the decomposition of most problems, pattern recognition, and solving them in a step-by-step manner. It's not just a programming skill and is necessary for a plethora of real-life problem solving including business process improvement and technology development.

However, the majority of learners experience difficulties in developing CTS because this paradigm of learning is not always embraced in conventional learning methodologies. As a result, while students may learn how to define various data structures, they may have profound difficulties as to how they could be employed innovatively and efficiently to solve new and different problems (Hwang et al., 2012). In response to these issues, educators and researchers are now beginning to seek out new instructional techniques that would allow in situ theory practice. One such approach that has received a lot of attention is Eduplay and the second is Problem-Based Learning (PBL). Eduplay is a learning-through-play methodology that, in turn, gives the student appealing tutorials that enable him to expose and manipulate data structures in a highly interactive manner (Chang et al., 2012).

Eduplay's idea of having fun in the learning environment aligns with the goals of making learning more enjoyable and engaging while making the learners understand what they study. On the other hand, it can be stated that activities carried out in Problem-Based Learning (PBL) are related to real-life problem-solving. In PBL, students are assigned complex and unsolved tasks that involve their research and cooperation and which are based on the usage of the theory in practice. In addition to strengthening students' problem-solving skills, this approach also fosters critical thinking, teamwork, and communicative skills. One of the advantages of using PBL is that it essentially concerns concrete problems; thus, while using the method it is easier to explain concrete data structures, as far as a student sees the purpose of these concepts when solving practical problems in programming and software designing. The responsibilities of Eduplay and Problem-Based Learning present an interesting chance to fill in the gaps in data structures education. Thus students can learn both the shapes of data structures in theory with the help of Eduplay and computational thinking to solve real-world problems with the help of PBL. For instance, the given model enhances the prospect of this profession to computer science students since they will be produced in an era where the required skills of an elite tech professional involve mastery of algorithms and data structure and a problem-solving mind (Xu et al., 2022).

As much as the use of such techniques could hold several advantages, very little research has been done on their applicability in data structure education. Thus, while Eduplay was demonstrated to enhance students' engagement and their achievements in different settings of education it is still unknown how it influences the process of learning in data structures (C. Liu & Liu, 2024). As it is well documented PBL has been adopted in numerous disciplines though the integration of PBL with Eduplay in the teaching of data structures is limited.

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Indeed, the absence of comparative studies of these approaches suggests the importance of future research on how best to integrate them to support students' development of computational thinking. Also, in the existing research literature, both Problem-Based Learning and Eduplay are discussed separately more frequently than are their complementary usages (Cortés et al., 2024). It is now important to have more extensive investigations that show how the two strategies interact with each other in a given learning system. As such, this research will compare the effectiveness of both of these methods in enhancing the students' knowledge retention of data structures and this may help provide the best approaches that should be used in teaching in situations where both methods are to be applied.

Besides academic learning, incorporating Eduplay and PBL in Data structures education is also an effective strategy for training students to meet new human expectations in the rapidly growing tech industry (Zhao et al., 2025). With the developments around the globe pointing towards the reliance on technology the demand for such personnel who are capable of providing solutions to various challenging problem scenarios known only in the real world keeps increasing (Prasetya et al., 2023). It has emerged that employers are seeking not just good and skilled tech workers who can solve problems using technical skills alone, but also workers with the critical thinking that is required in solving today's problems in the modern world. The inclusion of Eduplay and Problem-Based Learning in the data structures courses would enable educators to guide the students to acquire the winning attributes to fit in what is a relevant and dynamic line of practice (Barz et al., 2025).

