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Exploring Knowledge, Motivation, and Self-Efficacy in Physics Learning Among Malaysian Gifted Students

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Abstract: *This study investigates the motivational factors influencing gifted Malaysian students' engagement in physics, focusing on grade motivation, self-efficacy, career aspirations, and intrinsic interest. Conducted with 83 students from Kolej PERMATA@Pintar Negara, Universiti Kebangsaan Malaysia, the study utilized a quantitative approach, analyzing data with validated scales adapted to physics learning. Findings reveal that students view physics as highly relevant to both their academic goals and future careers, showing strong grade motivation and intrinsic interest in the subject. However, a significant gender difference was observed in self-efficacy, with male students expressing higher confidence levels. Career motivation also played a substantial role, as students associated physics knowledge with career advantages. The correlation analysis indicated that students perceived real-world applications of physics positively influence their intrinsic interest, though confidence in applying physics knowledge remains limited. These insights highlight the need for supportive instructional strategies that balance extrinsic and intrinsic motivation, fostering an inclusive environment to enhance engagement and confidence among gifted students pursuing STEM careers.*

Keywords: physics, knowledge, motivation, self-efficacy, gifted and talented students

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1. Introduction

Physics education plays a crucial role in developing critical thinking, problem-solving skills, and a deep understanding of the natural world. For gifted students, it offers an opportunity to challenge their intellectual abilities and foster their talents in science and engineering fields (Bao & Koenig, 2019). Analyzing students' attitude and motivation to learn is central in identifying needs and using stimulus for improvement or growth in physics education but also generally the larger problem that encompasses STEM education. Despite being one of the core subjects in sciences and important for critical thinking development and problem-solving capability, physics is often viewed as hard, making students less interested in learning it (Phang et al., 2020; Williams et al., 2003). The study is interested in gifted and talented student attitudes towards lessons in physics and their motivations for learning the subject, including grade motivation, self-efficacy, career aspirations and intrinsic interest.

Previous research has shown that students motivation tends to affect academic performance, especially the subjects considered as difficult or uncertain. The motivation to achieve good grades in physics can foster perseverance, while self-efficacy shapes students' confidence in their abilities (Fatonah, & Wicaksana, 2023; Ugwuanyiet al., 2020).

This paper aimed to investigate the influence of key motivational factors on gifted students' engagement with physics, specifically examining how grade motivation, self-efficacy, career aspirations, and intrinsic interest shape their attitudes toward the subject. By analyzing these elements, this study seeks to gain insights into the drivers of students' interest and persistence in physics, with the ultimate goal of informing strategies that foster a supportive and motivating learning environment for high-ability learners.

2. Literature Review

The motivation and attitude of students toward science and in particular physics, are two critical factors influencing their academic performance, as well as the likelihood that they will pursue a STEM (Science, Technology, Engineering and Mathematics) career. Many cited educational research that showed variables such as self-efficacy, motivation to get a good grade in the course, career aspirations, and intrinsic interest played key roles in student learning outcomes in physics, a subject often seen daunting due to its abstract concepts and complex problem-solving demands (Ardura, & Pérez, 2019; Fatonah, & Wicaksana, 2023).

Student motivation, especially grade-oriented motivation, has been widely researched in the context of academic achievement in physics. Grade motivation, defined as a student's drive to achieve high marks or excel in academic assessments, has been found to directly influence their effort, persistence, and study habits (Lau & Roeser, 2002). Students in this study showed strong motivation to achieve high grades and excel beyond their peers. While this type of grade-oriented motivation can enhance student engagement by promoting consistent study habits, certain studies warn that it may also displace the emphasis on deep learning to performing goals (Eccles & Wigfield, 2002), which may hinder physics conceptual understanding.

Another crucial element of physics education is self-efficacy, or the students' belief in whether they will be able to succeed in a subject. According to the social cognitive theory of Bandura (1997), students' self-efficacy does not only influence their academic performance but also helps them respond positively when faced with challenges. This is important because students with a high self-efficacy are more likely to approach complex problems in physics without avoidance. Recognizing how important self-efficacy can be, educators may design interventions that develop confidence and enhance motivation, particularly among underperforming groups with historically low self-efficacy such as female physicists.

