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The Relationship of Conceptual Understanding and Motivation of Grade 7 Learners: Basis for Strategic Interventions on Force, Motion, and Energy

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Abstract

Physics education plays a crucial role in developing critical thinking, problem-solving skills, and scientific literacy. However, Grade 7 learners frequently encounter difficulties in grasping fundamental physics concepts. This study investigated the level of conceptual understanding of learners and the relationships between level of motivation and the level of conceptual understanding of force, motion, and energy and five motivational factors (intrinsic, self-efficacy, self-determination, grade, and career) among Grade 7 learners in selected private schools in the Philippines. Employing a quantitative approach, a thirty (30) -item assessment tool, aligned with the MATATAG Curriculum, was developed and validated. A pilot test was administered to One Hundred Twenty (120) learners. The validated instrument was administered to forty (40) participants. Findings revealed significant learning gaps in conceptual understanding, with only one student (2.5%) achieving the passing standard. Distance-time graphs, followed by heat transfer, were identified as the most challenging topics. Spearman's rank correlation analysis revealed moderately positive relationships between conceptual understanding and intrinsic motivation ($\rho = .784$, $p < .001$), grade motivation ($\rho = .703$, $p < .001$), and career motivation ($\rho = .784$, $p < .001$). A statistically significant, but weaker, positive relationship was found between conceptual understanding and self-determination ($\rho = .422$, $p = .007$). In contrast, the relationship between self-efficacy and conceptual understanding was not statistically significant ($\rho = .299$, $p = .061$). These results highlight the need for possible instructional interventions addressing specific conceptual difficulties and suggest that fostering intrinsic, grade, and career motivation may be beneficial. The study recommends incorporating strategies that enhance higher-order thinking skills, connect learning to real-world applications and career paths, and provide targeted support in challenging topics to improve both motivation and conceptual understanding in physics.

Keywords: conceptual understanding, energy, force, motion, motivation

1. Introduction

Physics education is crucial for developing critical thinking, problem-solving skills, and scientific literacy, enabling individuals to understand the natural world. However, many learners find physics challenging due to its abstract concepts and mathematical demands. Studies indicate that Filipino junior high school learners, particularly under the K-to-12 program, struggle with mechanics topics such as force, motion, and energy (Nava & Camarao, 2017). These difficulties often stem from a perceived lack of real-world application, hindering their ability to connect concepts to daily life and leading to reduced engagement and motivation (Wangchuk et al., 2023). Such a disconnect not only impedes academic performance but also potentially discourages learners from pursuing careers in Science, Technology, Engineering, and Mathematics (STEM) fields (National Research Council, 2013).

While research affirms a positive link between STEM education and problem-solving skills (Gülen, 2019), bridging the gap between theoretical understanding and practical application remains a persistent challenge. The Department of Education’s MATATAG Curriculum seeks to address this by emphasizing foundational skills, reducing content overload, and promoting active learning, particularly for Grade 7 learners who are introduced to fundamental physics concepts (Department of Education, 2024). Despite these curriculum efforts, evidence suggests Grade 7 learners continue to face difficulties with specific physics topics. This highlights a critical research gap: a lack of specialized tools to assess learners' needs in Grade 7 physics (Orleans, 2020), which impedes the design of effective, targeted interventions.

Beyond curriculum and assessment, motivation significantly influences academic performance in science. It encompasses various dimensions, including intrinsic motivation (internal desire for learning), self-efficacy (belief in one's ability), self-determination (autonomy in learning), grade motivation (drive for academic performance), and career motivation (link to future job prospects). Intrinsic motivation has been linked to improved engagement and performance in physics (Gülen, 2019), while self-determination predicts course engagement and persistence (Wangchuk et al., 2023). Although self-efficacy is vital, studies caution that confidence alone does not always translate to higher conceptual understanding (Glynn et al., 2011). Similarly, while grade motivation can drive achievement, it may also encourage superficial learning (Orleans, 2020). Conversely, career motivation strongly influences long-term commitment to STEM fields (Glynn et al., 2011).

This study, therefore, seeks to address the identified challenges by developing a validated assessment tool to measure Grade 7 learners' conceptual understanding of force, motion, and energy, and by examining the relationship between various motivational factors and their physics learning outcomes. The key research objectives are to: (1) assess Grade 7 learners' conceptual understanding; (2) examine their levels of intrinsic, self-efficacy, self-determination, grade, and career motivation in physics; and (3) determine the relationship between conceptual understanding and these motivational factors. By integrating assessment tool development with motivation analysis, this research aims to provide valuable data for educators and contribute to ongoing efforts to improve physics education, fostering stronger foundations for success in physics and related STEM fields in the Philippines.

