Conceptual Understanding and Motivation of Grade 12 Learners on General Physics 1: Basis for Intervention

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ABSTRACT

This study examines the conceptual understanding and motivation among Grade 12 learners in General Physics1, focusing on topics such as center of mass, momentum, impulse, and collisions. A descriptive and correlational approach was employed, using an achievement test to assess conceptual understanding and the Physics Motivation Questionnaire II (PMQ II) to measure motivation levels. Data were collected from 34 learners through a combination of online and face-to-face surveys. Descriptive statistics revealed that the majority of students scored below the passing threshold in the achievement test, with an average score of 13 out of 30 points. Responses to the motivation questionnaire indicated a moderate level of engagement and interest, but with significant variability among students, highlighting disparities in their perception of physics' relevance and utility.

Correlation analysis between conceptual understanding and motivation yielded a coefficient (ρ) of 0.723 and a p-value of ($p<0.01$), indicating a statistically significant relationship. The findings indicate that as students' understanding improves, their motivation to learn increases significantly. These results highlight the importance of teaching methods that enhance clarity and engagement, suggesting that fostering better understanding can naturally boost student motivation. By prioritizing both conceptual mastery and motivational strategies, educators can create a more effective and positive learning environment, ultimately encouraging students to become more eager and confident learners.

Keywords: Achievement Test, Conceptual Understanding, General Physics 1, Motivation, Physics Education.

INTRODUCTION

Background of the Study

Physics education faces numerous challenges, particularly in high school settings where students often exhibit negative attitudes towards the subject. Research indicates that students frequently struggle with abstract concepts, leading to disengagement and a lack of motivation [1][2]. The relationship between students' motivation and their conceptual understanding is crucial; motivated students tend to achieve better learning outcomes [3]. Furthermore, inquiry-based learning approaches have been shown to enhance students' conceptual understanding and foster positive attitudes toward physics [4][5].

One of the core issues in high school physics education is that many students harbor significant negative attitudes towards the subject. These negative perceptions are often rooted in the perceived difficulty of abstract concepts within physics, which can be challenging to grasp [6]. The traditional teaching methods employed in many classrooms further exacerbate this issue, as they often prioritize rote memorization and problem-solving techniques over conceptual understanding and student engagement. Consequently, students may quickly disengage from the material, perceiving it as irrelevant or overly complex [7].

Motivation plays a pivotal role in students' academic success, particularly in subjects as complex as physics. Research has indicated that students who are intrinsically motivated tend to engage more deeply with the

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subject matter, leading to improved understanding and performance [8]. This intrinsic motivation often stems from a curriculum that includes hands-on, engaging activities that resonate with students' interests and life experiences. When students can see the practical applications of physics concepts and feel a personal connection to the subject, their motivation increases, resulting in higher levels of academic achievement [8].

Objectives of The Study

In this study the researcher focused on General Physics 1 concepts that were taken by the respondents during their Junior High School. The topics were limited to the: (1) Center of mass, (2) Momentum, (3) Impulse, and (4) Collisions. This paper assessed the Relationship of conceptual understanding and motivation of the Grade 12 learners to General Physics 1 topics. Determine the Conceptual Understanding of Grade 12 learners in Center of Mass, Momentum, Impulse and Collisions, Assess the level of motivation of Grade 12 learners, Establish the relationship between the Grade 12 learners conceptual understanding and level of motivation.

MATERIALS AND METHODS

The study utilized a descriptive research design to explore the relationship between learners' conceptual understanding and motivation in General Physics 1, focusing on Grade 12 students at Pagadian Capitol College Inc.

For this research, two primary instruments were employed: a test questionnaire and the Physics Motivation Questionnaire II (PMQ II). The PMQ II was adapted from Glynn and Koballa [9], while the newly created test questionnaire underwent a comprehensive validation process. This process involved leveraging the Department of Education's Most Essential Learning Competencies to identify essential learning outcomes related to Center of mass, Momentum, Impulse and Collision.

A table of specifications was also created to ensure question distribution was appropriately aligned with various cognitive levels as defined by Bloom's taxonomy. The final test questionnaire contained 30 items, each offering four answer choices and addressing both content-related questions and practical applications. The distribution of questions was designed to reflect different difficulty levels, categorizing items as easy (focused on remembering and understanding), intermediate (centered on applying and analyzing), and difficult (targeting evaluating and creating).

In the validation phase of the questionnaire, three evaluators conducted a content validation. They provided feedback through rating sheets, which resulted in an overall rating of 3.65, indicating that the questionnaire met evaluators' standards. This rating suggests that while significant modifications are not required, minor improvements could enhance its overall effectiveness.