Career motivation and intrinsic interest have a substantial impact on students' engagement in physics and their decisions to pursue physics-related careers. Career motivation, as seen in this study's analysis, is a significant factor, with students acknowledging the relevance of physics knowledge to future job opportunities and career advancement. Social cognitive career theory (Lent et al., 1994) indicates that career motivation could be important for STEM persistence, where students are more likely to continue studying physics if they believe it is useful for their future careers. Furthermore, intrinsic motivation, defined as an internal desire to engage with a subject for enjoyment and curiosity, is critical for deep, meaningful learning.

Gender differences in attitudes toward physics have been extensively studied, with findings suggesting that males often report higher self-efficacy in physics compared to females. Research suggests these differences may stem from societal stereotypes, classroom environments, and previous experiences with science education (Hazari et al., 2010). Addressing these gender-based discrepancies is crucial, as they can impact students' willingness to pursue physics beyond secondary education. Studies indicate that fostering an inclusive learning environment and providing positive role models in physics can enhance self-efficacy among female students, supporting a more gender-balanced interest in physics and STEM careers (Archer et al., 2012).

3. Method

This study was conducted on a sample of 83 students of Kolej PERMATA@Pintar Negara, Universiti Kebangsaan Malaysia, aged 16 to 17. This research is conducted using a quantitative approach. The most recent and trustworthy tools, the Attitude toward Chemistry Lessons Scale (ATCLS) (Cheung, 2009) and the Science Motivation Questionnaire II (SMQII), which was initially created for college students in the United States (Glynn et al., 2011), served as the basis for the survey questions. According to Cheung's (2009) and Glynn et al. (2011) initial validation work, ATCLS and SMQII can be adjusted to fit various scientific classifications.

Six constructs that characterize knowledge and motivation to learn physics make up the questionnaire that served as the primary research tool. There are 26 items in this questionnaire, with four to five items in each construct. A five-point scale was used to obtain the responses, starting with 1- Strongly Disagree, 2 - Disagree, 3 - Neutral, 4-Agree, and 5-Strongly Agree. Following this section, the questionnaire also included a set of demographic data focussing on age and gender.

Data analysis has been conducted using *IBM Statistical Packages for Social Science* (SPSS) v23 to determine the frequency, percentage, mean standard deviation, independent sample t-test and Pearson's correlation analysis.

4. Results and Discussion

Demographic Analysis

Table 1 presents a descriptive analysis of the respondents' demographic background, encompassing age and gender. A total of 83 participants were included in this study. The respondents' ages ranged from 16 years (n = 8, 9.6%) to 17 years (n = 75, 90.4%). Majority of respondents were male (n = 45.8, 54.2%), while females accounted for 38 participants (45.8%).

Table 1: Demographic Analysis

Characteristics		N	Percentage (%)
Age	16	8	9.6
	17	75	90.4
Gender	Male	45	54.2
	Female	38	45.8

Physics Knowledge

Analysis of students' perceptions regarding the utility of physics knowledge as shown in figure 1 reveals a strong recognition of its value, especially in understanding daily life applications (mean = 4.53) and addressing environmental challenges (mean = 4.33). Students also see physics as foundational for success in other academic subjects (mean = 4.07) and future careers (mean = 3.94). This aligns with previous research highlighting the importance of contextualizing physics in everyday life to enhance students' perceived relevance of the subject (Osborne et al., 2003). Integrating real-world applications in physics lessons may further strengthen students' connection to the subject, potentially improving their engagement and motivation.