2. Methodology

This study employed a quantitative approach to investigate the relationship between Grade 7 learners' conceptual understanding of force, motion, and energy, and various motivational factors. The research involved two main phases: instrument development and data collection/analysis.

The first phase focused on developing a valid and reliable 30-item multiple-choice assessment tool, aligned with the DepEd MATATAG Curriculum for Grade 7 physics, to assess conceptual understanding of force, motion, and energy. This instrument underwent rigorous expert validation, with experts evaluating items for language, clarity, curriculum alignment, response option suitability, real-world applicability, relevance to learning gaps, and mapping to Bloom's Taxonomy for cognitive rigor.

In the second phase, the validated assessment tool was administered to 40 Grade 7 learners from a private school in Iligan City, Philippines, to evaluate their conceptual understanding. Motivation was measured using an adapted Physics Motivation Questionnaire II (PMQ-II), capturing intrinsic, self-efficacy, self-determination, grade, and career motivation dimensions. Assessment results identified specific physics competencies with low mastery. Spearman's rank correlation analysis was then employed to examine relationships between learners' conceptual understanding scores and their scores on each motivational dimension from the adapted PMQ-II, informing targeted interventions.

2.1 Participants

The pilot test involved 120 students selected using systematic sampling from four Grade 7 classroom sections (A, B, C, and D) to evaluate Version 2 of the needs assessment tool. Every second student was selected from alphabetized class lists of Sections A (n = 20) and D (n = 20), while all students from Sections B (n = 41) and C (n = 39) participated. Six students declined, resulting in a final pilot sample of 120.

The main study utilized the final 30-item needs assessment with 40 students selected from the reserved portions of Sections A and D. Inclusion criteria for both phases were Grade 7 students aged 11 to 13 years. The study aimed for diverse learner representation in Iligan City and did not employ specific sampling strategies based on cultural background, gender, or socioeconomic status.

2.2 Development of the Assessment Instrument

The needs assessment tool's development and validation followed a systematic, multi-stage process. Initially, Version 1–a 40-item instrument was developed based on the DepEd MATATAG Curriculum's content standards for balanced/unbalanced forces, displacement/velocity, distance-time graphs, and heat transfer. A Table of Specifications (TOS) guided item distribution across topics and Bloom's Revised Taxonomy levels, ensuring content validity (Anderson & Krathwohl, 2001).

Version 1 underwent face validation by three experts (physics, test construction, English) who evaluated it using a Likert scale adapted from Quiao et al. (2024), assessing clarity, wordiness, response appropriateness, real-world application, and problem relevance. A pilot test of Version 1 was conducted with 120 Grade 7 students from a private school in Iligan City using systematic sampling across four sections. Pilot data were analyzed using the DepEd Grading Scale (2015), item difficulty/discrimination indices, and distractor analysis, adhering to recommended time limits (Brothen, 2012; Richter et al., 2024). Based on expert feedback and pilot results, the instrument was revised, resulting in a 30-item final version.

This final version, along with an adapted Physics Motivation Questionnaire (PMQ-II) based on Glynn (2011), was administered to 40 Grade 7 students from the same school to assess conceptual understanding and motivation across five dimensions: intrinsic, self-efficacy, self-determination, grade, and career motivation. Student PMQ-II responses were collected via a four-point Likert scale.

2.3 Data Analysis

The data analysis for this study was conducted in three stages. First, student academic performance on the needs assessment was evaluated using the DepEd Grading Scale.

Table 1: DepEd Grading Scale and Remarks

Grading Scale	Descriptors	Remarks
90-100	Outstanding	Passed
85-89	Very Satisfactory	Passed
80-84	Satisfactory	Passed
75-79	Fairly Satisfactory	Passed
Below 75	Did not meet expectations	Failed

Mean Percentage Scores (MPS) were calculated to identify physics topics where students demonstrated the least mastery. These MPS values were then interpreted using the descriptive equivalents outlined in DepEd Memo No. 160, s. 2012 (Table 2), providing a standardized measure of student performance. This analysis aimed to pinpoint specific areas of conceptual difficulty within the force, motion, and energy topics.

