Analysis of the Relationship between Learning Styles and Abilities in the 21st Century of Informatics Engineering Education Students in Team-Based Learning

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Abstrak

Keterampilan abad 21 seperti kolaborasi, komunikasi, berpikir kritis, dan literasi digital merupakan kompetensi penting yang harus dimiliki oleh lulusan pendidikan vokasi, khususnya pada Program Studi Pendidikan Teknik Informatika. Namun, perbedaan gaya belajar mahasiswa diduga dapat memengaruhi pencapaian kompetensi tersebut. Penelitian ini bertujuan untuk menganalisis hubungan antara gaya belajar dengan kemampuan abad 21 mahasiswa dalam konteks pembelajaran berbasis tim. Metode penelitian yang digunakan adalah kuantitatif dengan pendekatan korelasional. Sampel penelitian berjumlah 120 mahasiswa Program Studi Pendidikan Teknik Informatika Universitas Hatta. Instrumen yang digunakan berupa kuesioner gaya belajar dan tes kinerja berbasis proyek untuk mengukur keterampilan kolaborasi, komunikasi, berpikir kritis, dan literasi digital. Hasil analisis menunjukkan bahwa terdapat hubungan yang signifikan antara gaya belajar mahasiswa dengan penguasaan keterampilan abad 21, khususnya pada aspek kolaborasi dan berpikir kritis. Pembelajaran berbasis tim terbukti memfasilitasi berbagai gaya belajar dan mendorong pengembangan keterampilan yang relevan dengan tuntutan tenaga kerja digital. Kesimpulan dari penelitian ini adalah bahwa gaya belajar merupakan faktor penting yang perlu dipertimbangkan dalam perancangan pembelajaran berbasis proyek untuk menghasilkan lulusan vokasi yang unggul dan adaptif terhadap tantangan abad ke-21.
Kata Kunci: Gaya Belajar, Keterampilan Abad ke-21, Proyek Berbasis Tim, Kejuruan, Informatika

Abstract

21st century skills such as collaboration, communication, critical thinking, and digital literacy are important competencies that must be possessed by vocational education graduates, especially in the Informatics Engineering Education Study Program. However, differences in student learning styles are suspected to affect the achievement of these competencies. This study aims to analyze the relationship between learning styles and 21st century abilities of students in the context of team-based learning. The research method used is quantitative with a correlational approach. The research sample amounted to 120 students from the Informatics Engineering Education Study Program at Hatta University. The instruments used were learning style questionnaires and project-based performance tests to measure collaboration, communication, critical thinking, and digital literacy skills. The results of the analysis showed that there was a significant relationship between students' learning styles and mastery of 21st century skills, especially in the aspects of collaboration and critical thinking. Team-based learning has been proven to facilitate a wide range of learning styles and encourage the development of skills relevant to the demands of the digital workforce. The conclusion of this study is that learning style is an important factor that needs to be considered in project-based learning design to produce vocational graduates who are superior and adaptive to the challenges of the 21st century.

Keywords: *Learning Style, 21st Century Skills, Team-Based Project, Vocational, Informatics*

1. Introduction

The Industrial Revolution 4.0 era has marked a major transformation in the education landscape and the world of work. The development of digital technology, artificial intelligence, and automation demands that graduates of higher education, especially vocational education, not only master technical skills, but also develop non-technical competencies referred to as 21st century skills. These skills include collaboration skills, effective communication, critical thinking, and digital literacy [1] [2]. The World Economic Forum report (2020) also places these skills as a top priority in mapping the future of jobs [3].

Vocational education study programs such as Informatics Engineering Education are in a strategic position in preparing graduates who are not only adaptive to technological developments, but also able to innovate and work in cross-disciplinary teams. Therefore, the learning strategies used in higher education must be able to build these skills holistically. One of the most recommended approaches is *Team-Based Project Learning* (TBPL), as this model integrates teamwork, problem-solving, and collective responsibility in an authentic context [4].

However, one thing that is often overlooked in the implementation of these learning strategies is the difference in individual student characteristics, especially learning styles. Learning style is an individual's preference or tendency to absorb and process information. The three main types of learning styles that are widely used in educational research are visual, auditory, and kinesthetic (VAK) [5]. Students with visual learning styles, for example, find it easier to understand information through pictures and diagrams, while kinesthetic students are more comfortable learning through hands-on practice. These differences are very likely to affect how students respond to collaborative tasks and team projects.

Several previous studies have shown that learning styles affect student learning outcomes and motivation. Felder and Silverman [6] suggest that the mismatch between learning styles and teaching methods can lead to low motivation to learn. Meanwhile, research by Misbah et al. [7] found that the success of competency-based learning is highly dependent on the interaction between learning styles and teaching approaches. However, studies that specifically link learning styles to the achievement of 21st century skills in the context of team project learning are still limited, especially in vocational education in Indonesia.

