The Role of Life-Based Learning Project and Need for Achievement in Enhancing Student Capabilities and Competencies

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ABSTRACT

The purpose of this study is to examine the influence of Life-Based Learning (LBL) and Need for Achievement on the capabilities and competencies of Informatics Engineering students in a Mobile Programming course. This research used a quasi-experimental design with a 2x2 factorial arrangement. A sample of 64 students was divided into an experimental group (LBL) and a control group (Expert Centred Learning/ECL). Data were collected through cognitive tests, performance rubrics, and Need for Achievement questionnaires, then analyzed using two-way MANOVA. Results showed that the LBL group achieved significantly higher mean scores for capabilities (84.75) and competencies (87.28) compared to the ECL group (80.50 and 82.03). Students with high Need for Achievement also outperformed those with low motivation. Furthermore, a significant interaction was found between learning strategies and Need for Achievement on both capabilities (sig. 0.007) and competencies (sig. 0.009). In conclusion, the LBL approach is more effective than ECL in enhancing student outcomes and can successfully accommodate diverse level which s of Need for Achievement, particularly by lifting the performance of students with low motivation levels more effectively.

I. Introduction

Education has long been recognized as one of the key drivers of social and economic development. Through education, societies gain access to scientific knowledge, technological innovation, and human resource development that contribute to improving people's quality of life (Untari et al., 2021). In the field of Informatics Engineering, mobile programming has become an increasingly important competency as digital technologies continue to shape everyday activities, business operations, and industrial practices (Abtisam Aljarmi et al., 2025). Despite its importance, many university students still struggle to understand programming concepts, particularly when dealing with abstract logic, algorithmic thinking, and complex problem-solving processes (Durukan et al., 2020). These difficulties are often associated with instructional practices that rely heavily on static learning materials and lecturer explanations, which may not adequately illustrate how programming concepts operate in authentic situations (Guzdial, 2015). Previous studies have reported that project-oriented learning environments can help address these challenges by encouraging students to apply programming knowledge in meaningful contexts, resulting in better academic performance and deeper conceptual understanding (Akti Aslan et al., 2019).

Many challenges in higher education today stem from instructional practices that continue to position lecturers as the primary source of knowledge. One example is the Expert Centred Learning (ECL) approach, where learning activities are largely directed by the instructor and students have limited opportunities to actively construct their own understanding (Gai Harrison et al., 2011). As a result, students often become passive recipients of information rather than active participants in the learning process, which may hinder deep conceptual understanding and reduce classroom engagement (Beaumont et al., 2016). Addressing this issue requires more than simply revising teaching materials; it calls for a better understanding of students' learning needs through diagnostic assessment and continuous feedback. Such efforts can help identify specific learning difficulties and provide appropriate support for overcoming them. In response to these challenges, recent educational discussions have increasingly emphasized holistic learning approaches that view students not only as learners of academic content but also as individuals whose personal, social, and

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professional development should be nurtured throughout the educational process (Bulkani et al., 2025).

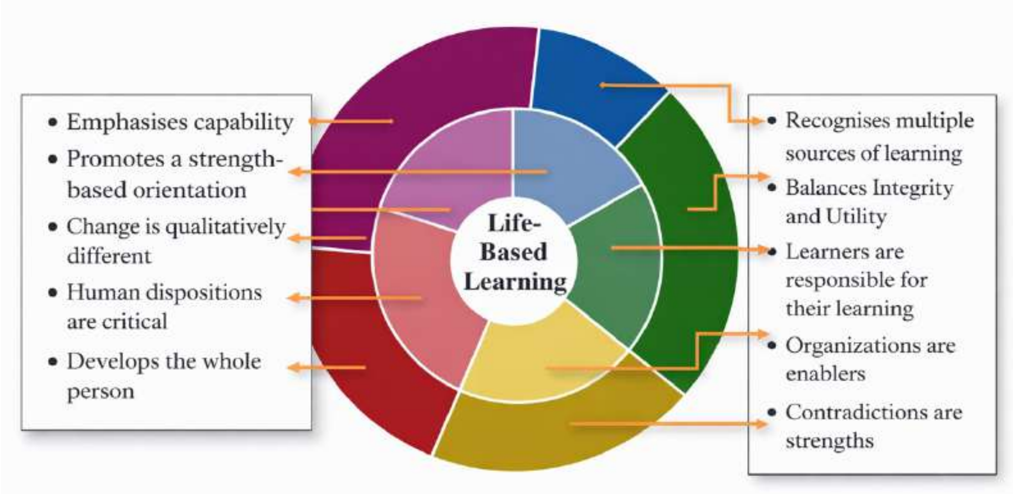

Fig. 1. Key features of holistic and networked life-based learning: an integrated model.