After validation, the questionnaire was distributed to a sample of 120 students at Dumingag National High School, and an item analysis assessed its performance. The analysis yielded a Cronbach's alpha of 0.90, indicating high reliability, alongside a Discriminating Index of 0.57, demonstrating that the test items effectively distinguish among varying levels of student comprehension. Overall, these findings indicate that the questionnaire is effective and has room for minor enhancements.

The current study involved a sample of 70 twelfth-grade students (43 females and 27 males) from Pagadian Capitol College Inc., where the researcher is employed. Data collection involved using a Google Form, available at the link https://forms.gle/PVgMKg7dXPp2BD1s6, in addition to face-to-face distribution of materials. This included the PMQ survey and an achievement test focused on General Physics 1. It is important to note that the participants had previously been introduced to General Physics 1 topics during their Junior High School years.

The table 1 outlines the key parameters used to validate the items in the study, ensuring the questions are clear, concise, and relevant. The parameters include clarity and balance, wordiness, appropriateness of responses, application to praxis, and relationship to the problem. Each parameter is designed to ensure that the questions are unbiased, easily understandable, and directly applicable to the participants' daily practices or expertise, ultimately contributing to the resolution of the study's problem.

Table 1. Parameters of Item Validation

Parameters	Description
Clarity and balance	The questions are complete; only one question is asked at a time; the participants can understand what is being asked; the questions are unbiased; questions are used using a neutral tone.
Wordiness	The questions are concise and understandable; the use of technical language is minimal and appropriate; the terms used are comprehensible by the target population; the questions are asked using affirmative (e.g. Instead of "Which methods not used" …use "Which methods are used").
Appropriateness of responses listed	The choices listed allow the participants to respond appropriately; the responses apply to all situations or offer a way to respond to unique situations; no responses cover more than one choice.
Application to praxis	The questions asked relate to the participants; daily practices or expertise.
Relationship to the problem	The questions are sufficient to resolve the problem in the study.

In accordance with ethical research standards, the researcher secured approval from the school administrator before proceeding with the study. A consent form was included in the distribution link to ensure all participants received adequate information about the study. Participation was entirely voluntary, and efforts were made to protect the students' identities through the use of coding for confidentiality.

Once the data was collected, the responses were organized and analyzed using descriptive statistics, such as averages and percentages. The ratings from the Physics Motivation Questionnaire were summarized in Table 5, complete with descriptions. Furthermore, the students' performance was evaluated based on the criteria detailed in Table 2, which aligns with the standards established by the Department of Education's K to 12 Grading System (DepEd Order No. 8, s. 2015).

Table 2. Descriptors for Performance

Descriptors	Range
Outstanding	90-100
Very Satisfactory	85-89
Satisfactory	80-84
Fairly Satisfactory	75-79
Did Not Meet Expectations	74 Below

Reference: DepEd Order No. 8, s. 2015

Table 3. Mastery Level and Percentage Equivalent

Mastery Level	Percentage Equivalent
Mastered	80-100
Nearly Mastered	75-79

Least Mastered	51-74
Not Mastered	50 and below

Reference: DepEd PPST-Module 11

RESULTS AND DISCUSSION

The data in table 4 shows students' mastery levels across various physics learning competencies, highlighting areas where significant improvement is needed. The mean percentage score of 44.14% places overall performance in the "Not Mastered" category. Among the competencies, the highest mastery level (57%) was achieved for predicting the motion of particles during collisions, which is classified as "Least Mastered." However, the majority of competencies scored below 50%, such as comparing elastic and inelastic collisions (31%), applying restitution concepts (43%), and explaining linear momentum conservation (47%). These low scores indicate that students face substantial difficulties understanding and applying fundamental principles.

Table 4. Mastery Level of Grade 12 Learners in General Physics 1 Competencies

Learning Competencies	**Frequency of Error**	**%**	**No. of Correct Responses**	**%**	**Mastery Level**
Differentiate center of mass and Geometric center and Relate the motion of center of mass and net external force acting on the system	109	64	61	36	**Not Mastered**
Relate the momentum, impulse, force, and time of contact in a system	91	54	79	46	**Not Mastered**
Explain the necessary conditions for conservation of linear momentum to be valid	90	53	80	47	**Not Mastered**
Perform an experiment involving energy and momentum conservation and analyze the data identifying discrepancies between theoretical expectations and experimental results when appropriate	70	51	66	49	**Not Mastered**
Compare and contrast elastic and inelastic collisions	94	69	42	31	**Not Mastered**
Apply the concepts of restitution coefficient in collisions	77	57	59	43	**Not Mastered**
Predict motion of constituents particles for different types of collisions (e.g., elastic, inelastic)	44	43	58	57	**Least Mastered**
Mean Percentage Score				**44.14**	**Not Mastered**

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Legend: Not mastered(50 % below}, Least mastered (51-74%), Nearly Mastered (75-79%}, Mastered (80-100%)

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This performance reflects a need for targeted instructional adjustments. The high frequency of errors (e.g., 64% for differentiating center of mass and geometric center) suggests prevalent misconceptions and gaps in conceptual clarity. Educators should consider incorporating hands-on activities, real-world applications, and simulations to make abstract concepts more tangible. Furthermore, assessments could be aligned with active problem-solving and experimental designs to build stronger connections between theoretical knowledge and practical applications. These interventions are critical for improving students' competency and overall engagement with the subject matter.