Table 2: Mastery Levels Using Mean Percentage Score (MPS)

Mean Percentage Score (MPS)	Descriptive Equivalent
96-100%	Mastered
86-95%	Closely Approximating Mastery
66-85%	Moving Towards Mastery
35-65%	Average
15-34%	Low
5-14%	Very Low
0-4%	Absolutely No Mastery

Second, responses from the motivation questionnaire were analyzed using frequency counts. The frequency of each response option for every item on the questionnaire was calculated to identify prevalent patterns and trends in student responses. This analysis provided insights into the overall levels of motivation across the five dimensions measured: intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation. By examining the distribution of responses on the Likert scale, the analysis aimed to understand students' perceptions and attitudes toward physics.

Finally, to investigate the relationship between conceptual understanding and motivation, Spearman's rank correlation (Spearman's ρ) was employed. This nonparametric statistical method was chosen due to the potential non-normal distribution of the assessment scores and the ordinal nature of the motivation data collected using the Likert scale. Spearman's ρ allowed for an examination of the monotonic relationship between the ranked scores on the needs assessment (representing conceptual understanding) and the ranked scores on each of the five motivation dimensions. This analysis aimed to determine the strength and direction of any associations between these two key variables.

3. Results and Discussion

3.1 Item Analysis and Validation

The development of the needs assessment tool began with the creation of Version 1, comprising 40 items designed to assess conceptual understanding of force, motion, and energy based on the DepEd MATATAG Curriculum. This initial version underwent rigorous face validation by three experts specializing in Physics, test construction, and English. Using a rating sheet adapted from Quiao et al. (2024), the experts evaluated using a Likert scale (4-1) for each item across several parameters: clarity, wordiness, appropriateness of responses, real-world application, and relevance to the research problem.

Table 3: Validators Rating Sheet Data

No.	Average Parameters					No.	Average Parameters				
	Clarity	Wordiness	Appropriateness of responses listed	Application to praxis	Relevance to the problem.		Clarity	Word-iness	Appropriateness of responses listed	Application to praxis	Relevance to the problem.
Q1	4	4	4	3.67	4	**Q21**	4	4	4	3.67	4
Q2	4	3.33	3.67	3.33	4	**Q22**	4	4	4	4	4
Q3	4	4	4	3.33	4	**Q23**	4	4	4	3.67	4
Q4	4	4	3.33	3.33	4	**Q24**	4	4	4	4	4
Q5	4	4	4	4	4	**Q25**	4	4	4	3.67	4
Q6	3.33	4	4	3.33	4	**Q26**	4	4	4	4	4
Q7	4	4	4	4	4	**Q27**	4	4	4	4	4
Q8	3.67	4	4	3.67	3.67	**Q28**	4	4	4	4	4
Q9	4	4	4	4	4	**Q29**	4	4	4	3.67	4
Q10	4	4	4	4	4	**Q30**	4	4	4	4	4
Q11	4	4	4	3.67	4	**Q31**	4	4	4	3.67	4
Q12	4	4	4	3.67	4	**Q32**	4	4	4	3.67	4
Q13	4	3.67	4	3.67	4	**Q33**	4	4	4	4	4
Q14	4	4	4	4	4	**Q34**	4	4	4	4	4
Q15	4	4	4	3.67	4	**Q35**	3.67	3.67	3.67	3.67	3.67
Q16	4	4	4	4	4	**Q36**	4	4	4	3.67	4
Q17	4	4	4	3.67	4	**Q37**	4	3.67	3.67	4	4
Q18	4	4	4	3.67	4	**Q38**	3.67	3.67	3.67	3.67	3.67
Q19	4	4	4	3.67	4	**Q39**	3.67	3.67	3.67	4	4
Q20	4	4	4	3.67	4	**Q40**	4	3.67	3.67	4	4

Legend: 1.00–1.74: Not Acceptable, 1.75–2.49: Below Expectations, 2.50–3.24: Meets Expectations, 3.25–4.00: Exceeds Expectations

As shown in Table 3, the majority of items received high ratings, with most averaging a score of 4.00 ("Exceeds Expectations"), indicating strong initial alignment with the evaluation criteria. However, some items received slightly lower average scores (3.33 or 3.67), suggesting areas for improvement. Specifically, while clarity and wordiness were generally well-rated, minor deviations highlighted the need for improved phrasing or conciseness in certain items (e.g., items 36, 38, and 39). Similarly, although the appropriateness of responses was generally high, some items required revisiting for comprehensiveness or relevance. Notably, several items received an average of 3.67 for real-world application, indicating a need to strengthen the connection between the assessment items and practical scenarios. Overall, the quantitative data from the expert ratings suggested that the initial items were well-designed but could benefit from refinement.

