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Level of Conceptual Understanding in Electricity and Magnetism Among Grade 10 Students

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ABSTRACT

In this 21st century learning, the trend in pedagogy is more akin to constructivism and progressivism as opposed to the more traditional essentialist. The purpose of this study is to determine the level of conceptual understanding of Grade 10 students in electricity and magnetism, and to examine how this understanding correlates with variables such as age, gender, and their latest grade in science. The respondents were fifty-eight Grade 10 students from Mindanao State University- Integrated Laboratory School (MSU-ILS) enrolled during the academic year 2018-2019. This study utilized a descriptive-correlation method of research. The 50-item questionnaire was administered to the respondents through stratified random sampling. The statistical tools used were frequency and percentage, weighted mean and standard deviation, Pearson Correlation, and Point Biserial Correlation Coefficient. The gathered data were statistically analyzed and interpreted. The findings revealed that majority of the respondents were 17 years old, female, and had a grade of 82.00 which was described as fair or satisfactory. The respond-ents obtained mean score of 37.52 for male and 36.85 for female during their midterm examination which indicates that their level of conceptual understanding is average. Furthermore, the findings depicted that there is no significant relationship between the respondents' profile and their level of conceptual understanding. Based on the empirical results of the study, the average level of conceptual understanding in electricity and magnetism is only fair/satisfactory, it is recommended that educators develop targeted interventions to improve this understanding. This could include interactive simulations, practical laboratory experiments, and inquiry-based learning activities specifically designed to enhance conceptual clarity.

Keywords : conceptual understanding, electricity, magnetism

1. Introduction

Educators should focus more on helping students develop their science skills when teaching Science than just memorizing facts. Teachers incorporate problem-based learning, educational technology, and project-based learning in their classrooms to enhance the learning of science. Teaching Science can be challenging for educators in ensuring students retain the knowledge they acquire (Mbonyiryivuze and Yadav, 2019).

Furthermore, comprehending scientific concepts require students articulate phenomena within the contexts they are studying. They need to understand the methods scientists use and how scientific knowledge progresses as essential components of their science education (Jones, 2019).

Educators continue to face challenges in accurately assessing student achievement and identifying those who may need additional support in learning. Understanding these challenges is crucial for developing effective educational strategies tailored to addressing these issues. For instance, recent research by Smith (2021) emphasizes that true understanding occurs when students can apply concepts confidently and adaptively, allowing for continuous refinement of their understanding. Moreover, as highlighted by Brown and Anderson (2020), the primary goal of education remains centered on deepening students' understanding of concepts by establishing meaningful connections that expand upon their existing knowledge within specific contexts. This approach not only cultivates critical thinking abilities but also encourages students to construct coherent frameworks of interconnected ideas.

Various factors such as age, gender, and academic performance in science shape students' conceptual understanding levels. Recent research suggests that age can influence success levels; however, its impact tends to lessen as students advance through their journey. For instance, a study conducted by Falk and Needham (2020) suggests that although younger students may initially face challenges with concepts, the impact of age on achievement diminishes over time due to educational experiences that offer equal opportunities.

Regarding gender differences, the research presents conflicting findings. McCulloughs (2020) indicates that female students often exhibit understanding of physics topics like electricity and magnetism. This observation aligns with trends reported by Dalit (2021), who found that girls excel over boys in academics, particularly in science subjects. However, other studies, like those by Adams and Brissenden (2019), suggest that gender does not influence comprehension of concepts. This implies that the role of gender may vary based on study contexts and methodologies.

Academic performance, typically assessed through grades, significantly impacts comprehension. Woessmann (2020) argues that while grades motivate students to learn, improper use can negatively affect their motivation and engagement. This is because students prioritize achieving grades over grasping the material. As a result, a student's recent science grade may only partially represent their understanding of topics such as electricity and magnetism. Fauth (2019) stress the importance of comprehension going beyond memorization. It involves applying knowledge across situations and developing a critical understanding of the subject matter. Electricity and magnetism are elements in physics at secondary and tertiary levels (Reif, 2021). Students must understand these concepts to enhance their overall scientific literacy. Research on students' grasp of magnetic fields has influenced the creation of teaching methods and evaluation tools to enhance comprehension and retention (Li & Singh 2019).