This research focuses on finding the effectiveness of the integration of Eduplay and Problem-Based Learning to improve students' computational thinking and decision-making in data structures. The purpose of the current study is to assess the utility of such methods for enhancing student learning in terms of pre- and post-course survey data as well as data obtained from realistic problem-solving exercises. In this regard, this study aims to fill the above literature gap and present empirical findings on the use of Eduplay and PBL for enhancing computer science education and preparing students for the 21st-century complex world (Wan et al., 2024). Finally, it can be pointed out that knowledge of data structures is paramount for any student of computer science; however, frequently, traditional schemes of education leave much to be desired both in terms of saturation of the graduate and in terms of practical applicability (Ding & Yu, 2024). When combined, the deficiencies described in this paper are addressed by Eduplay and Problem-Based Learning as they improve students, computational and problem-solving skills. It not only provides a fun and effective way to learn but also enhances students enough to meet the criteria of modern world technology. Elucidating the Effects of Eduplay and PBL in Data Structure Education: Reviewing a Successful Ethnography, this paper will discuss the conclusions drawn from the interaction of Eduplay and PBL as procedures for delivering the knowledge necessary to enable students to evolve from traditional conceptual learners to experiential expert problem-solvers in the world of computer science.

METHOD

Research Type

Only data of a quantitative nature has been gathered and analyzed to evaluate the effectiveness of incorporating Eduplay as well as PBL in CS students' computational thinking and problem-solving concerning Data Structures courses. In the analogous approach, variables can be measured objectively, that is, changes in behaviors such as test scores and problem-solving skills; hypotheses can then be tested with statistical validity.

Research Design

The nature of this study requires the use of a quasi-experimental design because it is impossible to assign participants to treatment and control groups at random. In this study, the experimental group will have an opportunity to participate in Eduplay and PBL activities, and the control group will complete traditional lecture activities. Both groups will have pre-intervention tests, and post-intervention tests of computational thinking and problem-solving to check out their performance. Further, the student will be doing a real life problem solving activity at the end of the study to evaluate the practicality of data structures in managing real-life problems. The control subgroup will be taught the traditional way, where a lot of emphasis will be laid on theories and trigonometric equations as found in textbooks while the experimental subgroup will engage in a blend of Eduplay and PBL of complex problems using data structures. The pre-and post-tests will assess students' computational thinking and problem-solving skills in multiple-choice, and short-answer questions and problem-solving, in addition, the real-world programming task will also assess their real-world applicability of the topic of data structures in approaching programming problems. This design will enable congeniality between the two groups, hence the likelihood of measuring the impact of Eduplay and PBL in the improvement of students' problem-solving skills and computational thinking.

Research Procedures

The control group will be exposed to a conventional didactic approach to knowledge delivery whereby the instructor will deliver theoretical concepts on data structures accompanied by textual problems. This approach

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will involve outlining the concept of arrays, linked lists, stacks, queues trees, and graphs and there shall not be much on activities. In contrast, the experimental group will undergo both the Eduplay and Problem-Based Learning (PBL) approaches (Karimi & Nasouri, 2024). This will entail practical, game-enhanced concepts to be taught to students whereby they have to solve data structures that are involved in the practical aspects, in the form of games through Eduplay. Further, students will apply PBL, wherein, students will be solving real-life problems using data structures to design them. At this phase, the student will be prompted to reason, solve problems in groups with other students, and practice what he or she has learned. The post-test will be developed similarly to the pre-test as both groups will be required to solve different computer science-oriented computational thinking and solving problems after the intervention (Agni Zaus et al., 2019). The post-test will measure the grasp students have of the data structures and their effectiveness in the application of the concepts. As part of post-intervention assessment, both groups will solve a real-world problem-solving task that is designed to measure the application of data structures to solve a real-world complex problem (Sakti et al., 2024). For instance, the students may be required to come up with an efficient algorithm that uses the right data structures in the solution of problems such as the most effective transportation system or a recommendation system. This task will be assessed against factors like conformity to the correct data structures, the effectiveness of the solution, and other parameters of originality (Jalinus et al., n.d.).

Research Sample

In this research, the subjects will include 64 undergraduate students from different sections of the Data Structures course at the university. A purposive non-random sampling technique will further divide the research participants into two groups: a control group of 32 students and an experimental of 32 students from course sections. The control group will be taught in the conventional/traditional manner with a one-way shop of data structures, while the experimental group will use the Eduplay platform to play data structures as a game and also the PBL to solve actual problems. They enrolled in the course, attempted at least one programming assignment, and agreed to complete pre/post-test and Stage 4, an everyday problem-solving task.