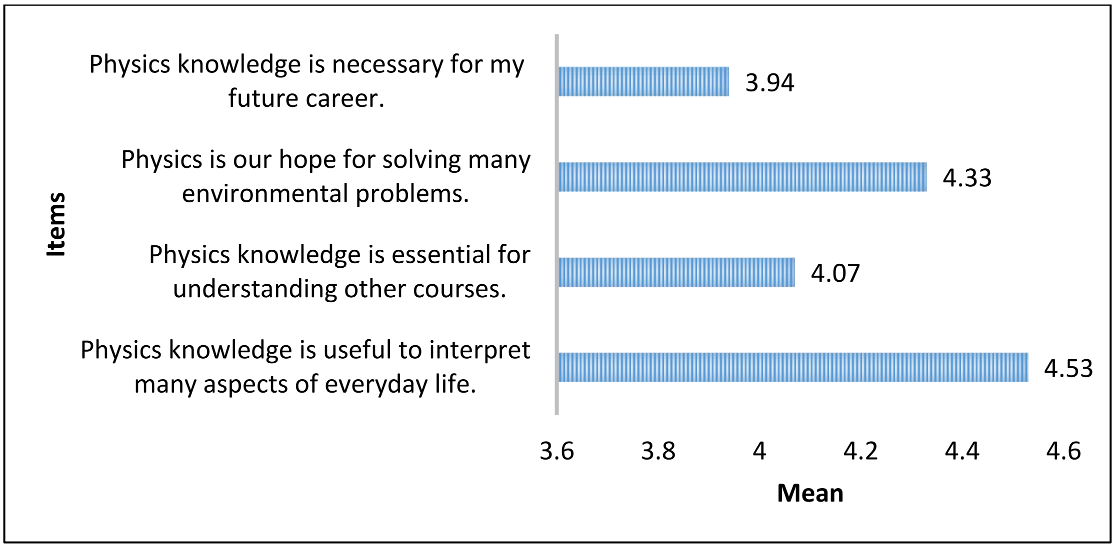

Figure 1: Use of physics knowledge in daily life

Motivation to Learn Physics

Figure 2 presents the motivations for learning physics among gifted and talented students. The motivation to achieve high grades in physics appears to be a significant factor for these students, with a mean score of 4.62 for the importance of achieving an "A" grade. This focus on academic performance aligns with findings by Pintrich and De Groot (1990), who identified grade motivation as a driver of engagement and effort in academic settings. However, the emphasis on grades may indicate an extrinsic motivation orientation, which has implications for learning depth. An overemphasis on grades could shift the focus from mastering concepts to simply achieving high scores, potentially affecting long-term interest and understanding.

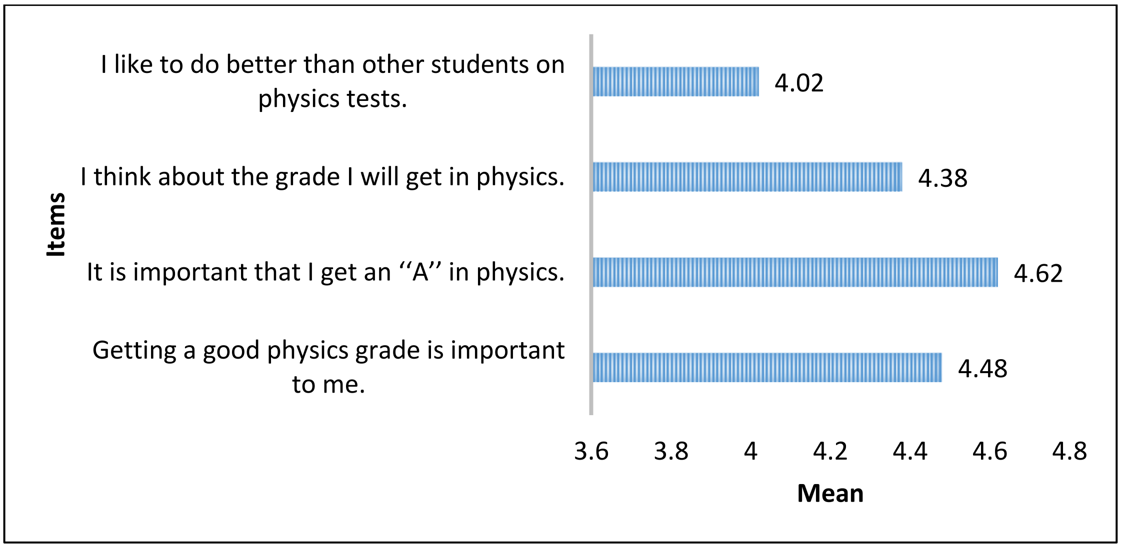

Figure 2: Grade motivation to learn physics

Self-Efficacy to Learn Physics

Figure 3 illustrates the self-efficacy of gifted and talented learners in studying physics. The analysis reveals a generally high level of self-efficacy among students, with an average score of 4.09 for confidence in achieving an "A" grade in physics. Notably, self-efficacy scores are higher among male students, with a statistically significant gender difference ($p = 0.031$), suggesting that male students in this sample feel more confident in their physics abilities. This finding supports previous research indicating that male students often report higher self-efficacy in physics (Britner & Pajares, 2006). Given the importance of self-efficacy for academic success (Bandura, 1997), addressing these gender disparities in physics could encourage more balanced participation and performance among students.