The qualitative feedback from the experts, summarized through thematic analysis in Table 4, provided valuable insights for revising the instrument. Key themes emerged from their comments and suggestions.

A primary concern was the need for greater clarity and conciseness in question phrasing to minimize ambiguity and ensure student comprehension. Experts recommended simplifying complex sentences, refining response options, and avoiding overly technical language. Contextualization and relatability were also emphasized, with suggestions to incorporate real-life scenarios and localized examples to enhance student engagement and understanding. Regarding question structure, the experts recommended primarily using multiple-choice formats for consistency and ease of scoring, advising against open-ended questions unless absolutely necessary. Ensuring scientific accuracy and precise terminology was another crucial theme, with recommendations to carefully review definitions, concepts, and examples for alignment with physics principles. Finally, readability and appropriateness of language for Grade 7 students were highlighted, with experts emphasizing the need for age-appropriate vocabulary and sentence structure.

Table 4: Thematic Analysis on Validators Comments/Suggestions

Theme	Comments
Clarity and Conciseness	V1 suggested redundant wording in Question #2. V3 recommended adjusting phrasing for clarity in Questions #6 and #8.
Contextualization and Relatability	V2 suggested contextualizing questions with local or daily-life scenarios. V3 recommended adding relatable examples, like "*A car accelerating on a highway*."
Question Structure and Response Types	V2 recommended moving to multiple-choice formats like PISA tests. V3 suggested more specific response options (e.g., specifying "*initially at rest*").
Scientific Accuracy and Terminology	V1 suggested rephrasing Question #32 about thermoelectric generators for clarity. V3 proposed changes to Question #14 Theme
Readability and Appropriateness	V2 recommended checking readability. V1 suggested replacing "*insulating*" with more familiar terms.
Feedback on Specific Questions	V3 suggested changes to Questions #1, #2, and #4 for better clarity. V1 recommended changes to various questions for precision and better phrasing.

Comprehensive feedback from quantitative ratings and qualitative comments led to the revision of Version 1 into Version 2 of the assessment tool. Key revisions involved converting essay and illustration-type items to multiple-choice, rewording unclear items, adjusting difficulty, and ensuring alignment with cognitive levels and curriculum competencies.

3.2 Item Results and Analysis from Pilot Test

Analysis of the pilot test (n = 120) revealed a mean score of 17.19 (out of 30) with a standard deviation of 6.14, indicating moderate test difficulty and variability in student understanding. The average item difficulty index (0.4598) suggested that most items were appropriately challenging, although four items were identified as difficult and potentially requiring revision. The average discrimination index (0.368) fell within the average range, indicating that most items differentiated between high- and low-performing students, but four items were non-discriminating and also required revision. Distractor analysis revealed that 22 items had ineffective or misleading distractors, necessitating careful review and revision. Based on these analyses, 19 discriminating items (47.5%) were retained, and 11 items were revised for clarity and improved distractors.

Table 5: Item Results and Analysis from Pilot Test

Central Tendency of Scores		Average Difficulty Index	
Range Mean Standard Deviation	8-32 17.1916667 6.14	Average Easy item Average items Hard items	0.4598 1 35 4
Multiple Choice Distractor Analysis		**Average Discrimination Index**	
Items with Okay Distractors Items with either Rejected or Defected distracters	18 22	Average Discriminating items Average Discrimination Not Discriminating	0.3680 19 17 4

Following revisions based on expert feedback and initial item analysis, a pilot test was administered to Grade 7 to evaluate the assessment tool's validity and reliability. Subsequently, the same respondents were used for the administration of the motivation questionnaire.

