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ENHANCING LEARNING HUMAN BODY SYSTEMS THROUGH THE INTEGRATION OF DIFFERENTIATED INSTRUCTION IN SIXTH GRADE

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ABSTRACT

The research aims to evaluate the effectiveness of integrating differentiated instruction to enhance the learning of human body systems in science among sixth-grade students. By exploring the current state of science education, the study identifies challenges related to instructional methods and resource availability, as well as the impact of outdated or insufficient teaching materials. It proposes solutions to bridge learning gaps and develop more engaging science instruction strategies that enhance student understanding and performance in elementary education. The study focuses on seamlessly integrating differentiated instruction into the lesson's application part. By tailoring instruction to diverse learning needs, the study examines whether differentiated instruction improves students' understanding and retention of the subject matter. An experimental research design was used with 26 Grade 6 students receiving differentiated instruction based on multiple intelligences. The results showed a significant improvement in the experimental group's performance after the intervention. The post-test results yielded an average score of 87.81, considered very satisfactory. The t-value of 12.578 and a p-value of 0.000 confirm that the difference in scores is statistically significant, indicating the effectiveness of differentiated instruction in improving student learning outcomes. This study has important implications for educators and school administrators, demonstrating that the integration of differentiated instruction in science lessons effectively enhances student learning and can be used as a model for future teaching strategies.

Keywords: Differentiated Instruction, Multiple Intelligences, Human Body System, Science Proficiency, Elementary Education.

I. INTRODUCTION

Science learning poses significant challenges for many students due to the abstract and complex nature of its concepts, as well as the mathematical reasoning often required (Anderman & Sinatra, 2022; Byukusenge et al., 2023). These difficulties contribute to students' perceptions of science as a particularly daunting subject (Rogayan et al., 2021). Consequently, many learners struggle to meet the minimum proficiency requirements, frequently achieving scores just at the passing level, around 75% (Al-Tameemi et al., 2023). Such struggles highlight the need for strategies to enhance student engagement and understanding in science education (Fisher & Frey, 2021).

Globally, diminishing interest in science, particularly at the primary level, is a well-documented concern. Research emphasizes the importance of early exposure to engaging and meaningful science experiences to sustain interest, which often peaks before adolescence (Habig & Gupta, 2021). Effective elementary science education should integrate hands-on activities, real-world applications, and collaborative discussions to nurture curiosity and understanding (Main, 2023).

In the Philippines, the performance of students in science remains alarmingly low. Based on OECD data, only 7% of Filipino students demonstrated high proficiency (Level 5 or 6), which involves applying scientific knowledge creatively and independently in diverse and unfamiliar situations (Organisation for Economic Co-operation and Development, 2023). Such findings underscore the urgency of addressing foundational gaps in science education (Department of Education, 2019).

Differentiated instruction remains a debated approach in addressing diverse learning needs. Critics, such as Tomlinson (2021), question its practicality in large, heterogeneous classrooms, particularly in resource-constrained settings. However, it identifies that differentiated strategies, such as formative assessments and feedback, as highly effective when implemented with precision (Stanja et al., 2023). Thus, it also highlight its potential to promote inclusivity, enabling educators to meet students at their individual levels and foster personalized learning experiences (Bernacki et al., 2021). While not without challenges, differentiation offers a pathway to enhance student engagement and achievement in science education (Hunaepi et al., 2024).

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To address the challenges in science education, a multi-faceted approach is required. Early exposure to engaging learning experiences, paired with inquiry-based and differentiated teaching methods, can transform how students perceive and perform in science (Habig & Gupta, 2021). Emphasizing teacher training and resource allocation is essential, particularly in under-resourced educational systems like the (Wagner et al., 2022). As the world increasingly demands scientific literacy and innovation, implementing these strategies is vital to equipping learners with the skills and curiosity needed to navigate and shape their futures (Hunaepi et al., 2024).

This study explores the potential of incorporating differentiated instructional strategies to enhance the teaching of the human body system among sixth-grade students at Cateel Central Elementary School. Despite the ongoing debate, this research investigates how thoughtfully designed, multimodal activities tailored to students' varied learning preferences might influence science learning outcomes. The findings aim to contribute to the discourse on effective strategies for improving elementary science education, particularly in contexts where proficiency remains low.