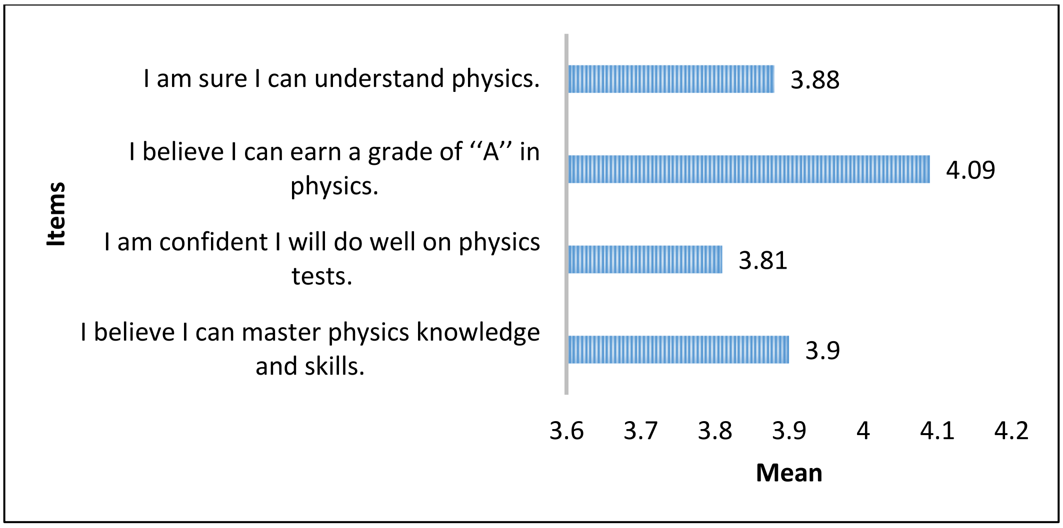

Figure 3: Self-efficacy to learn physics

Self-Determination to Learn Physics

Figure 4 illustrates the self-efficacy of gifted and talented learners in studying physics. Self-determination among students in learning physics shows moderate engagement, with "I study hard to learn physics" (mean = 3.77) and "I use strategies to learn physics well" (mean = 3.67) receiving the highest scores. These results suggest that while students exhibit a consistent effort toward mastering physics, there is room for strengthening their intrinsic motivation and study habits. Self-determination theory suggests that fostering autonomy and providing supportive learning environments can enhance students' intrinsic motivation (Ryan & Deci, 2000). Encouraging self-directed learning activities may further support these students in developing deeper engagement with physics.