Life-Based Learning (LBL) offers an alternative perspective on how learning can be organized by bringing real-life experiences and professional practice into the center of the educational process (Kastur et al., 2020). Rather than treating learning as an activity that occurs only within the classroom, LBL encourages students to connect academic knowledge with the situations they encounter in everyday life and future work environments. This approach seeks to support the development of the whole individual by integrating learning experiences, professional preparation, and personal growth into a meaningful and continuous process (Susilo et al., 2019). Through such experiences, students have opportunities to strengthen not only their technical abilities but also important attributes such as professional ethics, analytical thinking, and the capacity to interact effectively with others in complex social and workplace settings (Damsi & Suyanto, 2023). Previous studies have reported that learning activities grounded in real-world contexts can positively influence students' attitudes, communication skills, and overall engagement by helping them recognize the relevance of classroom knowledge to societal needs (Laora Silitonga et al., 2020; Li et al., 2026). In programming education, these authentic experiences are particularly valuable because students learn more effectively when they apply coding concepts to practical tasks involving data processing, visualization, and problem solving that resemble real professional challenges (Li et al., 2026).

Among the various factors that influence learning outcomes, internal motivation plays a particularly important role in helping students succeed in demanding technical disciplines (Graven, 2024; Abdul & Habeeb, 2026). One of the most widely recognized concepts in this area is McClelland's Need for Achievement (n-Ach) theory, which explains how individuals develop a strong desire to accomplish challenging goals and achieve standards of excellence that they personally value (McClelland, 1961, 1985). Individuals with a high level of achievement motivation are generally attracted to tasks that are challenging yet attainable. They tend to seek feedback on their performance, evaluate their progress, and assume responsibility for the outcomes of their efforts. In educational settings, these characteristics are often reflected in students who persist when facing difficult programming problems, actively search for additional learning resources, and regulate their own learning without relying heavily on external direction (McClelland, 1985). An important aspect of McClelland's theory is the view that achievement motivation is not a fixed personal trait. Instead, it can be strengthened through supportive learning experiences and environmental influences. This perspective is particularly relevant to the present study because it suggests that instructional approaches can help cultivate achievement-oriented behaviors. Drawing on this framework, the study assumes that students with high n-Ach are likely to thrive in autonomous and project-based learning environments, whereas students with lower levels of achievement motivation may benefit from learning experiences that provide clear relevance, authentic challenges, and meaningful external feedback. These characteristics closely align with the principles of Life-Based Learning (LBL), which emphasizes learning through real-life contexts and purposeful engagement with practical problems.

Students with a strong Need for Achievement are often characterized by their persistence, enthusiasm for challenging tasks, and willingness to invest sustained effort in reaching their goals (Edgerton & Roberts, 2014). These learners tend to remain engaged even when they encounter difficulties, viewing obstacles as opportunities to improve rather than as reasons to withdraw. Previous studies have shown that highly motivated students are more emotionally invested in learning activities and demonstrate greater consistency when working through complex problem-solving tasks (Hidayati et al., 2023; Wu et al., 2025). This tendency becomes particularly evident in project-based learning environments, where students are required to take initiative, make decisions, and manage real-world challenges throughout the learning process. Research conducted across different educational fields suggests that such experiences can strengthen both academic performance and learner engagement, highlighting the important role of intrinsic motivation in supporting meaningful learning outcomes. In courses such as English for Specific Purposes (ESP) and software development, students with strong achievement motivation often benefit from structured project activities that provide clear goals while allowing room for independent exploration and creativity (Hodis & Hodis, 2022). The availability of digital learning resources further enhances this process by offering interactive learning experiences that help maintain student interest and participation over time (Ofianto et al., 2022).

Experiences during the COVID-19 pandemic brought renewed attention to the role of student motivation in digital learning environments. As learning activities increasingly shifted to online platforms, individual motivation became a critical factor influencing students' ability to remain engaged and persist in their studies (Ryan et al., 2020). At the same time, advances in educational technology have created new opportunities to support learning through more interactive and immersive experiences. Technologies such as Augmented Reality (AR) and Virtual Reality (VR) allow students to explore technical concepts in ways that are often difficult to achieve through conventional instruction alone, making learning activities more engaging and meaningful (Sasmito et al., 2021). In vocational and technical education, the integration of such technologies is particularly valuable because it helps bridge the gap between classroom learning and workplace practices. To ensure that these learning experiences contribute effectively to student development, assessment should extend beyond measuring technical knowledge and include students' ability to analyze problems, understand relationships among complex events, and apply knowledge in authentic situations. This perspective is consistent with self-determination theory, which highlights the importance of intrinsic motivation as a key factor in sustaining long-term academic engagement and achievement. Furthermore, the development of Android-based learning materials can provide accessible and practical learning support, enabling students to interact with content in ways that are closely aligned with the demands of contemporary digital education.

This study contributes to the growing body of research on programming education by examining student learning outcomes through a broader set of evaluation indicators than those commonly used in previous studies. In addition to measuring programming performance, the assessment framework incorporates user interface design, data validation, sensor integration, and the practical usefulness of the mobile applications developed by students. These dimensions were selected to reflect the competencies expected in contemporary vocational and professional settings.

The study also extends existing research by bringing together two perspectives that are rarely examined within a single framework. While previous investigations have largely focused on project-based learning models or technology-supported programming instruction, the present study explores how the Life-Based Learning (LBL) approach interacts with students' Need for Achievement, as conceptualized by McClelland, in the context of vocational mobile programming education. By considering both instructional and motivational dimensions simultaneously, this research seeks to provide a more comprehensive understanding of the factors that influence student performance.