Conversely, learning about electricity and magnetism poses a task in science education. Investigations into students' understanding of magnetic fields have contributed to the design of teaching strategies, educational approaches, and assessment methods (Li & Singh 2019). These topics are considered components in physics and science curricula at primary through education levels (Reif, 2021). Previous research findings reveal varying levels of student performance in these areas, underscoring the necessity for exploration to enhance outcomes. In real life, it has been observed that many students face challenges grasping the ideas related to magnetic fields, which can significantly impact their performance in physics classes (Smith, Jones, & Clark, 2020).

The existing gap in this study highlights the necessity to delve deeper into these subjects. Initial data indicates that students often need help understanding concepts of electricity and magnetism. For instance, a recent study conducted by Brown and Finn (2020) discovered that 30% of high school students could accurately describe how electric currents and magnetic fields are interconnected. These results imply a deficiency in students' knowledge that requires exploration.

2 METHODOLOGY

2.1 RESEARCH DESIGN

The study used a quantitative descriptive-correlational design to explore the relationships among variables. It aimed to determine the demographic profile of Grade 10 students, including age, gender, and their latest grade in science, and to assess their level of conceptual understanding of electricity and magnetism. Furthermore, the study investigated the associations between students' profiles and their conceptual understanding. To analyze these relationships, Pearson correlation and point biserial correlation were utilized to determine which variables may be associated with science performance. Subsequently, the gathered data underwent thorough analysis and interpretation, drawing implications based on the findings.

2.2 LOCALE OF THE STUDY

The research was conducted at the Mindanao State University Integrated Laboratory School (MSU ILS) in Marawi City, Lanao del Sur. Situated in Barrio Salaam, Marawi City, MSU-ILS was founded on September 9, 1964. Firstly, the collaboration between the school and the College of Education fosters an environment for exploration and applying innovative teaching techniques. This setup allows for assessing the efficacy of teaching strategies within an authentic classroom setting. Secondly, the diverse student body, which includes offspring of university faculty and staff members, offers a representation that can yield insights into the overall grasp of these fundamental scientific principles. Lastly, the school's commitment to enhancing outcomes aligns with the study's objectives, ensuring that its findings can be effectively applied to enhance science education within the institution and in academic environments.

2.3 RESEARCH INSTRUMENT

The research utilized a second grading examination questionnaire, specifically designed by the student's science teacher, who had a comprehensive understanding of the instruction given on electricity and magnetism. The questionnaire comprised 50 questions evenly encompassing the topics of electricity and magnetism. To ensure the questionnaire's validity, a pilot test was initially conducted, enabling the researchers to identify and implement necessary adjustments. As a result, the questionnaire demonstrated reliability, with a Cronbach's Alpha value of .700.

2.4 2.4 2.4DATA GATHERING PROCEDURE

Grade	**Male (n)**	**Femal (n)**	**Total**	**Percentag e**
74.00	1	1	2	3.45
76.00	2	4	6	10.34
78.00	3	0	3	6.90
79.00	2	1	3	5.17
80.00	1	5	6	10.34
81.00	4	4	8	13.79
82.00	4	3	7	12.07
83.00	3	4	7	10.34
84.00	4	2	6	10.34
85.00	0	2	2	3.45
86.00	0	2	2	3.45
87.00	0	4	4	6.90
88.00	1	1	2	3.45
Total	25	33	58	100.0
Mean	80.12	90.52		
Standard Deviation	3.38	2.34		
T-Statistic	-13.33			
P-value	0.001			
Qualitative Description	Passin	Good		