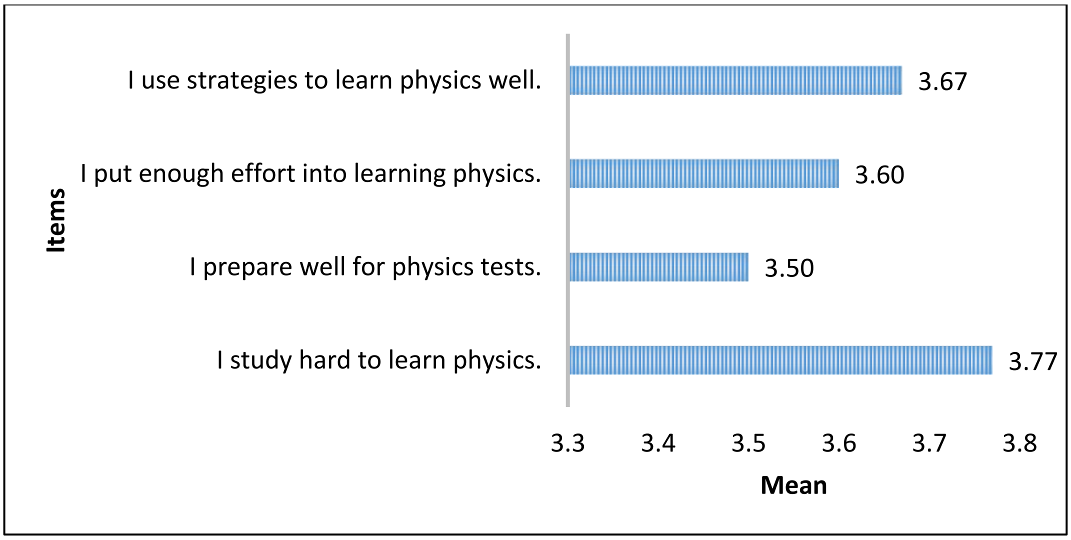

Figure 4: Self-determination to learn physics

Career Motivation to Learn Physics

Figure 5 depicts the career motivation factors driving physics learning among students. Students' career motivation is evident, as they believe that physics knowledge provides career advantages (mean = 4.17) and helps secure good job opportunities (mean = 4.15). This aligns with social cognitive career theory, which posits that students who perceive subjects as valuable for their future careers are more likely to engage with them (Lent et al., 1994). This career-oriented perspective highlights the importance of framing physics education within potential career contexts to maintain and enhance students' motivation.

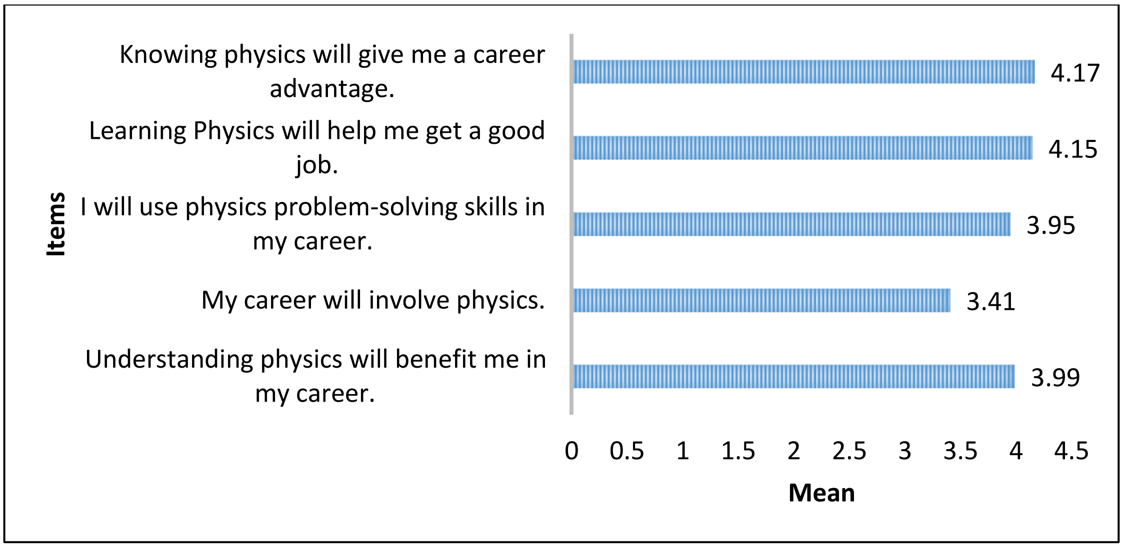

Figure 5: Career motivation to learn physics

Intrinsic Motivation to Learn Physics

Figure 6 illustrates the intrinsic motivation among gifted and talented learners to study physics. Intrinsic motivation, or the interest students have in learning physics for personal satisfaction, was relatively high, with "learning physics is interesting" scoring the highest mean (4.33). Other items, such as "enjoying learning physics" (mean = 4.19) and "relevance of physics to life" (mean = 4.17), also scored highly.

