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TEACHING PROGRAMMING THROUGH PRACTICAL PROBLEMS: AN APPLIED APPROACH WITH MINIMAL ENGLISH PROFICIENCY

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Abstract

This research examines the innovative integration of programming education with English language instruction through a Problem-Based Learning (PBL) approach, designed to enhance both technical proficiency and communication skills among higher education students with minimal English proficiency. Conducted with 110 students from diverse programming-oriented faculties at Azerbaijan Technical University, the study employed a mixed-methods design, incorporating surveys, classroom observations, and project-based activities to evaluate the effectiveness of this interdisciplinary methodology. The results, supported by robust statistical analysis, reveal that embedding programming within language learning significantly elevates students' motivation, accelerates technical vocabulary acquisition, and strengthens critical thinking abilities. The PBL framework, implemented through real-world projects such as weather applications and student assessment platforms, promotes learner autonomy, creativity, and collaborative problem-solving, aligning seamlessly with 21st-century educational needs. Classroom observations further indicate improved student engagement, self-confidence, and academic performance, underscoring the model's transformative potential. By bridging the gap between theoretical knowledge and practical application, this approach not only enriches digital and linguistic competencies but also offers a forward-looking, adaptable framework for modern education systems. As such, it stands as a theoretically grounded and practically inspiring resource for educators and researchers seeking to innovate teaching practices in diverse learning contexts.

Keywords: *Problem-Based Learning, Programming Education, English Language Teaching, Interdisciplinary Approach, Azerbaijan, 21st-Century Skills, Technical Vocabulary, Student Motivation*

Introduction

In the contemporary era, the rapid development of information technologies and the pervasive presence of digital literacy across all areas of life have made it necessary to teach programming skills from an early age. Particularly in higher education institutions, the integration of programming with other disciplines – including language instruction – contributes significantly to the development of both technical and communication skills among students (Robins, Rountree, & Rountree, 2003). In this context, the simultaneous teaching of English and programming skills emerges as one of the core requirements of modern educational models (Richards & Schmidt, 2013).

In the teaching process, it is crucial not only for students to acquire knowledge but also to be able to apply that knowledge in real-world contexts. Therefore, the integration of applied programming activities into English language classes is significant in terms of connecting language learning to technical contexts (Echevarria, Vogt, & Short, 2008). It is well established that contextual and project-based activities play a vital role in students' acquisition of new linguistic structures and terminology (Shih, 1986; Costa et al., 2005).

The educational shifts that occurred during the COVID-19 pandemic and students' attitudes toward online learning have shown that effective learning is not possible without technological support (Bingöl, Halisdemir, & Aghazade, 2022). In this context, the integration of programming education with language learning not only enriches the content but also enhances students' ability to engage in distance and technology-based learning (Allehyani & Algamdi, 2023).

Moreover, it is essential to apply methodologies that take into account the needs of second language learners. Research indicates that personalized and adapted instructional approaches significantly improve students' learning attitudes and outcomes (Derwing & Munro, 2005; Chamot, 2005). Thus, the aim of this study is to explore the integration of applied programming into English language instruction within the context of student needs, interdisciplinary connections, and technological transformation. Ultimately, this approach provides ample opportunities for students to develop not only technical knowledge but also academic and social communication skills (Nunan, 2003; Dafei, 2007).

Literature Review

The growing interest in the integration of programming and language teaching in recent years stems from the need for innovative approaches in education systems. Robins, Rountree, and Rountree (2003) discuss the challenges of learning programming and emphasize the importance of learning strategies tailored to students. Their research shows that programming not only develops technical skills but also fosters sequential thinking and a systematic approach to problem-solving. This aligns with the goals of language teaching (Goh, 2000).

Visual and contextual approaches in teaching English as a second language have been found to significantly enhance students' comprehension and production skills (Derwing & Munro, 2005). Reed and Railsback (2003) argue that when teachers in core subjects offer targeted and functional support for English language learners, learning efficiency increases. In this regard, subjects like programming, which are rich in technical terminology, can be beneficial for students in terms of developing purposeful academic writing and technical vocabulary (Shih, 1986; Richards & Schmidt, 2013). Similarly, the integration of technology-based teaching tools is supported by studies such as Fitria (2021), who discusses the potential of artificial intelligence in enhancing teaching effectiveness, particularly in language learning.