3.3 Conceptual Understanding on Force, Motion, and Energy

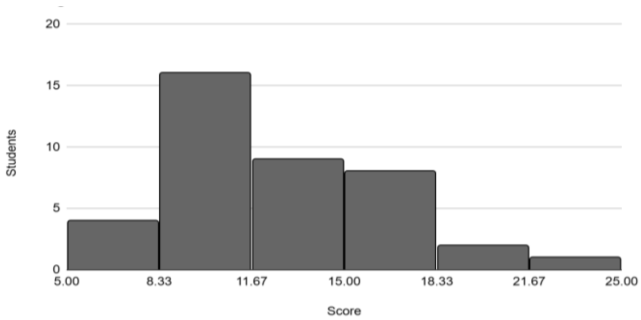

Figure 1. Score Distribution in Frequency of Raw Scores

The score distribution exhibited positive skewness, with the majority of scores concentrated in the lower range. Over 15 students scored between 8.33 and 11.67, representing the highest frequency. Scores above 18.33 showed a noticeable drop in frequency, and only a few students scored above 21.67, forming the tail of the distribution. This skewness suggests that most students demonstrated a limited understanding of force, motion, and energy.

Table 6: Mastery Level of Seventh Graders in Grade 7 Physics Learning Competencies

Skills Teste	Item	No. of Correct Responses	MPS%	Mastery Level
1. identify that forces act between objects and can be measured.	#1	28	70	Moving Towards Mastery
2. identify and describe everyday situations that demonstrate:	#2	25	62.5	Moving Towards Mastery

Table 6: (Cont')

Skills Teste	Item	No. of Correct Responses	MPS%	Mastery Level
a. balanced forces such as a box resting on an inclined plane, a man standing still, or an object moving with constant velocity;	#3	24	60	Average
	#4	27	67.5	Moving Towards Mastery
b. unbalanced forces, such as freely falling fruit or an accelerating car;	#8	13	32.5	Low
3. draw a free-body diagram to represent the relative magnitude and direction of the forces involving balanced and unbalanced forces;	#6	18	45	Average
	#7	13	32.5	Low
4. identify that when forces are not balanced, they can cause changes in the object's speed or direction of motion;	#5	18	45	Average
5. explain the difference between distance and displacement in everyday situations in relation to a reference point;	#9	17	42.5	Average
	#10	11	27.5	Low
	#26	24	60	Average
6. distinguish between speed and velocity using the concept of vectors;	#11	14	35	Average
	#12	19	47.5	Average
	#13	10	25	Low
	#29	18	45	Average
7. describe uniform velocity and represent it using distance-time graphs;	#14	13	32.5	Low
	#15	10	25	Low
	#16	9	22.5	Low
	#17	10	25	Low
	#18	17	42.5	Average
	#27	17	42.5	Average
	#30	17	42.5	Average
8. explain the difference between heat and temperature;	#19	20	50	Average
9. identify advantageous and disadvantageous examples of conduction, convection, and radiation;	#20	27	67.5	Moving Towards Mastery
	#21	19	47.5	Average
10. explain in terms of the particle model the processes underlying convection and conduction of heat energy	#22	15	37.5	Average
	#23	15	37.5	Average
	#24	11	27.5	Low
11. gather information from secondary sources to identify and describe examples of innovative devices that can be used to transform heat energy into electrical energy	#25	13	32.5	Low
	#28	19	47.5	Average

Analysis of the 30-item needs assessment administered to forty 7th graders revealed significant learning gaps. This framework categorizes performance from "Mastered" (96-100%) to "Absolutely No Mastery" (0-4%). None of the items were classified as "Mastered," and only two (6.7%) reached the "Nearly Mastered" level (75-79%). A substantial portion of items (36.7%) were categorized as "Moving Towards Mastery" (50-74%), while the majority (56.7%) fell into the "Not Mastered" category. Learners struggle most with items requiring higher-order thinking, such as distinguishing speed and velocity, analyzing distance-time graphs, and explaining heat transfer processes. Items involving the identification of balanced and unbalanced forces showed relatively better performance (up to 67.5% "Moving Towards Mastery"), whereas application-based items (e.g., drawing free-body diagrams, interpreting complex scenarios) had the lowest mastery levels (as low as 25%). To pinpoint the most challenging topics, the average frequency of errors was calculated for each of the four content areas.