In addition, there is debate in the literature about whether learning styles really have a significant impact on learning outcomes. Some researchers argue that adapting learning methods to learning styles does not always result in improved performance [8], while others emphasize the importance of adaptive instructional design for creating meaningful learning experiences [9]. In this context, empirical testing of the influence of learning styles on 21st century skills in project-based learning models becomes particularly relevant.

This research was conducted to fill this gap by quantitatively analyzing the relationship between student learning styles and 21st century skill mastery, namely collaboration, communication, critical thinking, and digital literacy, in the context of team-based learning. This research was conducted on students of the Informatics

Engineering Education Study Program at Hatta University, who have applied a team project approach in several core courses. Through a correlational approach, this study evaluates the extent to which learning style preferences contribute to the success of developing important skills in this digital age.

The main objective of this study is to identify a significant relationship between students' learning styles and 21st century skill mastery, as well as to evaluate the effectiveness of team-based learning approaches in accommodating these differences. The results of this research are expected to make a theoretical and practical contribution to the development of a vocational curriculum that is responsive to student characteristics, as well as support the achievement of adaptive, collaborative, and digitally competent graduate profiles.

2. Methods

This study uses **a quantitative** approach with a correlational **method**. The main objective of this approach is to find out the extent of the relationship between learning style variables (visual, auditory, kinesthetic) and students' mastery of 21st century skills (collaboration, communication, critical thinking, and digital literacy) in the context of *team-based project learning*. This design was chosen because it is suitable for testing the relationship between variables that are statistically non-causal.

The research was carried out at the Informatics Engineering Education Study Program, Faculty of Teacher Training and Education, Hatta University, Padang, West Sumatra. The research implementation time lasted from February to April 2025 during the implementation of project-based learning in one even semester core course.

The population in this study is all active students of the Informatics Engineering Education Study Program, Hatta University who take courses with a team project approach. Sampling was carried out by **purposive sampling** by considering student involvement in team projects, resulting in **a sample of 120 students** from various semesters.

The main instruments in this study consist of two parts, namely:

- **Learning Style QuestionnaireAdapting the VAK (Visual, Auditory, Kinesthetic) model** developed by [6]. The questionnaire consists of 30 statements with a 4-point Likert scale. The validity of the contents was tested through expert judgment, and the reliability of the instrument was tested using Alpha Cronbach with a value of $\alpha = 0.82$, indicating high reliability.
- **21st Century Skills Assessment rubricThe measurement rubric covers four aspects: collaboration, communication, critical thinking, and digital literacy. Each aspect is assessed from the results of student group project assignments using indicators developed based on the framework** [4]. The rubric was prepared with an assessment scale of 1–4 (low to very good), and was assessed by the teaching lecturer and observer using a structured observation sheet.

The research steps were carried out by identifying student groups who were active in project-based learning. Furthermore, the distribution of online learning style questionnaires was carried out through Google Form. During the lecture process, the implementation of team project tasks by students in groups of 4-6 people and the assessment of project results using the rubric of 21st century skills by lecturers and observers. After the implementation process is completed, data collection and processing of questionnaire results and project assessment data will be carried out. The data obtained was statistically analyzed the relationship between learning styles

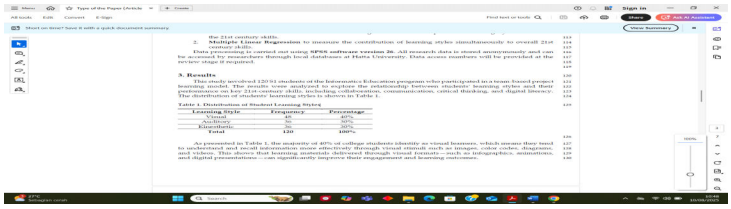
and 21st century skills.
The data were analyzed using two statistical techniques:

- **The Pearson Correlation test** to find out the strength of the relationship between learning styles and each of the 21st century skills.
- **Multiple Linear Regression** to measure the contribution of learning styles simultaneously to overall 21st century skills.

Data processing is carried out using **SPSS software version 26**. All research data is stored anonymously and can be accessed by researchers through local databases at Hatta University. Data access numbers will be provided at the review stage if required.