The distribution of scores in Figure 1 indicates that respondents on the achievement test scored between 8 and 19. The majority of respondents received a score of 14, with the average score being 13.38. The data presented in the figure suggests that most scores are clustered on the lower end of the scale.

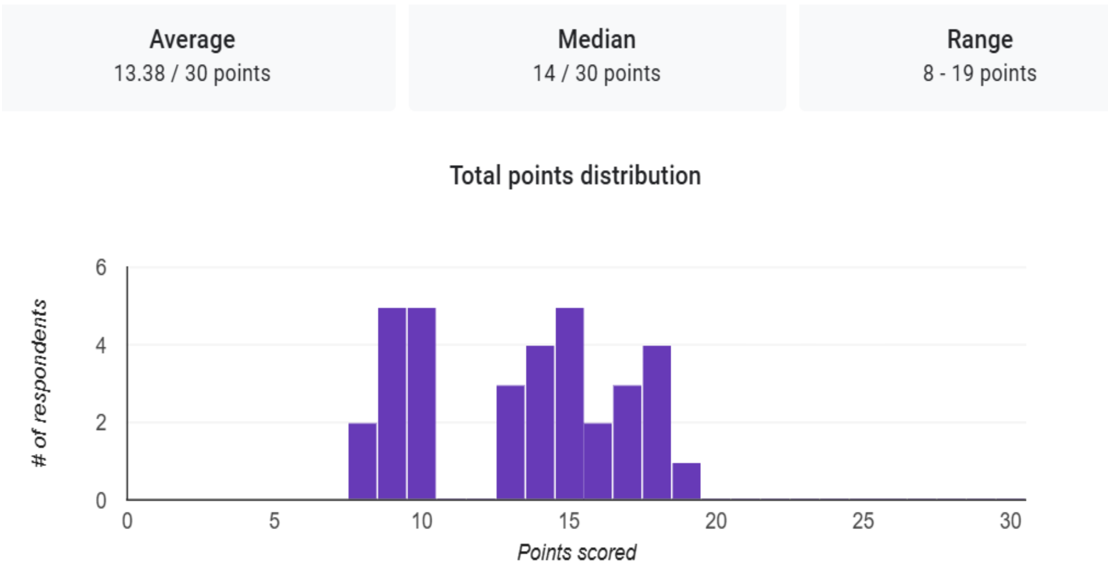

Figure 1. Total Points Distribution

The data collected in table 5 on the motivation levels of Grade 12 learners in physics reveals a generally positive trend in students' motivation and engagement with physics. A significant portion of students agree or strongly agree that physics is relevant to their everyday lives (60%) and captures their interest (60%). This indicates that many students find the subject meaningful and engaging. However, there is a notable split in responses regarding the purpose and career relevance of physics, with some students strongly disagreeing or disagreeing, suggesting that not all students see a clear connection between physics and their future aspirations.

These results highlights the importance of making physics more relatable and clearly linked to students' career goals. While many students are motivated and confident in their abilities, as seen in the high agreement rates for statements about understanding and applying physics concepts, there is room for improvement in demonstrating the practical and career-related benefits of physics. Educators should focus on bridging this gap by integrating real-world applications and career-oriented examples into the curriculum to enhance student motivation and perceived relevance of the subject.

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Table 5. Level of Motivation Summary of Result (N= 70)

Statements	Strongly Disagree (%)	Disagree (%)	Agree (%)	Strongly Agree (%)
1) I find the physics I learn to be relevant to my everyday life.	14 (20%)	14 (20%)	18 (25.7%)	24 (34.3%)
2) Learning physics captures my interest.	16 (22.9%)	12 (17.1%)	22 (31.4%)	20 (28.6%)
12) Studying physics gives my life greater purpose.	10 (14.3%)	28 (40.2%)	10 (14.3%)	22 (31.4%)
17) I feel curious about new discoveries in physics.	18 (25.7%)	18 (25.7%)	10 (14.3%)	24 (34.3%)
19) I enjoy exploring and learning about physics.	20 (28.6%)	8 (11.4%)	22 (31.4%)	20 (28.6%)
9)I feel confident about doing well on physics tests	16 (22.9%)	12 (17.1%)	30 (42.9%)	12 (17.1%)
14)I am sure I can succeed in physics labs and projects.	16 (22.9%)	16 (22.9%)	14 (20%)	24 (34.3%)
15)I believe I can develop strong physics knowledge and skills.	20 (28.6%)	14 (20%)	20 (28.6%)	16 (22.9%)
18) I am confident I can achieve an “A” in physics.	24 (34.3%)	18 (25.7%)	10 (14.3%)	18 (25.7%)
21)I feel capable of understanding physics concepts	10 (14.3%)	14 (20%)	18 (25.7%)	28 (40%)
5)I make a strong effort to understand physics.	10 (14.3%)	12 (17.1%)	24 (34.3%)	24 (34.3%)
6)I apply strategies to learn physics effectively.	18 (25.7%)	8 (11.4%)	12 (17.1%)	32 (45.7%)
11)I dedicate a lot of time to studying physics.	18 (25.7%)	16 (22.9%)	10 (14.3%)	26(37.1%)
16)I prepare thoroughly for				