Table 7: Mastery Level of Seventh Graders in Grade 7 Physics Topics

	Content			
	Balanced and unbalanced forces	Motion: displacement and velocity	Distance-Time graphs, Identifying and controlling variables	Heat transfer
Total frequency of error	154	177	187	181
Average	81	92	97	94.5
Rank	**4**	**3**	**1**	**2**

Analysis of content -specific performance (Table 5) revealed significant variations in mastery among Grade 7 learners based on the MATATAG Curriculum. Distance-Time Graphs emerged as the most challenging topic (187 total errors, average 97), followed by Heat Transfer (181 total errors, average 94.5). Motion: Displacement and Velocity ranked third (177 total errors, average 92), while Balanced and Unbalanced Forces was the least challenging (154 total errors, average 81). These findings align with existing research: difficulties with graphical representations like distance-time graphs (Mathai et al., 2024) and persistent misconceptions surrounding heat transfer (Fitzallen et al., 2016) are well-documented.

3.4 Learners Motivation in Physics Learning

The table below shows the frequency of responses from the 40 students on the motivation questionnaire using the Likert scale (4-always, 3-often, 2-rarely, 1-never) for each category: intrinsic motivation, self-efficacy, self-determination, grade, and career motivation.

Table 8: Motivation Questionnaire Results

Category/Statement	**4**	**3**	**2**	**1**
Intrinsic Motivation				
The physics I learn is relevant to my life.	21	16	3	0
Learning physics is interesting.	14	21	5	0
Learning physics makes my life more meaningful	15	9	16	0
I am curious about discoveries in physics	7	21	11	1
I enjoy learning physics.	14	21	5	0

Table 8: (Cont')

Category/Statement	4	3	2	1
Self-Efficacy				
I am confident I will do well on physics tests.	5	28	7	0
I am confident I will do well on physics labs and projects.	3	35	2	0
I believe I can master physics knowledge and skills.	7	20	13	0
I believe I can earn a grade of 90-100 in physics	4	19	16	1
I am sure I can understand physics	6	32	2	0
Self-Determination				
I put enough effort into learning physics.	3	27	10	0
I use strategies to learn science well	7	15	18	0
I spend a lot of time learning physics.	0	31	9	0
I prepare well for physics tests and labs.	14	19	7	0
I study hard to learn physics	16	9	15	0
Grade Motivation				
I like to do better than other students on physics tests.	8	27	5	0
Getting a good physics grade is important to me.	8	23	9	0
It is important that I get a grade of 90-100 in physics.	18	11	11	0
I think about the grade I will get in physics.	3	28	9	0
Scoring high on science tests and labs matters to me.	15	21	4	0
Career Motivation				
Learning physics will help me get a good job.	20	19	1	0
Knowing physics will give me a career advantage.	18	11	11	0
Understanding physics will benefit me in my career.	18	15	7	0
My career will involve physics.	18	16	5	1
I will use physics problem-solving skills in my career.	18	17	5	0

The results highlight that intrinsic motivation was strong among students, with 21 students always finding physics relevant to their lives and 14 always enjoying learning it. However, only 7 students always expressed curiosity about physics discoveries, showing some variation in interest levels. For self-efficacy, 32 students believed they could understand physics often or always, but only 6 students always expressed confidence in earning a grade of 90-100 in physics. In terms of self-determination, 27 students often or always put effort into learning physics, while only 14 students always prepared well for tests and labs. Grade motivation responses showed that 23 students always believed getting a good grade was important, but only 8 students consistently liked doing better than their peers. Career motivation was the strongest, with 20 students always believing physics would help them get a good job, and 18 students consistently seeing its relevance to their career and problem-solving skills. These numbers suggest that while most students are motivated by intrinsic, grade and career factors, some areas, such as self-efficacy and self-determination, don't influence learners' conceptual understanding that much.

3.5 Relationship between Conceptual Understanding and Motivation

Table 9. Spearman Correlation Results

Measure	Intrinsic Motivation	Self-Efficacy	Self-Determination	Grade Motivation	Career Motivation
Spearman's Correlation	0.784	0.299	0.422	0.703	0.744
Covariance	105.14	39.12	56.64	94.38	94.93
P-value (2-tailed)	0	0.06135	0.00663	0	0
X Rank Mean	20.5	20.5	20.5	20.5	20.5
Y Rank Mean	20.5	20.5	20.5	20.5	20.5
X Rank Stan. Dev.	11.53	11.27	11.53	11.55	10.97
Y Rank Stan. Dev.	11.63	11.63	11.63	11.63	11.63

The analysis revealed statistically significant positive relationships between conceptual understanding and intrinsic motivation ($\rho = .784$, $p < .001$), self-determination ($\rho = .422$, $p = .007$), grade motivation ($\rho = .703$, $p < .001$), and career motivation ($\rho = .744$, $p < .001$). The findings of this study highlight the significant role of motivation in students' conceptual understanding of force, motion, and energy. The results indicate that intrinsic motivation ($r = 0.784$, $p < .001$) and career motivation ($r = 0.744$, $p < .001$) exhibited the strongest positive correlations with conceptual understanding.