3. Results

This study involved 120 S1 students of the Informatics Education program who participated in a team-based project learning model. The results were analyzed to explore the relationship between students' learning styles and their performance on key 21st-century skills, including collaboration, communication, critical thinking, and digital literacy. The distribution of students' learning styles is shown in Table 1.
Table 1. Distribution of Student Learning Styles



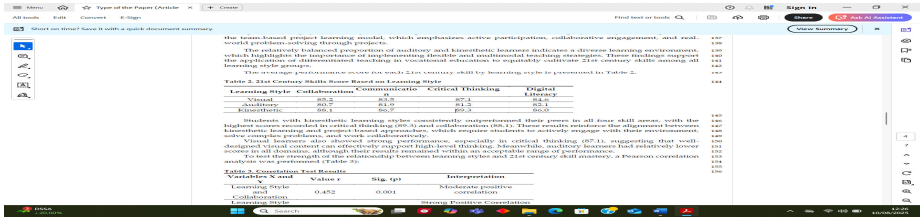
As presented in Table 1, the majority of 40% of college students identify as visual learners, which means they tend to understand and recall information more effectively through visual stimuli such as images, color codes, diagrams, and videos. This shows that learning materials delivered through visual formats—such as infographics, animations, and digital presentations—can significantly improve their engagement and learning outcomes.

Meanwhile, 30% of college students reported an auditory learning style, which indicates a preference for receiving information through listening. These learners generally perform better when engaging in lectures, discussions, oral explanations, and audio-based content. Learning strategies that emphasize group discussions, storytelling, or oral presentations are perfect for this type.

An additional 30% of college students are kinesthetic learners, who prefer hands-on experience and learn best through hands-on physical activity, object manipulation, and simulation. This learning style is very much aligned with the team-based project learning model, which emphasizes active participation, collaborative engagement, and real world problem-solving through projects.

The relatively balanced proportion of auditory and kinesthetic learners indicates a diverse learning environment, which highlights the importance of implementing flexible and multimodal teaching strategies. These findings support the application of differentiated teaching in vocational education to equitably cultivate 21st century skills among all learning style groups. The average performance score for each 21st century skill by learning style is presented in Table 2.

Table 2. 21st Century Skills Score Based on Learning Style

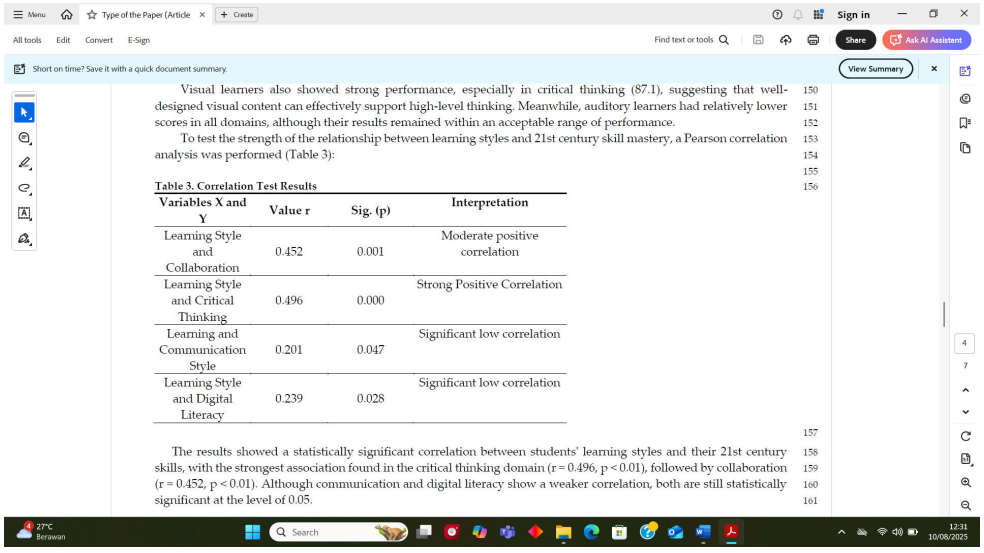


Students with kinesthetic learning styles consistently outperformed their peers in all four skill areas, with the highest scores recorded in critical thinking (89.3) and collaboration (88.1). These results reinforce the alignment between kinesthetic learning and project-based approaches, which require students to actively engage with their environment, solve complex problems, and work collaboratively.

Visual learners also showed strong performance, especially in critical thinking (87.1), suggesting that well designed visual content can effectively support high-level thinking. Meanwhile, auditory learners had relatively lower scores in all domains, although their results remained within an acceptable range of performance.

To test the strength of the relationship between learning styles and 21st century skill mastery, a Pearson correlation analysis was performed (Table 3):

Table 3. Correlation Test Results



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Variables X and Y	Value r	Sig. (p)	Interpretation
Learning Style and Collaboration	0.452	0.001	Moderate positive correlation
Learning Style and Critical Thinking	0.496	0.000	Strong Positive Correlation
Learning and Communication Style	0.201	0.047	Significant low correlation
Learning Style and Digital Literacy	0.239	0.028	Significant low correlation

The results showed a statistically significant correlation between students' learning styles and their 21st century skills, with the strongest association found in the critical thinking domain (r = 0.496, p < 0.01), followed by collaboration (r = 0.452, p < 0.01). Although communication and digital literacy show a weaker correlation, both are still statistically significant at the level of 0.05.