Interdisciplinary teaching models create favorable opportunities to integrate both language and technology learning within the same context. Alrabai (2016) shows that the motivation level of language learners and their interaction with technical knowledge directly affects their outcomes. This confirms the effectiveness of project-based learning, which is based on working on real-life problems (Met & Lorenz, 1997). Moreover, the role of technology in enhancing student engagement in both programming and language learning is also evident in studies by Eteng et al. (2022), who review effective strategies for teaching computer programming in developing countries.

Dafei (2007) has demonstrated a positive relationship between student autonomy and language skills. This relationship is also relevant in programming learning: when students work on their projects, they feel more responsible, engage in research on their own initiative, and collaborate with peers. This model promotes both critical thinking and academic freedom (Chamot, 2005). Such collaborative learning environments also align with Aizawa et al. (2023), who explore how students' language proficiency and academic skills improve when they actively engage in both technical and linguistic contexts.

Nazara (2011), in analyzing students' subjective assessments of their language skills, emphasizes that the use of technology in developing oral skills creates motivation. This suggests that programming activities can positively affect students' verbal expression skills as well as their written skills, an idea that also resonates with the findings of Wang (2024), who examines the effect of digital tools on teachers' and students' engagement during the COVID-19 pandemic.

Finally, research related to the COVID-19 period (Bingöl, Halisdemir, & Aghazade, 2022) reveals that the effective use of digital resources influences students' attitudes toward education. These findings align with research by Allehyani and Algamdi (2023), who demonstrate that teachers can apply more personalized and targeted teaching strategies through artificial intelligence applications, such as ChatGPT (Kostikova, I., Holubnycha, L., Besarab, T., Moshynska, O., Moroz, T., & Shamaieva, I. (2024)).

Methodology:

This study employs the **Problem-Based Learning (PBL)** approach to enhance the acquisition of programming skills through practical, real-life scenarios rather than relying solely on theoretical instruction. Rooted in constructivist learning theory, the PBL model encourages students to actively engage in the learning process by constructing knowledge through experience, rather than passively receiving information (Chamot, 2005; Derwing & Munro, 2005).

By contextualizing programming in meaningful, real-world tasks, students are encouraged to perceive coding as not merely a technical skill, but also as a tool for solving real problems. Projects such as weather applications, electronic registration systems, and student assessment platforms help students develop both algorithmic thinking and the ability to understand technical English terminology (Robins et al., 2003; Goh, 2000).

The methodology implemented in this study followed a five-stage PBL process:

1. **Problem Presentation** – A real-life problem, selected by the instructor, is introduced and contextualized within both programming and language frameworks (Nunan, 2003).
2. **Analysis and Discussion** – Students work in groups to analyze the problem, identify objectives, and determine the necessary knowledge. This stage fosters collaborative learning skills (Reed & Railsback, 2003).
3. **Solution Development** – Students conduct research, examine sample codes, and begin creating their own solutions. Learner autonomy and creativity are emphasized during this phase (Dafei, 2007; Allehyani & Algamdi, 2023).
4. **Presentation and Feedback** – Students present their projects to the class and receive feedback from peers and the instructor, supporting the development of critical thinking and self-assessment skills (Costa et al., 2005).
5. **Reflection** – Students review their learning processes, evaluate their performance, and make plans for future improvement.

This integrated methodology enhances not only programming competencies but also time management, problem-solving, and communication skills (Alrabai, 2016). Thus, programming classes serve as a multidimensional learning environment that supports technical and linguistic development simultaneously.

Participants. The study was conducted with 110 students from Azerbaijan Technical University, representing a range of faculties including Computer Science, English Language Education, and Engineering. This interdisciplinary participation enabled a comparative examination of the method's

effectiveness across different academic backgrounds.

Data Collection Instrument

Data were gathered through a 15-item structured questionnaire designed by the researcher. The questionnaire consisted of two sections:

1. Demographic Information – Age, department, year of study, etc.
2. Student Perceptions – Opinions on the integration of programming and English language learning, rated on a 5-point Likert scale (Strongly Disagree – Strongly Agree) (Armstrong, R. L. (1987)).

Survey Questions:

Below are five items selected from the structured questionnaire administered during the study:

1. Programming education made it easier for me to understand English.
2. Working on real-world problems increased my motivation.
3. Writing code with English terms improved my technical language skills.
4. Programming makes the language learning process more meaningful.
5. Group work made it easier for me to learn.

