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AN ANALYSIS OF THE IMPACT OF DIFFERENTIATED INSTRUCTION ON ACADEMIC ACHIEVEMENT AMONG GRADE X STUDENTS IN VOCATIONAL EDUCATION

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Abstract: This study aims to investigate the effectiveness of implementing differentiated instruction in improving student learning outcomes in Informatics for Grade X students at a vocational high school. Employing a classroom action research design over two cycles, data were collected through learning outcome tests, student attitude observations, and documentation. Both qualitative and quantitative approaches were utilized in data analysis. The findings reveal that the implementation of differentiated instruction was moderately effective, with an average N-Gain score of 75.6%. There was a significant improvement in student learning outcomes following the application of differentiated instructional methods. Quantitative analysis supported the effectiveness of this approach, as evidenced by a t-test value of 6.256 with 66 degrees of freedom and a significance level of < 0.001, thereby rejecting the null hypothesis (H_0). These results indicate that differentiated instruction can significantly enhance student engagement and academic performance, particularly in subjects such as Informatics that require logical and rapid thinking skills. The study underscores the crucial role of instructional innovation and teacher management strategies in addressing diverse student needs and optimizing learning outcomes. It recommends the broader application of differentiated instruction to enhance teaching quality and student achievement in vocational education contexts.

Keywords: innovation, instructional management, differentiation, learning outcomes

INTRODUCTION

In the 21st century, education must equip students with more than cognitive knowledge; it must foster critical thinking, collaboration, and adaptability in response to rapid technological change. Informatics is one of the essential subjects that directly supports these competencies. In the Indonesian education system, Informatics is taught from elementary to tertiary levels, indicating its fundamental role in preparing students for a digital and technology-driven society[1], [2].

Despite its relevance, student achievement in Informatics remains unsatisfactory. Learners often struggle to understand abstract and algorithmic concepts, which demand logical and structured thinking. This issue is exacerbated by the use of conventional, teacher-centered instructional methods[3]. These methods typically ignore students' individual learning preferences and readiness, resulting in passive learning, low motivation, and suboptimal outcomes[4], [5].

Differentiated instruction has emerged as a potential solution to this challenge. It involves adapting the content, process, and product of learning based on students' readiness, interest, and learning profiles. This model encourages personalized learning experiences and aims to create more inclusive and effective classroom environments. Differentiated instruction has been proven to improve student engagement and learning outcomes by aligning instruction with the learners' needs[6], [7].

Recent studies support this instructional approach. Tong and Singh [2] conducted a meta-analysis of literature from 2015 to 2024 and confirmed that differentiation in content, process, and product significantly influences both student achievement and perception in higher education settings. Their findings suggest that differentiated instruction enhances academic outcomes and promotes meaningful learning experiences[8]. In a related study, Khatri et al. [9] examined the impact of differentiated instruction on English Language Learners and found that it plays a critical role in improving academic performance by accommodating diverse linguistic and cognitive needs.

These findings highlight the relevance of differentiated instruction in vocational education contexts, where student diversity in interest, ability, and prior knowledge is prominent. Teachers must shift from being mere content deliverers to learning facilitators and instructional strategists. Effective instructional design must address learner variability to improve academic performance, especially in subjects like Informatics, which demand both technical and cognitive skills.

This study aims to investigate the effectiveness of differentiated instruction in improving learning outcomes among Grade X students in the Informatics subject. Using a classroom action research (CAR) model, this study examines the quantitative and qualitative impacts of differentiated strategies on student achievement. The findings are expected to provide empirical support for differentiated instruction as a viable model to enhance educational quality and student success in vocational high schools.

RESEARCH METHOD

This study employed a Classroom Action Research (CAR) methodology conducted over two cycles, following the model proposed by Kemmis and McTaggart[10]. Each cycle consisted of four stages: planning, acting, observing, and reflecting. The goal was to enhance learning outcomes through the implementation of differentiated instruction tailored to student diversity[11], [12].

The participants were 67 Grade X students enrolled in an Informatics course at a vocational high school. A purposive sampling technique was used, based on identified instructional challenges and prior student performance[13].

Data were collected using three primary instruments:

1. Learning Outcome Tests – Pre-tests and post-tests were administered during each cycle to measure cognitive gains. The tests were aligned with course objectives and focused on core Informatics competencies.
2. Observation of Student Attitudes – Student engagement and participation were monitored through structured observation checklists during the learning activities.
3. Documentation – Supporting data were gathered from lesson plans, instructional materials, student worksheets, and teacher field notes to ensure triangulation[14], [15].

A mixed-methods analysis approach was applied:

a. Quantitative data from test scores were analyzed using the Normalized Gain (N-Gain) formula[16], [17]:

$$N\text{-}Gain = \frac{\text{Post-test} - \text{Pre-test}}{\text{Maximum score} - \text{Pre-test}}$$

A paired-sample t-test was conducted using SPSS to determine the statistical significance of improvements, with a confidence level of 95% ($p < 0.05$).

b. Qualitative data from observations and documentation were analyzed using thematic analysis. Data reduction and categorization were employed to interpret behavioral changes and student responses to the intervention[18].