Accordingly, this study seeks to empirically investigate the influence of Life-Based Learning (LBL) and Need for Achievement on the development of both capabilities and competencies among Informatics Engineering students enrolled in a Mobile Programming course. The inquiry extends beyond the measurement of technical achievement to encompass contextual problem-solving skills and the ability to design and implement practical applications that reflect authentic industry demands. By situating learning within real-world contexts, the study aims to provide a comprehensive understanding of how authentic pedagogical environments foster student growth, not only in terms of technical proficiency but also in cultivating adaptive, achievement-oriented dispositions. This perspective highlights the transformative potential of LBL and achievement motivation in shaping learners who can integrate knowledge, skills, and values into meaningful professional practice.

A. Theoretical Framework

The present study draws on McClelland's Need for Achievement (n-Ach) theory as a conceptual foundation for understanding student motivation in programming education (McClelland, 1961, 1985). McClelland proposed that human behavior is influenced by three learned needs: achievement, power, and affiliation. Among these, the need for achievement is particularly relevant in learning environments that require persistence, problem-solving, and continuous skill development. In the context of programming education, achievement-oriented students are often motivated to improve their performance, overcome technical challenges, and gain mastery of increasingly complex tasks. To examine this construct, McClelland initially employed thematic apperception techniques and later incorporated self-report measures to identify motivational tendencies. His work suggests that individuals with high levels of achievement motivation typically prefer tasks that offer a reasonable degree of challenge, actively seek information about their performance, and are willing to accept personal responsibility for the outcomes they achieve. These characteristics make the concept of Need for Achievement especially useful for explaining differences in how students engage with demanding programming activities and respond to learning opportunities.

A significant contribution of McClelland's work lies in his assertion that achievement motivation is a dynamic construct one that can be cultivated rather than regarded as a fixed personality trait. Through Achievement Motivation Training (AMT), individuals are encouraged to develop stronger achievement-oriented behaviors by engaging in structured activities such as goal setting, performance feedback, and exposure to exemplary role models. These experiences foster a mindset oriented toward continuous improvement and purposeful effort. From this perspective, learning environments are not merely contexts for knowledge acquisition but active agents in shaping motivational dispositions, enabling students to internalize achievement values and translate them into sustained behavioral patterns. Consequently, AMT underscores the transformative potential of education in nurturing learners who are intrinsically driven to excel and adapt within achievement-oriented cultures.

The characteristics of the Life-Based Learning (LBL) approach align closely with the principles underpinning Authentic Meaningful Tasks (AMT). LBL fosters student engagement through authentic programming projects that mirror real-world challenges, enabling learners to apply theoretical knowledge in practical contexts. This approach also emphasizes multi-source feedback, allowing students to refine their work through diverse perspectives and iterative improvement. Moreover, by placing greater responsibility for learning on the students themselves, LBL cultivates autonomy, self-regulation, and reflective evaluation—key attributes of lifelong learners. Such experiences not only enhance technical proficiency but also nurture proactive learning behaviors, encouraging students to take ownership of their progress and continuously assess their development in relation to authentic performance standards.

Based on these considerations, it is reasonable to expect that the effectiveness of LBL may vary according to students' existing levels of Need for Achievement. Students with higher n-Ach may be particularly responsive to the autonomy and challenge offered by LBL, whereas students with lower n-Ach may benefit from the contextual relevance, authentic experiences, and continuous feedback embedded in the approach. In this sense, Life-Based Learning has the potential not only to support achievement-oriented students but also to create learning conditions that foster the development of achievement-related behaviors among those with lower levels of motivation.

Because achievement motivation may influence how students respond to learning experiences, it is important to examine the behavioral tendencies associated with different levels of Need for Achievement. Table 1 presents a summary of the characteristics commonly observed among students with high and low achievement motivation based on McClelland's theoretical perspective. These characteristics provide a useful reference for interpreting variations in student engagement, persistence, and learning performance throughout the implementation of Life-Based Learning activities. By considering these motivational differences, the study is better positioned to explain how students respond to authentic and project-oriented learning environments.

Table 1. Behavioral Characteristics of Students with High and Low Need for Achievement in Programming Learning.

Aspect	**High Need for Achievement**	**Low Need for Achievement**
Task Selection	Prefers programming tasks that are challenging but achievable	Tends to avoid tasks perceived as difficult or uncertain
Learning Approach	Actively explores alternative coding solutions and learning resources	Relies primarily on lecturer explanations and provided examples
Response to Feedback	Uses feedback to refine and improve application performance	Often requires repeated encouragement to act on feedback
Persistence During Debugging	Continues troubleshooting until problems are resolved	Becomes discouraged when encountering repeated errors
Responsibility for Outcomes	Takes ownership of project quality and completion	Depends more heavily on peers or external guidance
Initiative for Improvement	Voluntarily seeks additional practice and skill development opportunities	Completes only the minimum requirements of assigned tasks

II. Method

This study employed a quasi-experimental method using a 2x2 factorial design with a pretest-posttest non-equivalent control group arrangement (Takona, 2024). A quasi-experimental approach was considered appropriate because the participating classes had already been assigned by the department before the study was conducted, making random allocation of students impractical. The research examined two independent variables. The first was the learning strategy, which consisted of Life-Based Learning (LBL) and Expert-Centred Learning (ECL). The second was students' Need for Achievement, categorized into high and low levels based on the results of the achievement motivation assessment.