Survey Results Overview:

The following charts illustrate the distribution of student responses to key survey items related to their experience with integrated programming and English language instruction. These visual representations aim to highlight trends in student motivation, technical vocabulary acquisition, and collaborative learning outcomes. Each chart corresponds to one of the core statements from the questionnaire and reflects participants' levels of agreement on a five-point Likert scale (Armstrong, R. L. (1987)).

Data Analysis

Collected data were analyzed using SPSS statistical software. Frequency and percentage distributions were calculated, and cross-tabulations were used for further analysis of selected items. The results helped identify general trends and patterns in student opinions and attitudes.

Below is a summary of key survey results:

Question No	Question Content	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.	Programming education made it easier for me to understand English.	5	9	16	48	32
2.	Working on real problems increased my motivation.	2	6	12	53	37
3.	Writing code with English terms improved my technical language skills.	4	11	18	45	32
4.	Programming makes the language learning process more meaningful.	3	8	19	49	31
5.	Group work made it easier for me to learn.	2	5	14	51	38

Summary of Survey Data – Table

Summary of Observations

Needs analysis and classroom observations indicated that traditional lecture-based instruction is not sufficiently effective in enhancing student motivation or practical knowledge acquisition. The majority of students agreed that programming tasks based on real-life problems provided a more meaningful and goal-oriented learning experience. Participants in project-based learning activi-

ties demonstrated faster mastery of both programming skills and academic terminology (Nazara, 2011).

Additionally, challenges encountered during coding prompted students to develop research habits and encouraged peer-to-peer learning (Met & Lorenz, 1997). Observational data also revealed that student-created projects fostered greater self-confidence, and teachers reported increased classroom participation and more creative problem-solving tendencies (Bingöl et al., 2022).

Discussion and Results

As evidenced in the findings of this study, the integration of Project-Based Learning (PBL) with constructivist teaching methodologies significantly strengthens the effectiveness of student-centered education (Shih, 1986; Goh, 2000). Beyond the acquisition of technical skills, students demonstrated notable improvement in both written and oral communication abilities, highlighting the interdisciplinary benefits of combining programming with language learning.

This model not only facilitates the simultaneous development of programming and English skills, but also cultivates essential 21st-century competencies such as critical thinking, autonomous learning, and teamwork (Dafei, 2007; Allehyani & Algamdi, 2023). Through engaging in real-world projects, students were not merely passive recipients of knowledge but became active participants in knowledge construction (Chamot, 2005).

Survey Results

The needs analysis and structured questionnaire administered during the study provided valuable insights into students' experiences. Participants reported significantly higher motivation and engagement when programming was taught through practical, problem-based contexts rather than traditional lectures. They indicated that such approaches enhanced their understanding of both coding principles and technical English.

The challenges encountered in project development fostered analytical thinking, encouraged independent research, and stimulated collaboration among peers. According to survey responses, the majority of students expressed that their grasp of English programming terminology improved most effectively during the implementation of practical projects. They also noted gains in confidence when expressing ideas both orally and in writing (Derwing & Munro, 2005; Alrabai, 2016).

These findings are further supported by the following survey data, which reflect students' responses to key aspects of the integrated programming and language learning experience:

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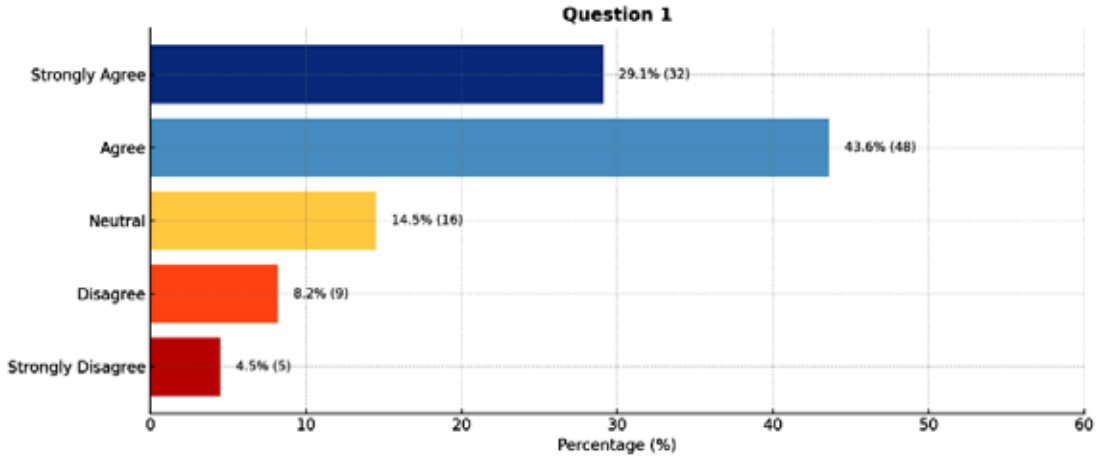
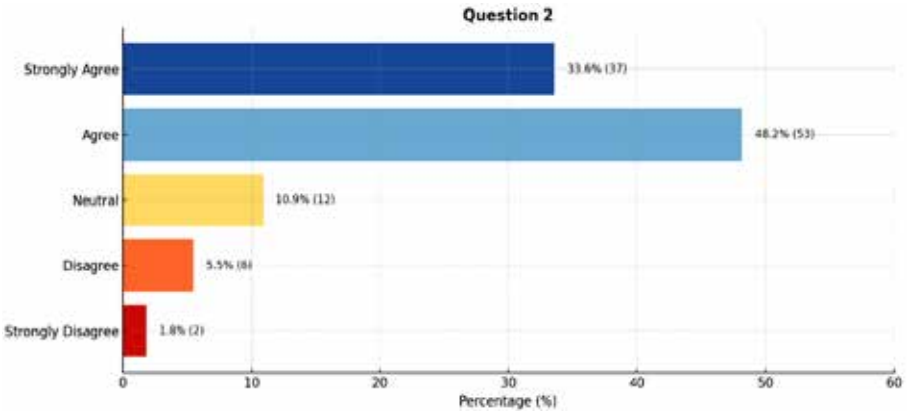
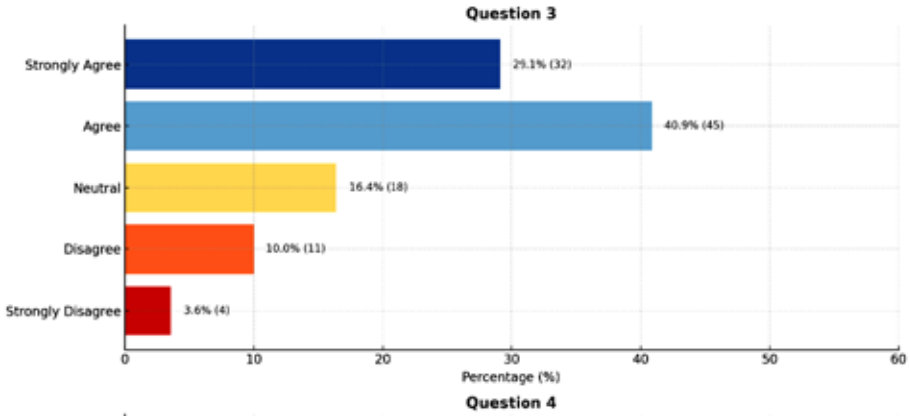
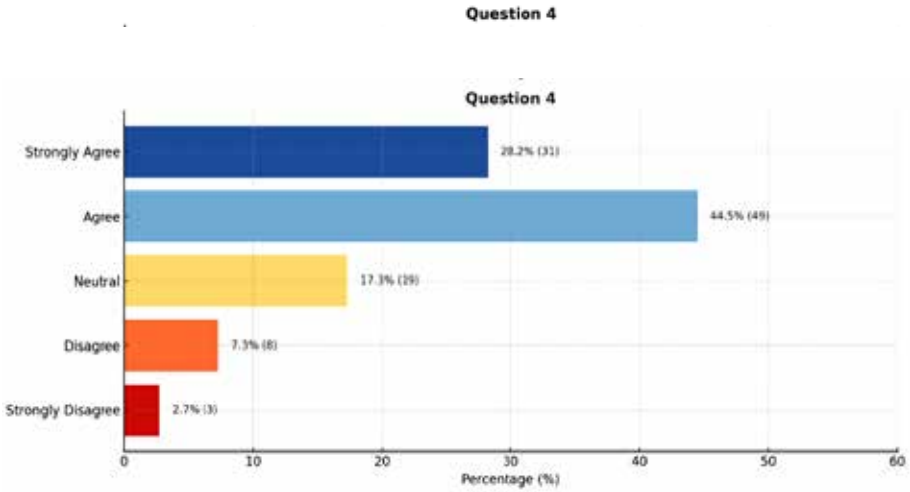
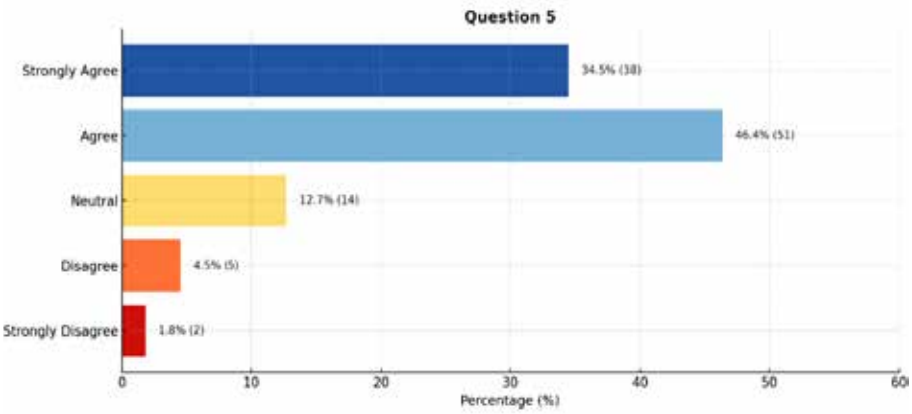