The criteria for success included:

a. A minimum average N-Gain score of 0.3, classified as a moderate improvement.
b. At least 75% of students actively participating in the differentiated learning process based on observational indicators[19].

RESULTS AND DISCUSSION

1. Results of Learning Outcome Tests

The results from both cycles demonstrate a clear improvement in students' learning outcomes after the implementation of differentiated instruction. In Cycle I, the average pre-test score of 58.2 increased to 74.1, with an N-Gain of 0.52, categorized as moderate. In Cycle II, the post-test average rose to 83.7, producing an N-Gain of 0.75, which is classified as high. This indicates that differentiated instruction substantially enhanced students' cognitive understanding of Informatics concepts.

According to Bloom's Taxonomy, learning outcomes at the cognitive domain are more effectively achieved when instruction is aligned with students' developmental readiness and learning styles. Tomlinson's theory of differentiated instruction supports this by proposing that modifying content, process, and product based on individual learner profiles increases instructional effectiveness. The improvement in student outcomes across both cycles reflects the increasing efficacy of differentiated strategies when applied consistently and responsively.

These findings are also consistent with Vygotsky's Zone of Proximal Development (ZPD), which emphasizes that students perform best when instructional tasks are situated just beyond their current level and supported with scaffolding [20], [21]. Differentiated instruction acts as this scaffold, providing appropriate challenge and support to meet learners where they are.

Empirical support for these interpretations is found in the meta-analysis conducted by Tong and Singh [2], which demonstrated that differentiated instruction—across content, process, and product—significantly enhances both achievement and learning perception in higher education. Although the present study was conducted at the vocational high school level, the instructional mechanisms and outcomes are comparable, particularly when addressing cognitive diversity.

Moreover, Khatri et al. [9] found that differentiated instruction had a profound impact on the academic performance of English Language Learners. This supports the notion that differentiation is particularly effective in classrooms with high variability in student readiness and background, as is typical in vocational education.

The upward trajectory in post-test scores also suggests increased student familiarity and comfort with differentiated tasks, reinforcing the idea that differentiation is not a one-time strategy but a continuous process that evolves with classroom dynamics. As students adapt to personalized approaches, their engagement and achievement tend to improve.

In conclusion, the observed gains provide strong empirical support for the application of differentiated instruction in improving learning outcomes. The findings are grounded in established learning theories and supported by recent research, affirming the value of this approach in addressing learner diversity and promoting academic success in secondary vocational education.

2. Statistical Analysis

The effectiveness of differentiated instruction was further validated through inferential statistical analysis using a paired-sample t-test. The test was conducted to determine whether the improvement in students' learning outcomes between the pre-test and post-test was statistically significant. The result showed a t-value of 6.256 with 66 degrees of freedom, and a significance value (p) < 0.001, which is well below the conventional alpha level of 0.05. Therefore, the null hypothesis (H_0)—which states that there is no significant difference between the pre-test and post-test scores—is rejected.

This statistical result confirms that the increase in post-test scores was not due to chance, but rather a result of the applied instructional intervention. The magnitude of the t-value also suggests a strong effect, reinforcing the impact of differentiated strategies on measurable academic outcomes.

From a theoretical perspective, the use of statistical validation aligns with best practices in evidence-based education, where instructional innovations must be supported not only by qualitative observation but also by robust

quantitative analysis [22]. The result aligns with Bloom's Mastery Learning Theory, which posits that with appropriate instructional strategies and sufficient time, nearly all students can achieve a high level of understanding [23]. Differentiated instruction provides the necessary variance in time and method, enabling students to learn at a pace and in a style that suits them.

Moreover, statistical significance is only one part of the equation; practical significance must also be considered. In this case, the N-Gain improvement from 0.52 to 0.75, along with the statistically significant t-test result, shows both strong quantitative and pedagogical impact. This dual confirmation is essential in classroom action research, which aims not just to observe change but to demonstrate that the change is meaningful, replicable, and instructionally grounded.

The findings further affirm conclusions from Tong and Sing, who, in their meta-analysis, emphasized the importance of differentiated instruction in consistently producing statistically significant improvements across educational levels. Similarly, Khatri et al. highlighted that measurable gains in student performance can be expected when instruction is responsive to learner variability, a core principle of the differentiated approach.In conclusion, the statistical analysis substantiates the claim that differentiated instruction significantly enhances academic performance. This not only validates the methodology used in this study but also provides a reliable model for broader application in diverse educational settings[24].

3. Observation of Student Attitudes

Observational data showed a positive trend in student engagement and participation across both cycles. In Cycle I, 68% of students demonstrated active learning behaviors, such as asking questions, participating in discussions, and completing tasks independently. This figure increased to 84% in Cycle II, indicating a significant behavioral shift toward more active and self-regulated learning.