II. METHODS

Research Design

This paper utilized an experimental research design. As a scientific research method, experimental research involves manipulating one or more independent variables while controlling other potentially affecting factors to observe and measure the effects on dependent variables (Hill et al., 2021).

The research study focused exclusively on an experimental group composed of Grade 6 students from Cateel Central Elementary School. This design facilitated a thorough exploration of the effects of differentiated instruction on enhancing learning human body system in the subject of Science. By concentrating solely on this group, the study aimed to establish causal links between the independent variable (differentiated instruction) and the outcomes, enhancing the validity and reliability of the findings.

One of the key strengths of experimental research is its ability to replicate studies, which reinforces the reliability of the results. Replication involves repeating an experiment under the same conditions to verify the original findings, thereby solidifying the empirical evidence for the observed effects (Shadish et al., 2002). This replicability is crucial for advancing knowledge, as it ensures that findings are not merely the result of random chance or specific to a particular sample or context.

Research Respondents

The study aimed to test the effectiveness of an intervention by working with ten (26) Grade 6 students. The respondents included Bodily-kinesthetic intelligence is the most prevalent, demonstrated by nine students excelling in physical activities and movement-based learning, followed by interpersonal intelligence with seven students adept at social interactions, while verbal and logical-mathematical intelligences are equally represented with five students each, showcasing balanced proficiency in language skills and logical reasoning.. These students were selected based on their primary l multiple intelligences identified through standardized assessments. Random sampling within each multiple intelligence categories ensured proportional representation. Inclusion criteria required students to be in Grade 6 and have parental consent.

The study employed an experimental research design focused solely on the experimental group, which received differentiated instruction as the intervention. This intervention was delivered during class our structured to enhance learning in human body system. By systematically applying the intervention and comparing the students' learning human body system before and after the intervention, the researcher aimed to observe the cause-and-effect differences attributable to the intervention.

All respondents were administered pre-test and post-test questionnaires, and only those who completed both tests were included in the final analysis. To ensure data validity, respondents who were absent during the post-test but completed the pre-test were excluded from the analysis.

Research Locale and Duration

The study was conducted at Cateel Central Elementary School, Castro Avenue, Poblacion, Cateel, Davao Oriental as the study area because the researcher was completing their practice teaching internship there. This connection provided the researcher with an in-depth understanding of the school environment and allowed for easier access to participants, which facilitated smoother data collection and engagement throughout the study.

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The intervention or data gathering from the respondents was completed in May 2024. The respondents were given a two-week intervention consisting of five weekly sessions.