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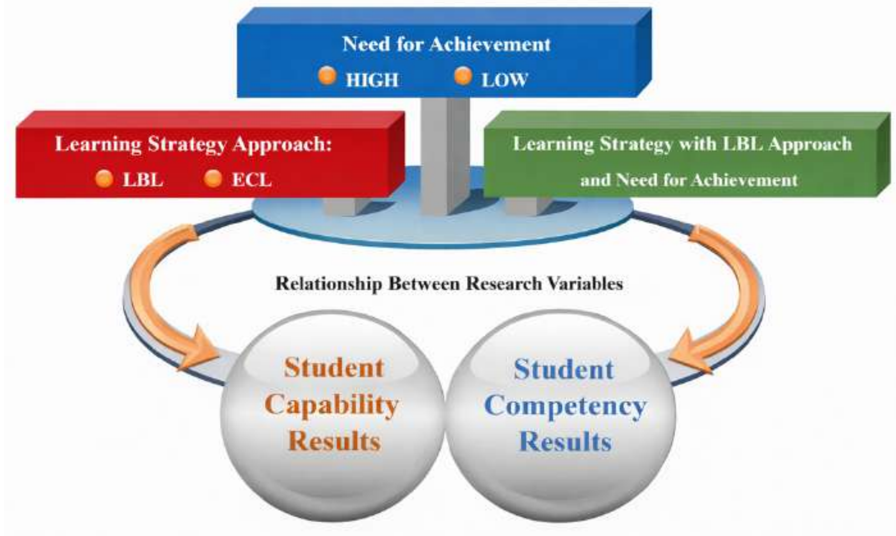

Fig. 2. Conceptual framework illustrating the relationships among learning strategy, Need for Achievement, student capability, and student competency.

The study focused on two dependent variables, namely students' capability and competency in mobile programming. These outcome variables were selected to capture both the students' ability to apply programming concepts and their overall proficiency in developing functional mobile applications. The structure of the factorial design used in the study is summarized in Table 2.

Table 2. Distribution of Experimental Conditions Based on Learning Strategy and Need for Achievement

Need for Achievement	Life-Based Learning	Expert Centred Learning
High Need for Achievement	LBL–High n-Ach	ECL–High n-Ach
Low Need for Achievement	LBL–Low n-Ach	ECL–Low n-Ach

The factorial design generated four experimental conditions representing combinations of learning strategy and students' Need for Achievement. Two groups were taught using the Life-Based Learning (LBL) approach, while the remaining groups received instruction through Expert-Centred Learning (ECL). Within each instructional condition, students were further classified into high and low Need for Achievement categories based on the results of the achievement motivation assessment. This arrangement enabled the study to examine both the main effects of each variable and their potential interaction on students' capability and competency in mobile programming.

A. Participants

The population of this study consisted of 171 fourth-semester Informatics Engineering students at STIKI. Sampling was conducted using cluster random sampling, as all students possessed equivalent initial standards based on university entrance and psychological test scores. Two classes were selected: Class A (n=32) as the experimental group and Class B (n=32) as the control group.

B. Research Procedure

The research was conducted over 10 meetings, each lasting 150 minutes. The procedure followed a systematic framework to ensure consistency (Takona, 2024). Meeting 1 involved a pretest where students developed a Body Mass Index (BMI) application. Meetings 2 through 9 were treatment sessions focusing on two main topics: user interface design and data processing. Finally, meeting 10 consisted of a posttest involving the creation of a concert ticket booking application (TicketBox) and the completion of the Need for Achievement questionnaire. The procedure is visualized in Fig. 1.

C. Instruments

Four primary instruments were used. First, a cognitive test (pretest and posttest) measured programming skills directly, focusing on Android-based teaching materials (Sasmito et al., 2021). Second, a capability rubric consisting of seven components-app stability, features, UI, data validation, storage, hardware integration, and utility-was used for assessment. Third, a competency rubric evaluated individual, group, environmental, and workplace skills. Lastly, a Need for Achievement questionnaire, adapted from established scales and containing 30 Likert-style items, was administered to categorize students. This instrument aligns with self-determination theory, which emphasizes intrinsic drive for academic success (Ryan et al., 2020).