Students responded positively to the varied learning activities, which included tiered tasks, flexible grouping, and choice-based assignments. These differentiated strategies allowed students with different readiness levels to access the content in meaningful ways.

4. Interpretation and Discussion

The results align with previous studies on the benefits of differentiated instruction. Tong and Singh [2] highlighted the significant influence of content, process, and product differentiation on learning outcomes in higher education. Similarly, Khatri et al. [9] emphasized that differentiation is particularly effective for diverse learners, including those with varying academic backgrounds or language proficiency.

In this study, differentiated instruction improved not only cognitive outcomes but also affective engagement. Students reported feeling more confident and motivated when learning materials matched their ability levels and interests. The combination of tiered content and student-centered activities provided meaningful scaffolding and increased ownership of the learning process[25].

The success of this intervention also underscores the importance of teacher instructional management. Teachers must have the capacity to diagnose student needs, design differentiated materials, and facilitate a flexible learning environment. When these components are well-executed, differentiation becomes a powerful tool to enhance academic achievement.

5. Limitations and Further Research

Although the study yielded positive results, it was limited to one subject (Informatics) and a single class context. Further research across multiple subjects, grade levels, and school types is recommended to validate the generalizability of these findings. Additionally, exploring digital tools to support differentiation may further enhance its scalability and efficiency in modern classrooms[26], [27], [28].

While this study provides encouraging evidence of the effectiveness of differentiated instruction, its scope was limited to a single subject area—Informatics—and focused solely on one class at the Grade X level. This narrow focus restricts the generalizability of the findings across broader educational contexts. Differences in subject matter, curriculum demands, and student cognitive profiles may produce different outcomes if the same instructional model were applied in disciplines such as Mathematics, Language, or Social Sciences. Moreover, the success of the intervention was influenced by the specific characteristics of the class and the teacher's ability to implement differentiation effectively[29], [30], [31], [32].

Future research is recommended to expand the application of differentiated instruction across multiple subject areas and educational levels to examine whether similar improvements in learning outcomes occur[33], [34], [35], [36], [37], [38]. Additionally, studies involving different school environments—including urban, rural, and inclusive education settings—can offer richer insights into contextual adaptability. Given the increasing integration of technology in education, it is also essential to investigate the role of digital tools and learning platforms in facilitating and scaling differentiation practices. Digital support systems, such as adaptive learning software or learning management systems (LMS), could offer dynamic solutions for managing diverse learner needs more efficiently in the 21st-century classroom.

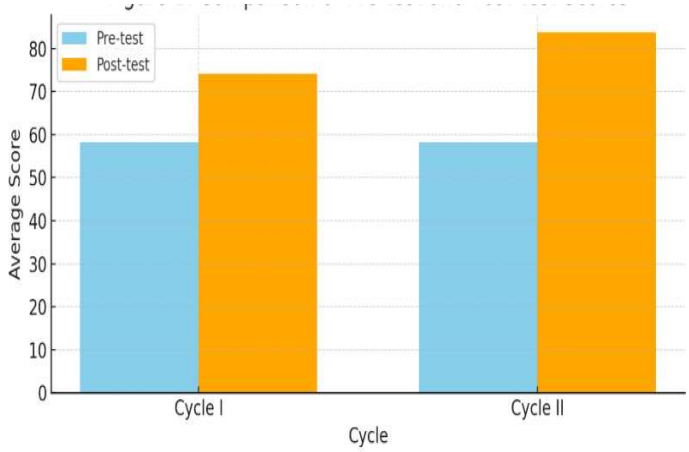

Figure 1. Comparison of Pre-test and Post-test Scores

This graph shows a significant improvement in student learning outcomes following the implementation of the differentiated instruction model. In Cycle I, the average score increased from 58.2 to 74.1, while in Cycle II, the post-instruction score rose further to 83.7. This improvement reflects the effectiveness of the differentiation approach in facilitating better academic achievement, as supported by the N-Gain analysis and statistical testing.

CONCLUSION

This study concludes that the implementation of the differentiated instruction model is proven effective in improving student learning outcomes in the subject of Informatics. Conducted through a two-cycle classroom action research design, the intervention led to a significant and consistent improvement in cognitive achievement among students.Quantitative findings revealed that the students' average scores increased steadily from the first to the second cycle, with N-Gain scores progressing from moderate to high categories. The paired-sample t-test also indicated statistically significant results, confirming that the improvement was meaningful and not due to random chance.

Qualitative data supported these outcomes, showing increased student engagement, participation, and motivation during differentiated learning activities. Students responded positively to instructional strategies that were tailored to their individual needs, readiness levels, and interests.Therefore, differentiated instruction not only enhances academic performance but also fosters more inclusive and meaningful learning experiences. Teachers are strongly encouraged to integrate differentiated strategies in a structured and continuous manner, especially in diverse classrooms.This research was conducted in Class X of SMK Negeri 6 Kota Batam, located in Kota Batam, Kepulauan Riau, Indonesia. The findings confirm that differentiated instruction is both applicable and impactful in this educational context and can serve as a model for other similar institutions.

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