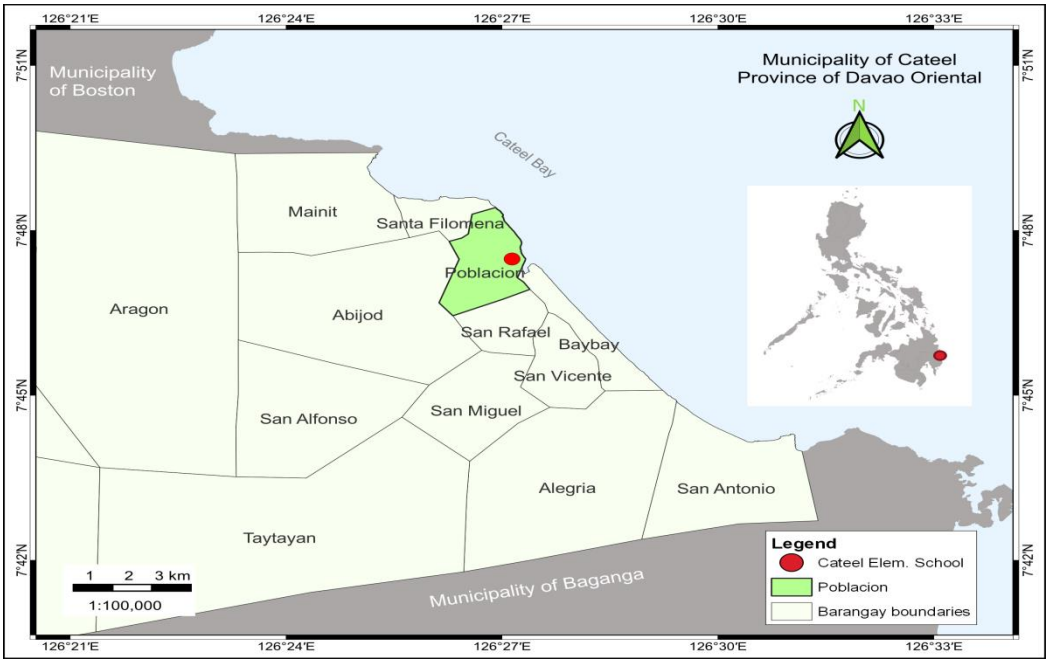

Figure 1. Map showing Cateel Central Elementary School (CCES)

Research Instrument

In this study, the learning competency focused on explaining how the organs of each organ system work together, coded as S6LT-IIa-b-1 in the K to 12 Science Curriculum Guide. A specialized research instrument was developed and subjected to rigorous validation and reliability checks to evaluate this competency. Content validity was established using Aiken's V coefficient, with expert ratings on the instrument's alignment with learning outcomes, essentiality, and item quality, achieving a high coefficient of 0.91 (Sireci and Bond, 2014). Reliability was assessed using Cronbach's alpha, resulting in a coefficient of 0.60 (Ahdika, 2017), indicating acceptable consistency. These assessments underscored the instrument's robustness, confirming its ability to accurately and consistently measure students' understanding through pre-test and post-test evaluations. The rigorous validation and reliability processes ensure that the instrument effectively measures the intended learning outcomes, providing a reliable tool for assessing student progress in understanding the collaborative functions of organ systems.

Data Collection

The data collection process for this study began with obtaining ethical clearance from the Research Ethics Office. The researcher submitted all necessary documents, including the research proposal, questionnaires, informed consent forms, curriculum vitae, and a list of potential risks with corresponding solutions. Once approval was granted, the questionnaires were reviewed by three experts to ensure content validity. The experts' feedback was analyzed, resulting in a high validity score, indicating that the questionnaires were suitable for assessing learning competency.

Next, a pilot test was conducted at San Rafael Integrated School to test the reliability of the questionnaires. The results were analyzed using Cronbach's alpha, which showed acceptable consistency for the tool's intended purpose. Following this, the researcher sought permission from the School Principal of Cateel Central Elementary School to conduct the research. Upon approval, letters were submitted to class advisers, outlining the study objectives and requesting permission to use the research tool with students. The respondents of this research were 24 Grade 6 students from Cateel Central Elementary School, selected through a complete enumeration sampling technique. In this method, the entire class was chosen to participate, ensuring that all students received the intervention as part of the study.

The data collection process involved administering pre-test questionnaires to evaluate the students' initial performance in science. Subsequently, the respondents took a multiple intelligence test to identify their dominant intelligence. Based on these results, the researcher conducted an intervention, providing

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differentiated instruction tailored to each student's multiple intelligences. After the intervention, post-test questionnaires were administered to assess any improvements in performance. Finally, the post-test questionnaires were collected, totaled, encoded, analyzed, and interpreted to draw conclusions from the study.

III. DATA ANALYSIS

Content Validity. The content validity of the tool was determined using Aiken's V coefficient. This statistical measure reflects the degree of consensus among experts regarding the relevance of each item to the learning objectives, its necessity, and the overall quality of the items included in the tool. In this study, the calculated Aiken's V coefficient was 0.91, which indicated a strong level of validity. A value this high suggests that the tool was well-aligned with the intended learning objectives and was highly relevant for assessing the participants' knowledge and skills, as supported by the work of Sireci and Bond (2014).

Reliability. The reliability of the tool was assessed using Cronbach's alpha, a widely used measure of internal consistency. The tool achieved a Cronbach's alpha value of 0.60 (Ahdika, 2017), indicating an acceptable consistency for its intended use. This value indicates that the tool consistently measured what it was intended to measure across different items and participants. The high reliability score suggests that the tool was stable and produced dependable results, which is essential for ensuring that the data collected accurately reflects the participants' learning achievements, as noted by Ahdika (2017).