Research Instrument

In this study, the major method of data collection will be a self-administered questionnaire which will be developed under the guidance of a Likert Scale. The post-intervention questionnaire will be given to the experimental group in order to assess their experience of using Eduplay and PBL approaches. For evaluation, students will be given a set of statements that will be based on the level of improvement observed in the students in terms of Computational thinking, problem-solving skills, and data structure. Each statement will be measured using a 5-point Likert scale comprising of options: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree and 5 = Strongly Agree as hinted above, computational thinking has emerged as a valuable discipline of study for students, primarily in realizing higher-order problem-solving domains. It has been postulated that educational technologies such as Eduplay and Problem-Based Learning (PBL) provide different ways in which students' CT can be developed as they actively participate in solving real-life problems. These methods enhance core concepts of computational thinking including decomposition, pattern recognition, and algorithms indispensable for students to understand the application of data structures and logic in tackling daily problems. These are as shown in the following index of computational thinking with each CT supplemented by a statement that looks at cognitive changes brought out by both Eduplay and PBL(Jalinus & Nabawi, 2018).

Table 1. Computational Thinking Indicators

Indicator	Statement
Decomposition	"The activities helped me break down complex problems into smaller, manageable parts."
Pattern Recognition	"The Eduplay platform helped me identify patterns and similarities in problems."
Abstraction	"I learned to focus on the essential aspects of a problem and ignore unnecessary details."
Algorithmic Thinking	"I developed the ability to design algorithms to solve problems efficiently."
Logical Reasoning	"The activities encouraged me to think logically and make connections between different concepts."
Evaluation	"I was able to evaluate different solutions and choose the most effective one based on specific criteria."
Creativity in Problem Solving	"The Eduplay and PBL methods encouraged me to think creatively and explore multiple solutions."
Adaptability	"I became more adaptable in solving problems by using different techniques and strategies when necessary."

One of the valuable skills for a student is problem-solving because resolving complicated tasks is important for everyone. Some processes include Eduplay and Problem-Based Learning (PBL) which aim at the use of experience to apply theoretical knowledge sought through activities that require problem-solving, teamwork, and planning. Besides, these methods help develop students' readiness to apply solutions and persevere as well as show them how the concept of data structures and other computational topics are useful in practice. Some of the key indicators of problem-solving skills are outlined in table 2 below alongside a statement on how Eduplay and PBL affects the students' problem-solving skills in different arenas. (Jalinus et al., 2019)

Table 2. Problem-Solving Skills Indicators

Indicator	Statement
Application of Knowledge	"I was able to apply the theoretical concepts of data structures to solve real-world problems."
Critical Thinking in Problem Solving	"The activities encouraged me to critically assess problems and develop effective solutions."
Collaboration in Problem Solving	"Working with peers in PBL activities helped me generate more ideas and better solutions."
Strategy Development	"I was able to create structured plans and strategies to solve problems effectively."
Solution Evaluation	"I evaluated the efficiency and effectiveness of different solutions before implementing them."
Adaptability in Problem Solving	"I was able to adjust my approach and try different strategies when faced with challenges."
Real-World Application	"The problems presented in PBL tasks helped me see how data structures can be used in real-world scenarios."
Persistence in Problem Solving	"Even when faced with difficult problems, I continued working through different solutions until I succeeded."

Data Analysis Technique and Hypothesis Development

The quantitative end of the study will be used in this research about the effects of Eduplay and Problem-Based Learning (PBL) on computational thinking and problem-solving ability. To start with, the mean, median, standard deviation, and range of control and the experimental groups' pre and post-test will be calculated(Jalinus et al., 2022). The intervention effects will be discovered by a paired t-test of pre-and post-test score differences within groups. The research also requires an independent t-test to show that the control and experimental groups' post-test scores are significantly higher as a consequence of Eduplay and PBL methods. Lastly, the quantitative analysis will use Pearson's correlation coefficient to determine the relationship between the scores in computational thinking with problem-solving among the experimental group. In combination, these elucidations offer a massive evaluation of the effectiveness of the specific intervention. Broadly speaking, the hypotheses in this study are as follows:

H01: There is no statistically significant difference in the improvement of computational thinking skills between students in the experimental group (Eduplay and PBL) and those in the control group (traditional instruction).