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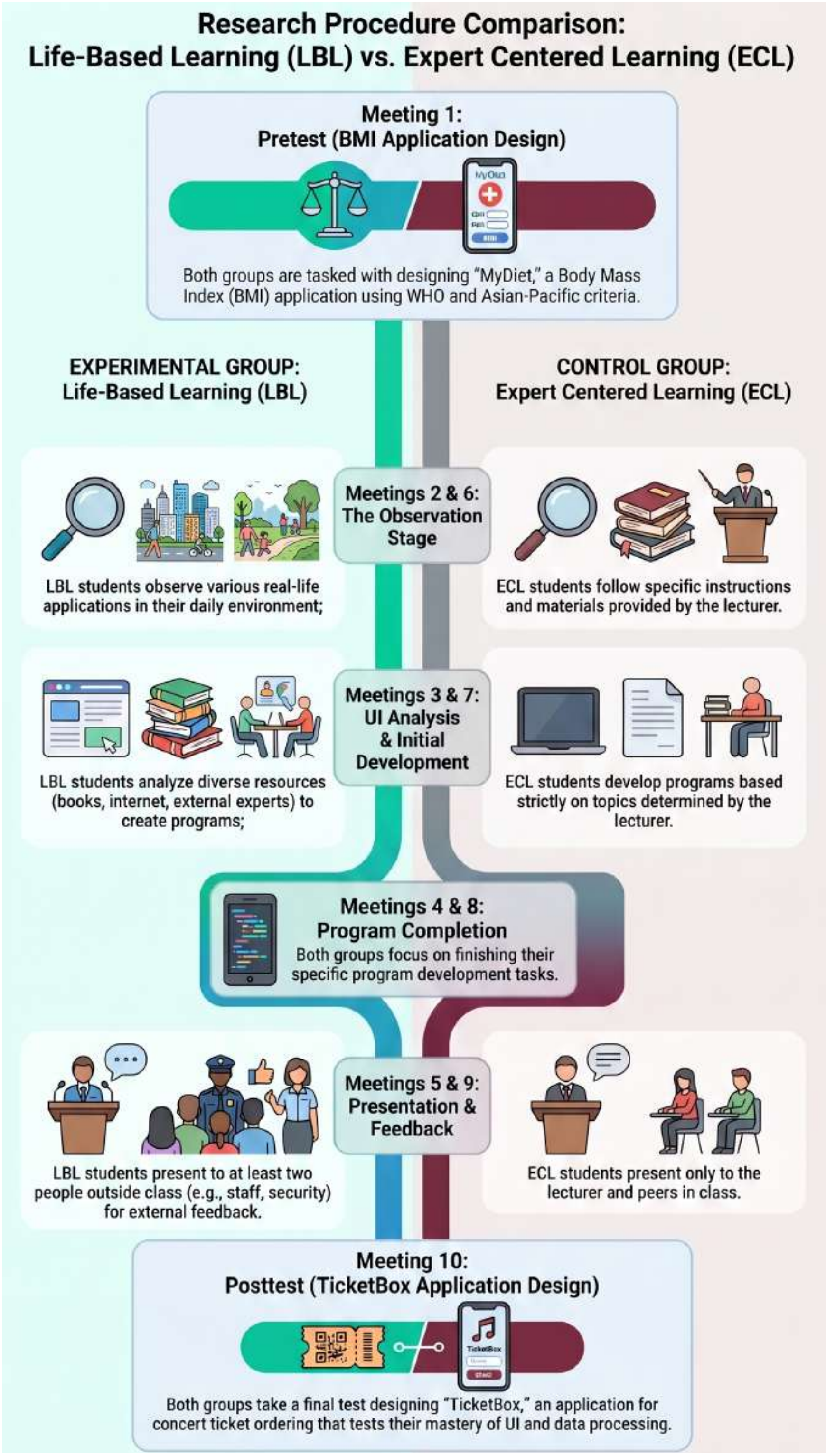

Fig. 3. Research Procedure

D. Data Analysis

Data analysis was performed using two-way Multivariate Analysis of Variance (MANOVA) to examine main and interaction effects. Statistical prerequisites were met, including multivariate normality and homogeneity of covariance matrices. The analysis was supported by interactive multimedia frameworks to enhance the validity of the learning outcomes. All statistical tests were conducted at the 5% significance level using IBM SPSS Statistics 24. This diagnostic-informed approach ensures that the impact of instructional interventions is accurately measured.

III. Results and Discussion

The descriptive statistical analysis shows that students in the Life-Based Learning (LBL) group achieved higher scores compared to the Expert Centred Learning (ECL) group. Specifically, the LBL group reached a mean capability score of 84.75 and a competency score of 87.28, while the ECL group scored 80.50 and 82.03, respectively. Furthermore, students with a high Need for Achievement consistently outperformed those with a low Need for Achievement across both learning strategies. The complete descriptive data are presented in Table 3. Based on Table 3, it is evident that students taught with the LBL approach achieved higher overall mean scores. This performance gap is further visualized in Fig. 2, which compares the outcomes between Life-Based Learning and Expert Centred Learning.

Table 3. Descriptive Statistics of Capability and Competency

Learning Strategy	Need for Achievement	Capability (Mean ± SD)	Competency (Mean ± SD)	n
Life-Based Learning	High	88.44 ± 2.19	90.56 ± 2.19	16
	Low	81.06 ± 1.98	84.00 ± 1.79	16
Expert Centred Learning	High	82.75 ± 2.02	84.00 ± 1.46	16
	Low	78.25 ± 2.02	80.06 ± 2.21	16