Mean. The mean was calculated to address the first and third statements of the problem. This statistical measure provided an average score that was then transmuted to the Department of Education (DepEd) grading system for interpretation. The DepEd grading scale, outlined in Table 1, was used to interpret the mean scores. The grading scale classified the scores into categories such as Outstanding (90-100), Very Satisfactory (85-89), Satisfactory (80-84), Fairly Satisfactory (75-79), and Did Not Meet Expectations (Below 75). This conversion allowed for a standardized interpretation of the results, making it easier to assess the participants' performance relative to established benchmarks.

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Table 1. K to 12 grading scale and interpretation

GRADING SCALE	INTERPRETATION
90 – 100	Outstanding
85 – 89	Very Satisfactory
80 – 84	Satisfactory
75 – 79	Fairly Satisfactory
Below 75	Did Not Meet Expectations

T-test. The T-test was utilized to analyze whether there were significant differences between the pre-test and post-test scores of the control and experimental groups. This statistical test was crucial in addressing the second and fourth statements of the problem. By comparing the means of the two groups before and after the intervention, the T-test determined whether the instructional methods had a statistically significant impact on the participants' performance. The interpretation of the T-test results was based on the p-value, as shown in Table 2. If the p-value was less than 0.05, it indicated a significant difference between the groups, suggesting that the intervention had a notable effect. If the p-value was 0.05 or greater, it suggested no significant difference, indicating that the instructional methods did not have a substantial impact on the outcomes, as described by Brianne (2018).

Table 2. Table of interpretation

p-value	INTERPRETATION
Less than 0.05	There is a significant difference.
0.05 or more	There is no significant difference.

IV. RESULTS

Results on Multiple Intelligence

Table 3. Summary of students' multiple intelligences

Multiple Intelligences	Frequency
Bodily-kinesthetic	9
Interpersonal	7
Verbal	5
Logical-Mathematical	5

Table 3 shows the distribution of students' multiple intelligences within the study group. The data indicates that Bodily-kinesthetic intelligence is the most common among students, with nine out of twenty-five demonstrating a strong proficiency in physical `activities and learning through movement. Interpersonal intelligence follows, with seven students excelling in social interactions and understanding others' emotions. Both Verbal and Logical-Mathematical intelligences are equally represented, with five students in each category. This distribution highlights the diverse intellectual capabilities within the group, emphasizing the need for teaching strategies that accommodate these varied strengths.

Level of Pre-test Scores

This section presents the respondents' pre-test scores. The pre-test was carried out to collect data for the learners' pre-test results for this paper. The purpose of the pre-test was not only to determine the students' science proficiency and prior knowledge but also to ascertain their overall performance on the test. Table 4 displays the pre-test score level.

Table 4. Level of pre-test scores

Score Interval	Frequency	Percentage	Standard Deviation	Mean	Grade Percentage	Remarks
5 and below	8	32.00	2.74	7.44	67.71	Did not meet Expectations
6-10	12	48.00				
11-15	5	20.00				
16 and above	0	0.00				
Total	25	100.0				

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Table 4 presents the pre-test scores of the respondents, showcasing their initial understanding of the human body system. The results reveal that a significant portion of the students did not meet the expected standards. Specifically, 32% of the students scored 5 or below, and 48% scored between 6-10. No student scored above 15, indicating a clear gap in their prior knowledge and proficiency in the subject.

Level of Post-test Scores

Following the intervention, the respondents' post-test results were ascertained. The respondents received instruction using differentiated instruction or teaching methodology.

The findings presented in Table 5 indicate that participants' post-test scores were very satisfactory. This means that the intervention used affects the respondents' scores and can be deemed as helpful as it is.

Table 5. Level of post-test scores

Score Interval	Frequency	Percentage	Standard Deviation	Mean	Grade Percentage	Remarks
5 and below	0	0.00				
6-10	0	0.00				
11-15	7	28.00	1.17	15.88	87.81	Very Satisfactory
16 and above	18	72.00				
Total	25	100.0				

After implementing differentiated instruction, Table 5 shows a marked improvement in the students' post-test scores. The majority, 72%, scored 16 or above, and none of the students scored below 11. The mean score increased significantly from the pre-test mean of 7.44 to a post-test mean of 15.88. This result suggests that the differentiated instruction effectively enhanced the students' understanding of the human body system.