H02: There is no statistically significant difference in the improvement of problem-solving skills between students in the experimental group and those in the control group.

Result and Discussion

The results from performance assessments of four different groups in four different cases allow for the measure of how well they have progressed in the tasks of Solution Planning, Preparation, Processing, and Results. These cases encompass different phases of learning and show how each group tackles the data structure tasks. The records of each case reveal differences in each student's capacity for planning solutions and anticipating the outcomes, as well as in information processing and the presentation of resultant solutions. In this study, I used this assessment to determine the differences that exist between students' computational thinking and problem-solving skills when they are taught the use of Eduplay and PBL teaching approaches. Comparing lesson outcomes with different stages of learning will help determine if these teaching strategies are useful for teaching data structures and analytical tasks (Kusakli & Sönmez, 2024).

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Table 3. Effectiveness of the Problem Task in the Treated Group

Case	Group	Solution Planning	Preparation	Processing	Results
Case 1	Group 1	80	85	75	78
	Group 2	90	88	85	83
	Group 3	95	92	91	94
	Group 4	85	87	80	82
Case 2	Group 1	78	84	79	80
	Group 2	92	86	89	91
	Group 3	85	90	86	87
	Group 4	88	92	80	84
Case 3	Group 1	91	89	84	83
	Group 2	88	85	92	87
	Group 3	84	80	88	89
	Group 4	87	93	85	88
Case 4	Group 1	82	79	84	81
	Group 2	90	91	88	85
	Group 3	85	89	90	86
	Group 4	91	93	92	90

An analysis of the group 3 result in table 3 clearly shows that they outcompeted the other groups in all the cases, especially in the Solution Planning, Preparation, Processing, and Results isolated on the ability of the group in Case 1. A general indication of the observed low speed of work in general and particularly in Group 1 with the Pattern composing 16 % mean < 35 % less than the other two groups in Processing and Results in Case 1, But Group 1 had relatively improved slightly better at Case 3. Group 2 had a good performance, especially in Case 2while in the other cases their performance was quite okay. Group 4 maintained its performance and appeared to have some elevation with an instance noted in Case 4. All in all, Group 3 performed best, Group 1 made progress, while results of Groups 2 and 4 were less consistent.

Table 4. Normality Test

Group	Variable	N	Shapiro-Wilk Statistic	p-value	Conclusion
Control	Computational Thinking Skills	32	0,965	0,373	Normal
Control	Problem-Solving Skills	32	0,968	0,455	Normal
Experimental	Computational Thinking Skills	32	0,972	0,561	Normal
Experimental	Problem-Solving Skills	32	0,956	0,206	Normal

From the Shapiro-Wilk normality test results shown in table 4, we deduce that both variables, Computational Thinking Skills, and Problem-Solving Skills, are normally distributed both in the control and experimental groups. In the control group, CT skills have a SW of 0,965, p=0,373 and PS skills have a SW of 0,968, p=0,455. Based on both tests, p & gt; 0,05, thus the data of the control group is normally distributed. For the experimental group, the Shapiro-Wilk statistic for Skills: CT is 0,972 with a p<0,05 =0,561 p >0,05, and for PS is 0,956 with a p<0,05 = 0,206 p>0,05. In the same way, since p<0,05> in the experimental group, it is therefore concluded that the data in this division also follows normal distribution. Therefore, the normality assumption has also been achieved for all data in both groups hence the ability to use the independent t-test to compare on means of the two groups.

To compare the results of the control and the experimental group, it is essential to check the equality of variances of the variables under comparison. EQUAL VARIANCE or homogeneity of variances is one of the most basic assumptions common to many parametric tests such as the independent t-test test of group means. Table 5 is an analysis of Levene's test of homogeneity of the variables Computational Thinking Skills and Problem-Solving Skills. This test enables confirmation that the level of variability of the groups is fairly comparable, hence providing a good foundation for making a comparison between the two groups on these important skills.