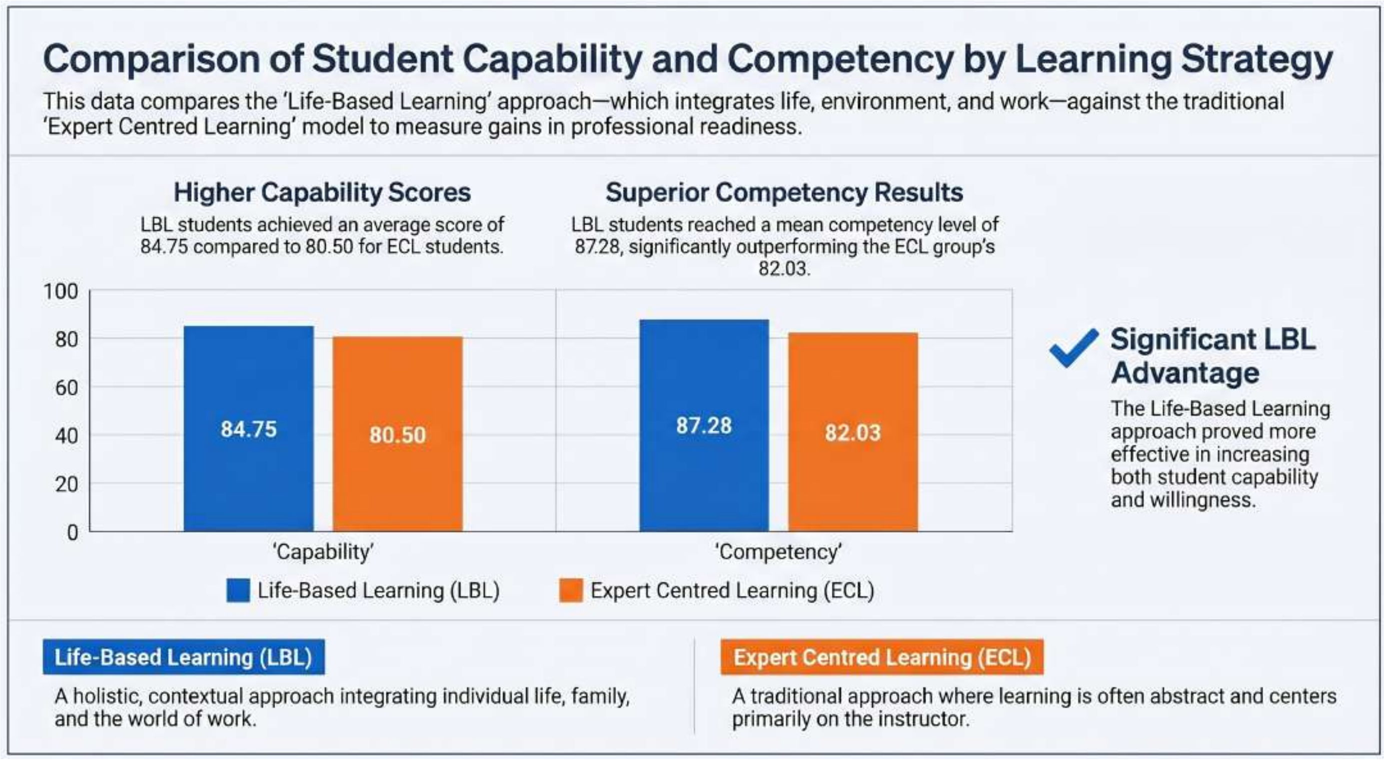

Fig. 4. Comparison of Outcomes by Learning Strategy

The data reveal a clear performance distinction: students with a high Need for Achievement consistently outperformed their peers with lower motivational tendencies. This finding underscores the pivotal role of achievement motivation in shaping learning outcomes, particularly within authentic, task-based environments. The complete descriptive statistics are presented in Table 4, which provides a detailed comparison of student performance across motivation levels. To further highlight the magnitude of this disparity, the descriptive comparison is summarized in Figure 5, which illustrates the performance gap between high- and low-motivation groups. Taken together, these results reinforce the argument that motivational dispositions significantly influence both capability and competency development, thereby validating the integration of achievement-oriented frameworks into instructional design.

Table 4. Descriptive Statistics of Capability and Competency by Need for Achievement

Need for Achievement	Capability (Mean ± SD)	Competency (Mean ± SD)	N
High	85.59 ± 3.55	87.28 ± 3.80	32
Low	79.66 ± 2.43	82.03 ± 2.81	32
Total	82.63 ± 4.25	84.66 ± 4.24	64

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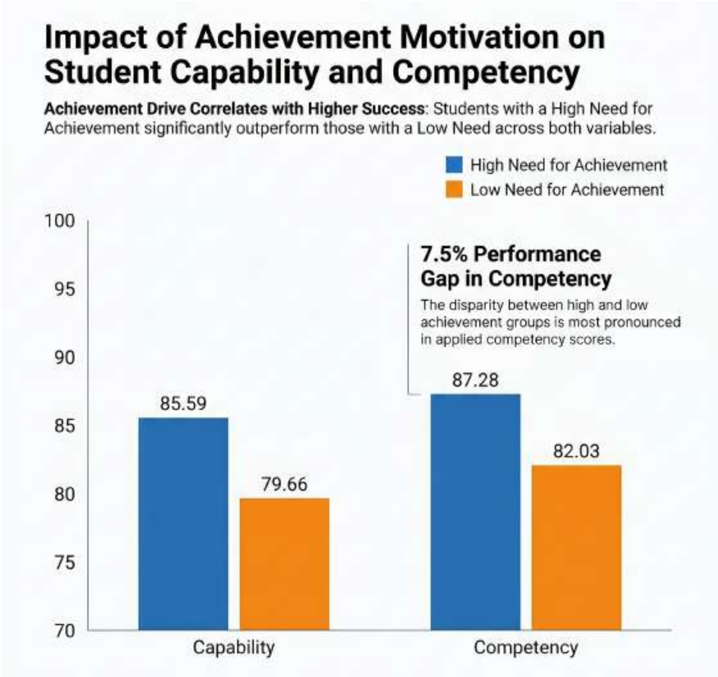