These findings suggest that students who are genuinely interested in learning science or who perceive it as essential for their future careers tend to develop a deeper understanding of scientific concepts. This aligns with self-determination theory (Deci & Ryan, 2000), which emphasizes the importance of intrinsic motivation and career-oriented goals in fostering meaningful learning experiences. Given the strong correlations observed, instructional approaches should focus on fostering students' natural curiosity and emphasizing the relevance of physics to real-world applications. Integrating project-based learning, hands-on experiments, and discussions on career pathways in science may help sustain students' engagement and deepen their conceptual understanding.

Moreover, grade motivation ($r = 0.703$, $p < .001$) also demonstrated a strong positive correlation, indicating that students who are driven by academic performance tend to achieve higher conceptual understanding. While external motivators such as grades can enhance performance, research suggests that an overemphasis on grades may lead to surface-level learning rather than long-term retention of scientific concepts (Ryan & Deci, 2000). Encouraging inquiry-based learning and problem-solving activities may help students develop a deeper understanding beyond performance-based outcomes. In contrast, self-determination ($r = 0.422$, $p = .007$) showed a statistically significant but comparatively weaker correlation, implying that while students who perceive autonomy in their learning exhibit better conceptual understanding, other motivational factors—such as intrinsic interest and career aspirations—may exert a stronger influence.

Interestingly, self-efficacy ($r = 0.299$, $p = .061$) did not exhibit a statistically significant relationship with conceptual understanding. This finding is somewhat unexpected, as self-efficacy is often linked to academic performance (Bandura, 1997). While students may believe in their ability to succeed, this confidence alone may not necessarily translate into deeper conceptual learning unless it is accompanied by high levels of intrinsic engagement and active learning strategies. This finding suggests that fostering self-efficacy without simultaneously encouraging intrinsic motivation may not be sufficient to enhance conceptual understanding.

Overall, these findings imply that an effective science education strategy should nurture both intrinsic and extrinsic motivation (grade, and career) while promoting active engagement with scientific concepts. By fostering motivation through meaningful and career-relevant learning experiences, educators can better support students in developing a strong foundation in physics.

4. Conclusion

The study identified significant learning gaps in Grade 7 students' understanding of force, motion, and energy, particularly in higher-order thinking tasks such as interpreting distance-time graphs, distinguishing speed and velocity, and explaining heat transfer. While some students progressed, the majority struggled, especially with application-based questions like drawing free-body diagrams. These findings align with prior research on student difficulties in physics, highlighting the need for targeted interventions.

Motivation analysis revealed students generally view physics as valuable and relevant to daily life and future careers. Intrinsic and career motivation were strong, though self-efficacy and self-determination varied, with some students lacking confidence in assessments and study habits. Statistical analysis confirmed strong positive correlations between conceptual understanding and intrinsic, career, and grade motivation. However, self-efficacy was not significantly correlated, suggesting confidence alone does not guarantee deeper learning.

Study limitations, including the specific school setting and lack of a direct absolute motivation measure, suggest findings should not be overgeneralized. While this study used a quantitative questionnaire (PMQ-II) for motivation, it lacked qualitative insights into students' underlying reasons and challenges. Future research could enhance understanding by incorporating qualitative methods like interviews or focus group discussions. Building upon these findings, future research should also develop and implement specific teaching interventions targeting identified conceptual difficulties, such as those related to distance-time graphs and heat transfer. Investigating the effectiveness of these interventions through quasi-experimental or experimental designs would provide valuable insights into improving conceptual understanding and fostering motivation. Furthermore, exploring the long-term impact of integrating real-world applications and career pathways on student engagement and academic performance would be beneficial. Additionally, future research should consider expanding sample size, incorporating diverse instructional approaches, and examining other cognitive and environmental factors influencing learning outcomes.

Given these insights, a multi-faceted approach integrating both motivational and cognitive strategies is recommended to enhance student engagement and conceptual understanding. Teachers and curriculum developers should explore instructional methods that foster higher-order thinking and integrate engaging, real-world physics applications while addressing motivational and learning strategy gaps.

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