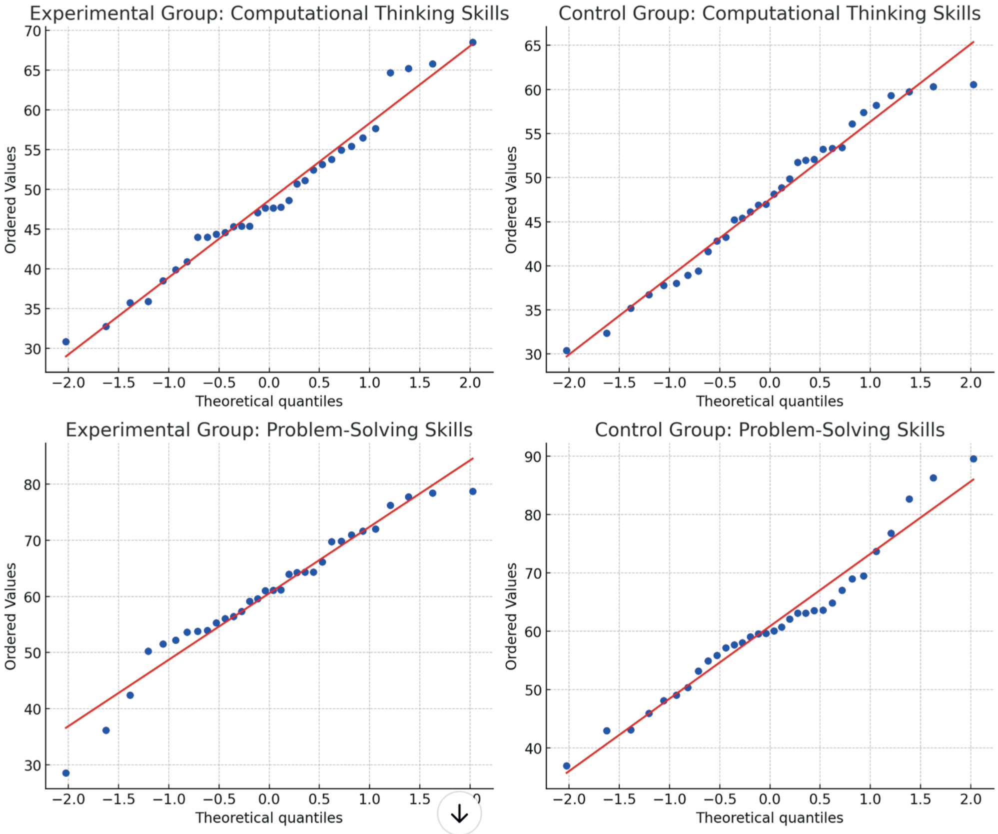

Figure 1. Normality test for computational thinking skills and problem-solving

Table 5. Uji Homogenitas

Variable	Levene Statistic	p-value	Conclusion
Computational Thinking Skills	0,984	0,426	Equal Variance
Problem-Solving Skills	1,152	0,318	Equal Variance

In turn, the results of Levene's test for the homogeneity of variances in table 5 confirm that both the Computational Thinking Skills and the Problem-Solving Skills variables are equal in terms of variance in both the control and the experimental groups. For Computational Thinking Skills, the Levene Statistic is 0,984 and the p-value is 0,426; for Problem-Solving Skills, the Levene Statistic is 1,152 and the p-value is 0,318. Both the $p>0,05$, hence we cannot reject the null hypothesis that the variances of the two groups are equal for both independent variables. This result ensures that the data passed through homogeneity of variance which cleared the way for employing the basic tests such as the independent t-test for testing the means between control and experimental groups. To test the significance of the difference between the Problem-Solving Skills and Computational Thinking Skills of students before and after the experiments and to compare the results of the Eduplay and PBL between the experimental and control groups, a t-test study was conducted. Table 6 summarises the means and standard deviation the difference between groups and level of significance.