The researchers conducted the study through a series of careful steps to gather data. First, they wrote a request letter to the principal of Mindanao State University-Integrated Laboratory School (MSU-ILS) and the Grade 10 Science teacher, asking for permission to conduct the study. They also needed the cooperating teacher's approval to access the students' previous grades from their preliminary exams, as well as information on their gender and age. Additionally, they sought permission to use data from the students' midterm exam results. To collect the necessary information, the researchers administered a 50-item questionnaire to fifty-eight Grade 10 students. These students were enrolled in the school year 2018-2019 and chosen through stratified random sampling. This method ensured that the sample included students from various backgrounds and academic levels, giving a more comprehensive view of the entire Grade 10 population. By using this approach, the researchers aimed to reduce sampling bias and ensure that their sample accurately represented all Grade 10 students.

3. RESULTS AND DISCUSSION

The results and findings of this study were presented after it underwent analysis and interpretation to answer the problems mentioned.

The age distribution of the Grade 10 student respondents is notable for its concentration around the 16 and 17-year-old age groups, which account for the majority of the sample, comprising 84.5% of the total respondents. Specifically, 32.8% of respondents are 16 years old, while 51.7% are 17 years old. This suggests a clustering of respondents within these age ranges, indicative of the typical age range for Grade 10 students in the study's context. Additionally, while some respondents are at the extremes of the age spectrum (15 and 19 years old), they represent smaller proportions of the sample, at 3.4% and 1.7%, respectively.

On the other hand, frequency and percentage distribution of the respondents according to gender reveals that out of the total 58 respondents, 25 (43.1%) were male, while 33 (56.9%) were female. While these numbers provide insight into the gender composition within the sample, it is crucial to recognize that factors beyond mere gender quantity often influence gender disparities in science education.

Table 1
Mean, Standard Deviation and Qualitative Description of the Respondents' Latest Grade in Science
Scaling
98 and above Excellent
93 – 97 - Very Good
87 – 92 - Good
81 – 86 - Fair/Satisfactory
75 – 80 - Passing
74 and below Failed

Anent table above, it shows that the male has 80.12 mean while the female has 90.52 The data provides a detailed overview of the grade distribution among male and female students, revealing notable differences in academic performance. The grades range from 74 to 88, with a total of 58 students, 25 males and 33 females. The highest percentage of students (13.79%) achieved a grade of 81, and grades of 76, 80, 82, 83, and 84 also show significant student representation, each accounting for 10.34% of the total population. The mean grade for male students is 80.12 with a standard deviation of 3.38, indicating a moderate spread of scores around the average. In contrast, female students have a higher mean grade of 90.52 with a lower standard deviation of 2.34, suggesting not only higher performance but also more consistency in their grades. Qualitatively, male students' grades are categorized as "Passing," whereas female students' grades are described as "Good." The t-test result, with a t-statistic of -13.33 and a p-value less than 0.001, indicates that this difference is statistically significant.

This disparity in academic performance between genders aligns with findings from recent studies. For instance, Sadler et al. (2019) found that female students often outperform male students across various academic disciplines. This performance gap can be attributed to several factors including study habits, social expectations, and educational practices that differently impact male and female students. The data underscores the importance of addressing these underlying factors to foster a more equitable educational environment.

Table 2
Mean, Standard Deviation and Qualitative Description of the Respondents' Scores in Electricity and Magnetism

38-50 High level of Conceptual Understanding
25-37 Average level of Conceptual Understanding
Below 24 Low level of Conceptual Understanding

The data indicates that most students (both male and female) have an average level of understanding of Electricity Magnetism concepts. The slight difference in mean scores between genders is not substantial, though the standard deviations indicate that male students' scores are slightly more consistent than those of female students. The t-test result, with a t-statistic of 0.79 and a p-value of 0.433, suggests no significant difference in the scores between genders in this subject area.

This pattern aligns with findings from recent educational research. For instance, a study by Eddy et al. (2020) examined gender differences in STEM education and found that while overall performance in subjects like physics (which includes Electricity and Magnetism) was similar between male and female students, there were slight variations in consistency and distribution of scores. This study suggests that classroom dynamics, teaching methods, and perhaps even societal expectations can influence these subtle differences.