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physics tests and labs.	14 (20%)	18 (25.7%)	18 (25.7%)	20 (28.6%)
22)I study hard to improve my understanding of physics.	26 (37.1%)	10 (14.3%)	12 (17.1%)	22 (31.4%)
2)I aim to outperform other students in physics tests.	10 (14.3%)	28 (40%)	20 (28.6%)	12 (17.1%)
4)Getting good grades in physics is a priority for me	14 (20%)	18 (25.7%)	16 (22.9%)	22 (31.4%)
8)Achieving an "A" in physics is very important to me.	14 (20%)	18 (25.7%)	12 (17.1%)	26 (37.1%)
20)I often think about the grades I receive in physics.	18 (25.7%)	22 (31.4%)	14 (20%)	16 (22.9%)
24)Performing well on physics tests and labs is significant to me.	22 (31.4%)	18 (25.7%)	12 (17.1%)	18 (25.7%)
7)Learning physics will be helpful for my future career.	16 (22.9%)	20 (28.6%)	10 (14.3%)	24 (34.3%)
10)Knowledge of physics will give me an advantage in my job.	18 (25.7%)	10 (14.3%)	20 (28.6%)	22 (31.4%)
13)Understanding physics is valuable for my career aspirations	26 (37.1%)	18 (25.7%)	10 (14.3%)	16 (22.9%)
23)My career will require me to use physics knowledge.	24 (34.3%)	10 (14.3%)	14 (20%)	22 (31.4%)
25)I believe physics problem-solving skills will benefit my future work.	20 (28.6%)	10 (14.3%)	18 (25.7%)	22 (31.4%)

The analysis on table 6 shows a strong positive link between how well students understand concepts and their motivation levels. With a correlation score of 0.723, it's clear that better understanding often leads to higher motivation. The p-value, which is less than 0.01, tells us this connection is meaningful and not just random. The researcher's reject the null hypothesis and automatically accept the alternative hypothesis which state that there is a significant relationship between the two variables. This means we can be confident that improving understanding can help boost motivation.

Based on that analysis, when students grasp concepts well, they tend to feel more motivated to learn. This highlights the importance of teaching methods that make concepts clear and engaging. By focusing on both understanding and motivation, teachers can create a more positive and effective learning experience for students. Essentially, helping students understand better can naturally make them more eager to learn.

Table 6. Spearman Rho Correlation Analysis between Conceptual Understanding and Motivation

VARIABLES	CORRELATION(ρ)	P-VALUE	INTERPRETATION
Conceptual Understanding	0.723	$p < 0.01$	Reject the null hypothesis
Motivation			

Note: p<0.01-Highly significant, p=0.02 - 0.05 - Significant, p>0.05 - Not significant.

On the other hand, the study at University of Rwanda - College of Education reports on the implementation of the Mechanics Baseline Test (MBT) to track the students conceptual understanding in mechanics. The results showed that the performance occurred only in 12 out of 26 MBT items, and the researchers identified areas of mechanics that need teaching improvement. The study also found a positive correlation between students' confidence in answering questions and their correct answers, informing lecturers to use various teaching approaches to effectively employ the "teaching and learning bucket" (TLB) model [10].

CONCLUSION AND RECOMMENDATIONS

The analysis shows a clear and strong connection between how well students understand concepts and their motivation to learn. When students grasp ideas more effectively, they tend to feel more motivated and engaged in their studies. This relationship is not just a coincidence—it's backed by solid evidence, with a high correlation score and a very low p-value. This means teachers can be confident that focusing on improving understanding will likely lead to more motivated students. Essentially, when students "get it," they're more excited to keep learning.

To make the most of this insight, teachers should focus on teaching methods that make concepts clear and interesting. Using real-life examples, interactive activities, and integration of technology can help students connect with the material. At the same time, creating a supportive and encouraging classroom environment can boost their confidence and motivation. By helping students understand better and feel more engaged, teachers can create a positive learning experience that benefits everyone.

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