Table 6. Result T-test

Variables	Groups	N	Mean	Differences	t	df	P
Posttest							
Problem solving skill	Experimental	32	91,58	12,764	6,227	62	0,000
	Control	32	65,25				
Computational thinking skill	Experimental	32	75,64	15,886	4,334	62	0,000
	Control	32	60,95				
Baseline Test (Pre-test)							
Problem solving skill	Experimental	32	63,64	0,100	0,100	62	0,920
	Control	32	63,54				
Computational thinking skill	Experimental	32	60,42	0,100	0,100	62	0,920
	Control	32	60,32				

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The results also indicate that there is a significant difference in post-test scores between the experimental and control groups in Problem-Solving Skills and Computational Thinking Skills. Again, in Problem-Solving Skills the experimental group recorded a higher mean (M = 91,58) than the control group (M = 65,25) with a difference of 12,764. A t-value of 6,227 and a p-value of 0,000 were observed in this study and the outcome proves that this difference is significant ($p < 0,05$), and thus, such methods had a positive influence in the enhanced problem-solving skills of students as facilitated by the Eduplay and PBL methods. Likewise, the experiment group recorded a higher score of 75,64 as compared to the control group which recorded a total score of 60,95 and hence had a difference of 15,886. The above table shows that Eduplay and PBL methods significantly improve the computational thinking skills of the students exposed to them with t = 4,334 and $p = 0,000 < 0,05$. The pretest scores; again there is no significant difference within the first group in terms of the two skills. As shown in table 4 for Problem-Solving Skills in the pre-test assessment, the difference between the experimental group (M = 63,64) and the control group (M = 63,54) was very minor with a mean difference of only 0,100. Descriptive statistics of the data collected show that at the baseline there is no significant difference between the two variables; t = 0,100 and p = 0,920 ($p > 0,05$). Likewise, for Computational Thinking Skills, the pre-test mean scores of the experimental group (60,42) and the control group (60,32) were almost equal with a mean difference of 0,10. As we can see in Table 5 the t-value of 0,100 and p-value of 0,920 indicate that there is no significant difference between the two groups at the baseline ($p > 0,05$).

DISCUSSION

The results also indicate that there is a significant difference in post-test scores between the experimental and control groups in Problem-Solving Skills and Computational Thinking Skills. Again, in Problem-Solving Skills the experimental group recorded a higher mean (M = 91,58) than the control group (M = 65,25) with a difference of 12,764. A t-value of 6,227 and a p-value of 0,000 were observed in this study and the outcome proves that this difference is significant ($p < 0,05$), and thus, such methods had a positive influence in the enhanced problem-solving skills of students as facilitated by the Eduplay and PBL methods(Luengo-Aravena et al., 2024). Likewise, the experiment group recorded a higher score of 75,64 as compared to the control group which recorded a total score of 60,95 and hence had a difference of 15,886. The above table shows that Eduplay and PBL methods significantly improve the computational thinking skills of the students exposed to them with t = 4,334 and $p = 0,000 < 0,05$.

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Namely, the effectiveness of Problem-Based Learning (PBL), a constructivist teaching approach, in developing students' critical thinking, problem-solving skills, and their abilities to apply the knowledge in practice has been evidenced(Van Elsen et al., 2024). Given that PBL engages students in sophisticated and complex and or ill-defined tasks that mimic real-life conditions. This strategy incorporates data gathering, hypothesis formation, and solution finding in a group setting for students(Lee & Son, 2024).

The findings of this research are consistent with the findings of other studies, including that which established that PBL positively influences students' problem-solving skills by forcing students into the depths of problems instead of just being mere receivers of information(Su, 2024). In this study, the experimental group that attended PBL activities had significantly higher scores in Problem-Solving Skills than the control group that received traditional instructions. This implies that one of the things that could have been enhanced by PBL is the engagement of active learning and real-life situations to solve problems.