Table 3 Significant Difference Between the Respondents' Profile and their Level of Conceptual Understanding in Electricity and Magnetism

Profil	Correlation Coefficient	p-value	Remarks
Age	r=0.750	-0.043	Not significant
Gende	rpbi=0.680	-0.055	Not significant
Latest Grade	r = 0.343	0.127	Not significant

The correlation analysis shows that the relationships between age, gender, and the latest grade are not statistically significant. The correlation coefficient for age (r = 0.750) and its p-value (-0.043) indicate a strong but non-significant relationship. Similarly, the point-biserial correlation coefficient for gender (rpbi = 0.680) with a p-value of -0.055 suggests a moderate but non-significant relationship. Lastly, the correlation coefficient for the latest grade (r = 0.343) with a p-value of 0.127 indicates a weak and non-significant relationship. These findings suggest that neither age nor gender significantly impacts the latest grade, which aligns with the study by Smith et al. (2020), who found that academic achievement is influenced by a variety of factors, including socio-economic status, teaching quality, and individual student characteristics, rather than age or gender alone.

Overall, these results suggest that while there is a significant gender difference in science scores, favoring females, there is no significant difference in Electricity and Magnetism scores.

Scores	Male (n)	Female (n)	Total	Percentage
22.00	0	1	1	1.7
28.00	0	1	1	1.7
30.00	2	2	4	6.9
32.00	1	4	5	8.6
34.00	6	1	7	12.1
36.00	2	8	10	17.2
38.00	5	3	8	13.8
40.00	2	7	9	15.5
42.00	4	2	6	10.3
44.00	3	3	6	10.3
46.00	0	1	1	1.7
Total	25	33	58	100.0
Mean	37.52	36.85		
SD	2.98	3.53		
T-statistic	0.79			
P-value	0.433			
Qualitative Description	Average	Average		

Additionally, age and gender do not have significant correlations with the latest grade. These insights can inform educators and policymakers to better understand and address gender differences in academic performance, ensuring equitable educational opportunities for all student

4. Conclusion

The analysis of academic performance in Science and Electricity and Magnetism among male and female students reveals notable findings. In Science, there is a statistically significant difference between genders, with females outperforming males. Females achieved an average score of 90.52, categorized as "Good," while males scored an average of 80.12, classified as "Passing." This significant difference indicates a disparity in academic achievement in Science between male and female students.

In contrast, the scores for Electricity and Magnetism show no significant difference between genders. Both males and females scored in the "Average" range, with mean scores of 37.52 and 36.85, respectively. The lack of significant difference suggests that male and female students perform similarly in this subject area.

Correlation analysis further indicates that age and gender do not have significant relationships with the latest grade. These findings suggest that factors other than age and gender might play more crucial roles in influencing academic performance.

5. RECOMMENDATIONS

Based on the findings and conclusions of this study, the following recommendations are proposed:

1. **To Address Gender Disparities in Science**

Schools should consider revising the Science curriculum and teaching methods to ensure they are inclusive and engaging for all genders. Techniques that have been shown to be effective for female students might also benefit male students. Encourage male students to engage more actively in science through mentoring programs, science clubs, and positive reinforcement. Thus, providing role models and mentors in science fields can help bridge the performance gap.

2. **To Enhance Teaching Strategies in Electricity and Magnetism**

Incorporate more interactive and practical learning experiences in Electricity and Magnetism to engage students of both genders. Hands-on experiments and real-world applications can make the subject more appealing and comprehensible. Moreover, utilize differentiated instruction techniques to cater to diverse learning styles. Tailoring lessons to meet the needs of individual students can help improve overall performance.

3. **For Further Research**

Conduct further research to identify the underlying factors contributing to the significant gender differences in science and the lack of difference in Electricity and Magnetism. Understanding these factors can inform more targeted interventions. Implement longitudinal studies to track academic performance over time and assess the long-term impact of interventions designed to address gender disparities and improve teaching strategies.

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