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These findings suggest that learning style is a meaningful factor in determining how students engage and successfully develop 21st century competencies, particularly in a collaborative, problem-based, and technology integrated learning environment. Thus, educators are encouraged to consider learning style preferences when designing project-based learning activities to maximize student engagement and learning outcomes.

4. Discussion

The findings of this study provide strong evidence that students' learning styles significantly influence the acquisition of their 21st century skills in a team-based project learning environment. The results showed that kinesthetic learners achieved the highest scores in all domains measured-collaboration, communication, critical thinking, and digital literacy- suggesting that learning by doing remains an important mechanism for deep learning, particularly in vocational education settings [11], [12].

This is in line with the theoretical foundation of experiential learning, which states that students learn best when they are actively involved in building knowledge through experience and reflection [13]. The project-based learning model, which requires students to solve authentic problems in teams, naturally caters to kinesthetic learners who thrive in a hands-on, interactive environment [14]. This supports the work of Kolb (1984) and more recent findings by Michaelsen et al. (2004), who advocate active learning design in higher education [13], [15].

Visual learners, who represent the largest proportion of the sample, also show strong performance, especially in critical thinking. This may be due to the presentation of complex tasks that are structured and visual in a project-based environment, such as the use of diagrams, digital workflows, and visual planning tools. Previous research has shown that visual scaffolding can improve analytical processing, especially in problem-solving and design-based disciplines [16], [17].

In contrast, auditory learners, while still achieving acceptable outcomes, showed the lowest overall performance. This suggests a possible mismatch between instructional delivery and their preferred learning style, especially in a learning environment that relies heavily on visual and tactile engagement [18]. Although group discussions and peer presentations are embedded in the project structure, they may not be enough to fully support auditory processing. This points to the need for a more balanced instructional approach that integrates verbal reflection, guided discussions, and audio-based resources [19].

The moderate to strong correlation between learning styles and skills such as collaboration and critical thinking underscores the idea that there is no one-size-fits-all approach to learning. These findings echo previous research by Felder and Silverman (1988), which emphasized the need to align teaching strategies with students' cognitive preferences to improve learning effectiveness [20]. In addition, the significant but weaker correlations found in communication and digital literacy imply that other mediating factors-such as previous exposure to technology, language fluency, or social-emotional competence-may also play an important role in shaping these competencies [21], [22].

From a pedagogical perspective, these results advocate adaptive and differentiated teaching in vocational education. Educators are encouraged to conduct learning style assessments at the beginning of the semester and design project assignments that accommodate diverse preferences. This can include providing multiple entry points to content (e.g., visual diagrams, audio commands, practice tasks), taking turns leadership roles in teams, and incorporating student choices in the way they demonstrate learning outcomes [23], [24].

Importantly, the implications of this study go beyond individual student preferences. They highlight the potential of team-based project learning not only as a method of knowledge transmission but also as a vehicle for skill development that aligns with real-world expectations [25]. As the industry increasingly demands adaptable,

collaborative, and digitally literate workers, educational institutions must ensure that teaching models are inclusive, flexible, and competency-oriented [3].

In summary, this study contributes to the growing body of literature advocating personalized and skill-integrated learning in vocational education. This study reinforces the idea that recognizing and responding to diversity of learning styles is not just a pedagogical issue-it is a strategic imperative to prepare students to succeed in an ever-evolving and 207 technology-driven world.

5. Conclusion

This study has shown a significant relationship between students' learning styles and their mastery of 21st century skills in the context of team-based project learning. In particular, kinesthetic learners outperformed their visual and auditory peers in terms of collaboration and critical thinking, highlighting the effectiveness of active and hands-on learning strategies in vocational education. The presence of varied learning style profiles among students also underscores the need for differentiated teaching and pedagogical flexibility to ensure equitable learning outcomes.

The findings suggest that learning style is not just an individual preference, but an important factor that shapes how students engage with content, interact in teams, and develop important competencies in the workplace. By integrating multimodal strategies into project-based learning environments, educators can better support diverse learners while improving the development of collaboration, communication, critical thinking, and digital literacy skills.

Ultimately, this study confirms that aligning pedagogical approaches with learners' cognitive preferences is a strategic step to achieve high-impact, skill-oriented vocational education. Future research may explore additional moderation variables such as motivation, prior knowledge, or team dynamics to further refine adaptive learning designs for the 21st century.

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