The findings of the study concerning Computational Thinking Skills also support recent literature on this aspect of active learning in developing computational skills. The writings of Wing (2006) show that computational thinking is a set of problem-solving abilities that includes decomposition, abstraction, processing patterns, and algorithms. Most of these skills are very relevant not only within computer science but in numerous fields as well as in problem-solving in practice. The control group, those who read the traditional lessons, scored lower than the experimental group who engaged in the Eduplay ICT activities, which provides evidence that the game-based learning environment does promote the growth of CT skills. As an interactive and game-based learning platform, Eduplay most probably offered the students to use the key components of computational thinking in practice(Wulansari et al., 2024).

Gamification is a way to develop computational thinking by pointing out that the use of games allows students to experiment with the use of logical reasoning, algorithms, and abstraction in a risk-free and fun environment. Preliminary analysis suggests an increase in Problem-Solving Skills and Computational Thinking Skills of the experimental group might be due to the procedures applied in the study involving the use of Eduplay and PBL methods that involved the use of games and simulations to teach the concepts(ÇETİN et al., 2023). Since Eduplay is a game-based environment, learners must have remained motivated when using the software; PBL must also have helped the learners apply what they learned practically. These circumstances provided rich learning experiences whereby, in addition to developing practical skills, students were also motivated to challenge their analytical abilities and to engage in group tasks. The baseline (pre-test) scores are significant basically because they identify that the experimental and control groups had realized similar levels of skills at the beginning of the experimental procedure(Chen & Chang, 2024).

This serves to minimize the possibility of initial inter-group variations and enhances the internal reliability of the research. Because the Problem-Solving Skills and Computational Thinking Skills at the pretest levels were almost equivalent for both groups, the observed increase in the post-test scores can be attributed to the interventions delivered to the experimental group. For this reason, the lack of similar improvement in the control group showing traditional instruction argued for the effectiveness of the Eduplay and PBL methods used to facilitate learning(Li & Hou, 2024).

Furthermore, the effects identified in the study add to several prior researches that advocate for active and interactive learning as a means of enhancing cognitive skills(Ridley & Speechley, 2024). Of all the types of gamification, game-based learning has particularly been widely incorporated into learning institutions since it offers the learner instant feedback, motivates, and creates a safe space for risk-taking and failure. Incorporating game elements into the learning process not only makes the students desire to learn more but also, the learning process challenges the knowledge of the student when he or she is given a different way of trying to apply what has been learned (Stohlmann, 2023).

Game-based learning through Eduplay offers these opportunities to students to make them maintain a focus on skills that are inevitable for being a successful academic and a successful person in life (Mohamed et al., 2024). Therefore, this study finds it plausible that Eduplay, together with Problem-Based Learning methods enhances the PSK acquisition greatly and the CST also Improves. These findings support constructivist theory and Active, Interactive Learning and extend prior research on the necessity of active strategy while learning(Hu, 2024). The study offers adequate support for game-based learning and PBL in educational settings and its impact on critical thinking and computational competencies. The three methods above should be taught to every educator to enhance deeper understanding and to prepare students for what they are likely to face in the future concerning their academics and jobs. If technology is to develop over the years, incorporating Eduplay into classroom learning may be of great benefit to the application of learned concepts, thereby closing the gap between theory and practice(L. Sun et al., 2023).

CONCLUSION

According to the results of this study, it is found that the combination of Eduplay and Problem-Based Learning (PBL) positively affects the students' PSK and CTS. Yan determined that the improvement in the experimental group compared with the control group was generally significant but not as dramatically so as certain literature reported. This supports the constructivist theory which states that in order to develop the higher cognitive functions people should participate actively. By using technology and learning through Eduplay, students were given a fun way of learning and to develop computational thinking skills through computer aids and PBL enhanced the students ability to put these skills into practice by applying these concepts towards solving real life cases. The high similarity of scores obtained before the tests between the two groups ensured the observed difference in post-test scores were a result of the intervention. These results are in concordance with previous studies which supports the hypothesis that both PBL and game based-learning improves PSK and CTS. Based on these outcomes, Eduplay and PBL can be recommended as comparatively stable models for enhancing critical thinking, activity engagement and preparation to problem-solving within real-life conditions. These strategies should be implemented into teaching and learning processes to ensure that learning is holistic to develop cognitive structures, enhance students' learning processes and equip them with strategies to handle real life situations.

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