Fig. 5. Comparison of Student Capability and Competency by Need for Achievement Level

Hypothesis testing using two-way MANOVA confirmed these findings. The results showed a significant main effect for the learning strategy (Sig. 0.000) and Need for Achievement (Sig. 0.000). Most importantly, a significant interaction was found between the two variables for both capability (Sig. 0.007) and competency (Sig. 0.009). This interaction confirms that the impact of LBL is significantly enhanced when aligned with the student's motivational level.

The findings suggest that the LBL approach is superior to ECL because it treats the student as a "whole person" by integrating real-life contexts into technical subjects. This method aligns with immersive diagnostic approaches that bridge conceptual gaps in complex programming logic. By allowing students to present their work to external experts and practitioners, LBL creates a dynamic feedback loop that is absent in teacher-centered models.

The significant interaction effect found in this study can be interpreted through McClelland's concept-tualization of n-Ach. McClelland argued that individuals with high n-Ach are intrinsically motivated by tasks that provide moderate challenge and immediate feedback, characteristics inherent to the LBL approach, where students develop real-world applications (e.g., TicketBox) and receive critiques from external users. In contrast, the ECL approach, which is teacher-directed and lacks authentic feedback loops, fails to stimulate high n-Ach students' need for personal responsibility and mastery. Consequently, the performance gap between high and low n-Ach students was more pronounced in the ECL group, while LBL narrowed this gap.

Moreover, McClelland emphasized that n-Ach is not a fixed trait but can be situationally activated by environmental cues. The LBL environment, with its emphasis on life-relevant problems, multiple sources of learning (books, internet, external interviews), and presentations to real audiences, serves as a powerful situational trigger for achievement motivation, even among students classified as low n-Ach. This explains why low n-Ach students in the LBL group (mean capability 81.06) outperformed those in the ECL group (78.25). The contextualized, participatory nature of LBL provides the very "moderately difficult challenges" and "feedback-rich" settings that McClelland identified as essential for activating achievement motivation.

Another key insight from McClelland's work is that n-Ach is associated with preference for innovation and calculated risk-taking. In programming, innovation involves trying new coding solutions, integrating sensors, designing user-friendly interfaces, all components of our capability rubric. LBL encourages such risk-taking by allowing students to explore beyond the syllabus, whereas ECL penalizes deviation from instructor-provided solutions. Therefore, LBL not only accommodates high n-Ach students but also provides a safe environment for low n-Ach students to gradually develop achievement-oriented behaviors. This finding supports McClelland's argument that n-Ach can be cultivated through training programs that offer challenge, feedback, and personal responsibility, precisely what LBL delivers.

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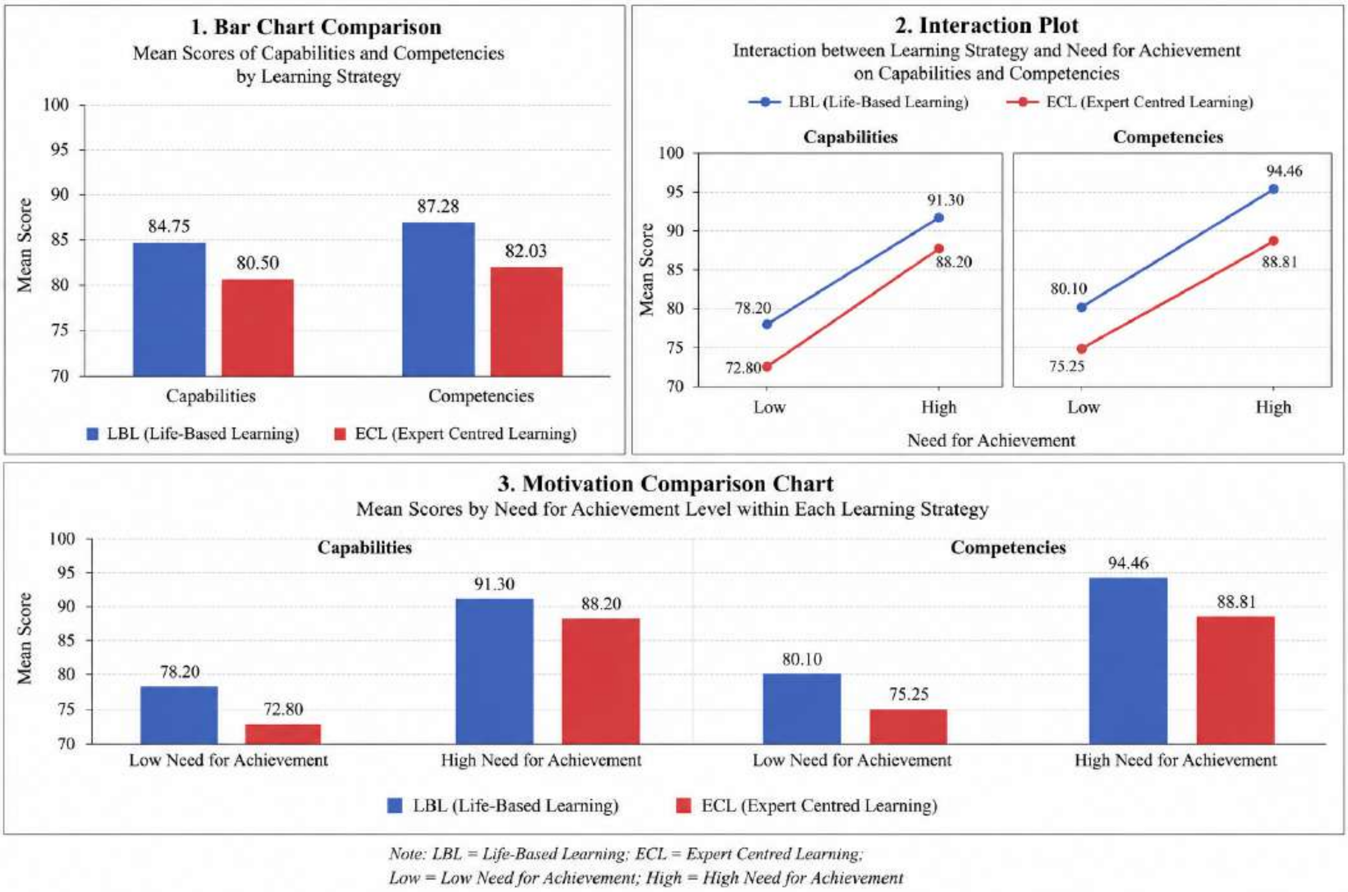