Difference between Pre-test and Post-test Score

The post-test and pre-test results for the respondents were computed and compared after the intervention. The mean comparison between the pre-test and post-test of the participants is presented in Table 6.

Based on the table, the post-test scores between the control and experimental groups differ significantly, indicating improved learning proficiency. The results suggest a substantial difference in pre-test and post-test scores, showing that differentiated instruction increases learners' ability to understand the human body system in science.

Table 6. Mean comparison between pre-test and post-test scores

Group	Mean	Standard Deviation	t-value	p-value	Interpretation
Pre-test	7.44	2.74			
Post-test	15.88	1.17	12.578	0.000	Post-test scores between the two groups differ significantly.

Table 6 presents a comparison between pre-test and post-test scores. The results demonstrate a substantial improvement, with a significant increase in the mean score from 7.44 to 15.88. The standard deviation decreased from 2.74 to 1.17, indicating more consistent performance among the students after the intervention. The t-value of 12.578 and a p-value of 0.000 confirm that the difference in scores is statistically significant, highlighting the effectiveness of differentiated instruction in improving student learning outcomes.

V. DISCUSSION

The results of this study underscore the importance of incorporating diverse teaching strategies, particularly differentiated instruction, to address the varied intelligences of students. The findings align with Howard Gardner's theory of multiple intelligences, which posits that individuals possess different kinds of intellectual strengths (Gardner, 2013). In this study, students with Bodily-kinesthetic and Interpersonal intelligences, the most frequently observed with 9 and 7 students respectively, showed significant improvement in post-test

scores when instructional methods were tailored to their strengths, while students with Verbal and Logical-Mathematical intelligences, each represented by 5 students, also benefited from approaches aligned with their unique abilities.

The low pre-test scores reflect challenges in science education, consistent with global reports that highlight a learning gap in Filipino students (Clarke, 2022; Desmon, 2022). The lack of adequate resources, such as laboratories and teaching materials, further exacerbates this issue, making it difficult for students to grasp complex scientific concepts (Akuma and Callaghan, 2016; Sarangapani, 2018; Chala, 2019). Socioeconomic factors also play a crucial role, with students from low-income families facing additional barriers to accessing quality education (Bernardo, 2021; Moscoviz and Evans, 2022).

The significant improvement in post-test scores following the implementation of differentiated instruction supports the effectiveness of this approach in enhancing student learning. Differentiated instruction aligns with the students' dominant intelligences, facilitating a deeper understanding of the material (Anwer, 2019; Freedman, 2015). Activities tailored to these intelligences—such as hands-on experiments for Bodily-kinesthetic learners or collaborative tasks for Interpersonal learners—contribute to higher engagement and better retention of knowledge (Garzón et al., 2020; Onyishi and Sefotho, 2020).

Moreover, the success of differentiated instruction in this study is consistent with findings from other research that emphasize its ability to address diverse learning needs and improve academic outcomes (Jones, 2017; Tank and DuPont, 2020; Olanrewaju Adebisi, 2021). By providing personalized attention and feedback, differentiated instruction helps bridge the learning gap, particularly in resource-limited settings (Essa et al., 2023).

In conclusion, the results of this study reinforce the value of differentiated instruction in science education. By catering to the diverse intelligences of students, educators can create more inclusive and effective learning environments, ultimately leading to improved academic performance and a deeper understanding of scientific concepts.

VI. CONCLUSION

The study highlights the significant impact of differentiated instruction on students' understanding of the human body system, emphasizing its importance in science education. Differentiated instruction, which tailors teaching methods to meet diverse learning needs, proves to be more effective than traditional approaches, as evidenced by the substantial improvement in post-test scores. This method not only enhances student engagement and motivation but also addresses educational equity by providing all students, regardless of their socioeconomic background, with the opportunity to succeed in complex subjects like science.

Based on these findings, it is recommended that schools invest in professional development for teachers to equip them with the skills necessary to implement differentiated instruction effectively. Additionally, integrating technology into the classroom can further support personalized learning, making lessons more engaging and accessible. Regular assessment and feedback mechanisms should also be established to monitor and adjust instructional strategies, ensuring they continue to meet the diverse needs of all students.

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