Question 2
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
33.6% (37)
48.2% (53)
10.9% (12)
5.5% (6)
1.8% (2)
0
10
20
30
40
50
60
Percentage (%)


Question 3
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
29.1% (32)
40.9% (45)
16.4% (18)
10.0% (11)
3.6% (4)
0
10
20
30
40
50
60
Percentage (%)


Question 4
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
28.2% (31)
44.5% (49)
17.3% (19)
7.3% (8)
2.7% (3)
0
10
20
30
40
50
60
Percentage (%)


Question 5
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
34.5% (38)
46.4% (51)
12.7% (14)
4.5% (5)
1.8% (2)
0
10
20
30
40
50
60
Percentage (%)

Interpretation of Results and Conclusion

The visuals presented above illustrate the distribution of student responses to the key survey questions, clearly reflecting the overall effectiveness of project-based and problem-oriented learning methodologies. These approaches were particularly impactful in promoting both language acquisition and technical skill development. Moreover, students benefited from collaborative and research-driven coding tasks, which enriched their learning experience and encouraged deeper engagement with the subject matter.

Key Findings

Based on the survey analysis and classroom observations, the following core findings emerged:

1. *Enhanced Motivation and Participation:* Problem-based learning significantly increased students' motivation in both programming and English language instruction, fostering more active classroom participation (Robins et al., 2003).
2. *Effective Integration of Language and Content:* Teaching technical terminology through practical, real-life projects supported a Content and Language Integrated Learning (CLIL) approach, allowing for deeper conceptual understanding (Shih, 1986; Richards & Schmidt, 2013).
3. *Development of 21st-Century Skills:* Participation in group-based projects helped students develop essential skills such as collaboration, time management, critical thinking, and creativity (Chamot, 2005; Nazara, 2011).
4. *Positive Perception of the Integrated Model:* Most students found the combined teaching of programming and English to be interactive, goal-oriented, and highly effective.
5. *Observed Improvement in Academic Performance:* Teacher observations indicated that the applied model not only improved students' creativity but also positively impacted their academic performance (Costa et al., 2005; Bingöl et al., 2022).

Conclusion

In summary, the integration of problem-based learning and project-oriented activities has proven highly effective in fostering both technical and linguistic competence. This model encourages active learning, supports knowledge creation, and cultivates the critical 21st-century skills required in today's academic and professional environments.

The results of this study align with international research findings and confirm that programming, when used as a vehicle for language learning, transforms the learning environment from one of passive knowledge reception to one of active engagement, creativity, and meaningful application (Echevarria et al., 2008; Nunan, 2003; Dafei, 2007).

Ultimately, the interdisciplinary approach adopted in this study not only enhances students' digital literacy but also empowers them to express themselves more confidently, think critically, and approach problems with creativity and adaptability – qualities that are indispensable in the modern world (Allehyani & Algamdi, 2023; Met & Lorenz, 1997).

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