Fig. 6. Interaction plot between learning strategy and Need for Achievement on student capability. The steeper decline for high n-Ach from LBL to ECL indicates that high-motivation students are more sensitive to the learning environment, while low n-Ach students benefit relatively more from LBL.

The significant interaction effect ($p = 0.007$ for capability and $p = 0.009$ for competency) is visualized in Figure 6, which plots the mean capability scores across learning strategies for high and low n-Ach groups.

A. Practical Implications

The findings of this study have several important implications for vocational higher education, particularly in mobile programming instruction. First, the implementation of Life-Based Learning (LBL) demonstrates that contextual and project-oriented learning environments can significantly improve student capabilities and competencies. Students become more actively involved in solving authentic programming problems, which encourages analytical thinking, creativity, and collaboration skills.

Second, integrating Need for Achievement into the learning process highlights the importance of motivational factors in technical education. Students with high achievement motivation tend to demonstrate greater persistence and responsibility when completing programming tasks. However, this study also found that students with lower motivation levels can improve significantly when supported through contextualized learning experiences and real-world projects.

Third, the use of LBL in mobile programming courses aligns well with the demands of Industry 4.0 and digital transformation. The approach prepares students not only to master programming syntax but also to develop adaptive competencies, problem-solving abilities, and professional attitudes required in the workplace.

Therefore, vocational institutions are encouraged to integrate Life-Based Learning principles into other programming-related courses such as web programming, database systems, and software engineering. Lecturers should also provide authentic project experiences, collaborative activities, and reflective learning opportunities to strengthen students' learning engagement and achievement motivation.

Although the findings confirm the effectiveness of the Life-Based Learning approach in improving students' capabilities and competencies, several limitations should be acknowledged to provide a balanced interpretation of the results and to guide future studies.

B. Research Limitations

Several limitations should be acknowledged in this study. First, the research was conducted only within one Informatics Engineering study program, with a relatively small sample size of 64 students. Consequently, the findings may not fully represent students from different institutional or disciplinary contexts.

Second, the study focused specifically on the Mobile Programming course. Different results may emerge when the Life-Based Learning approach is implemented in other vocational or technical subjects that require distinct cognitive and practical competencies.

Third, this study primarily examined capability and competency outcomes, while other important variables such as self-efficacy, learning styles, digital literacy, and collaborative skills were not included in the analysis. Future research is recommended to incorporate these additional variables to provide a more comprehensive understanding of Life-Based Learning's effectiveness.

Finally, the measurement of Need for Achievement relied on self-report questionnaires, which may be subject to bias. Further studies may employ mixed-method approaches involving interviews, observations, and learning analytics to obtain richer insights into students' motivational dynamics.

IV. Conclusion

The empirical findings of this study demonstrate a high level of compatibility between the research objectives and the observed outcomes. The implementation of Life-Based Learning (LBL) significantly enhances student capability and competency in mobile programming compared to the conventional Expert Centred Learning (ECL) approach. On average, students in the LBL group achieved superior results (capability: 84.75; competency: 87.28) compared to those in the ECL group (capability: 80.50; competency: 82.03). Furthermore, individual psychological factors play a critical role, as students with a high Need for Achievement consistently outperformed their low-motivation peers. The most vital contribution of this research is the confirmation of a significant interaction effect between learning strategies and motivation (Sig. 0.007 for capability and 0.009 for competency). This indicates that the LBL approach is particularly effective in optimizing the potential of students by aligning technical mastery with real-world life experiences and professional contexts. Consequently, LBL provides a more inclusive and adaptive learning ecology for Informatics Engineering students in the digital era.

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