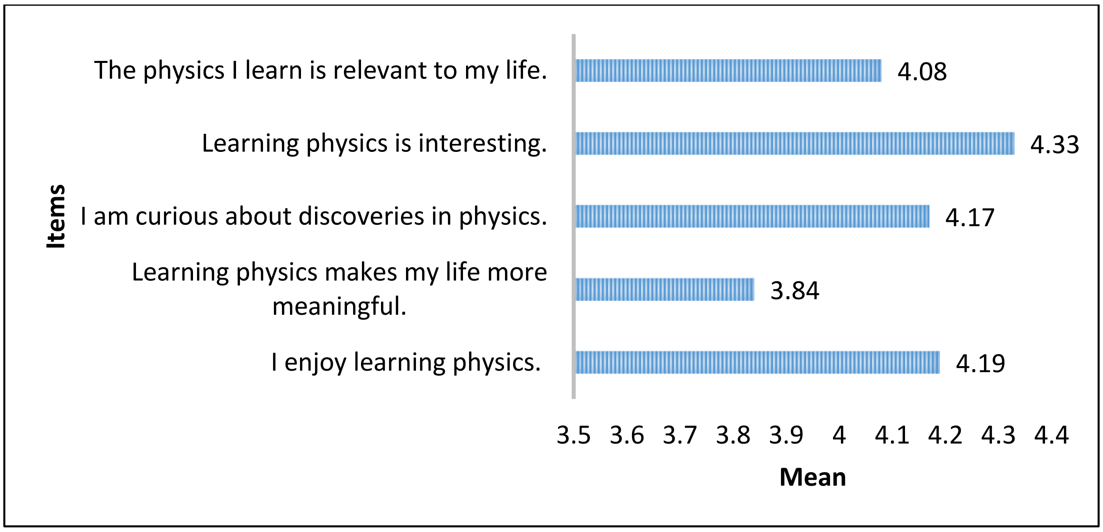

Figure 6: Intrinsic motivation to learn physics

Intrinsic motivation is associated with deeper learning and persistence, indicating that maintaining students' curiosity and interest in physics can support academic success. The high intrinsic motivation scores revealed in this study indicate that the students find physics intellectually stimulating and relevant, which previous research has shown is positively correlated with improved academic performance causing persistence in STEM fields (Ryan & Deci, 2000).

T-test Analysis

The difference in motivation to learn physics among gifted and talented students based on gender was examined using an independent samples t-test, the results of which are presented in Table 2. The analysis included six variables: use of physics knowledge, grade motivation, self-efficacy, self-determination, career motivation, and intrinsic motivation. The findings indicate that the p-values for the t-test exceeded the significance level of $\alpha = 0.05$ ($p > 0.05$) for all six variables, except for self-efficacy. This suggests that a significant difference exists in self-efficacy based on gender.

Table 2: Difference in knowledge and motivation to learn physics among gifted and talented students based on gender

Variable	Gender	Mean	Std. Deviation	t-value	p-value
Use of physics knowledge	Male	4.25	0.549	0.631	0.530
	Female	4.18	0.522		
Grade motivation	Male	4.42	0.580	0.729	0.448
	Female	4.32	0.620		
Self-efficacy	Male	4.07	0.814	2.194	0.031
	Female	3.73	0.557		
Self-determination	Male	3.61	0.927	-0.399	0.691
	Female	3.68	0.618		
Career motivation	Male	4.07	0.701	1.771	0.080
	Female	3.76	0.884		
Intrinsic motivation	Male	4.18	0.623	0.938	0.351
	Female	4.04	0.766		

n = 83

Pearson's Correlation Analysis

Table 3 reflects the Pearson's correlation analysis between the use of physics knowledge, grade motivation, self-efficacy, self-determination, career motivation and intrinsic motivation. A range of moderate to a weak relationship was observed between the variables. Results revealed that the highest moderate and significant relationship was obtained between the use of knowledge and intrinsic motivation (r= 0.638, p= 0.000), suggesting that students who perceive physics as valuable for real-world applications are also more likely to develop a personal interest in the subject. On the other hand, the weakest correlation was observed between student's use of physics knowledge and self-efficacy, with r= 0.303, p= 0.000), indicating that while students recognize the value of physics, this does not necessarily translate to confidence in their own abilities. These findings underscore the need for integrated teaching approaches that build both knowledge application and self-confidence.

Table 3: Correlation analysis between use of physics knowledge, grade motivation, self-efficacy, self-determination, career motivation and intrinsic motivation

	UK	GM	SE	SD	CM	IM
Use of physics knowledge (UK)	1	0.496**	0.303**	0.573**	0.593**	0.638**
Grade motivation (GM)	0.496**	1	0.465**	0.526**	0.367**	0.607**
Self-efficacy (SE)	0.303**	0.465**	1	0.457**	0.383**	0.494**
Self-determination (SD)	0.573**	0.526**	0.457**	1	0.400**	0.524**
Career motivation (CM)	0.593**	0.367**	0.383**	0.400**	1	0.584**
Intrinsic motivation (IM)	0.638**	0.607**	0.494**	0.524**	0.584**	1

** Correlation is significant at the 0.01 level (2-tailed)

5. Conclusion

This study offers valuable insights into what motivates gifted students to engage with physics. The results show that students see physics as relevant to both their knowledge and future careers, often linking it to real-life situations or potential jobs. Grades are a strong motivator, indicating that academic performance plays a major role in student engagement, while many students also expressed a true love for the subject, which may keep them interested beyond high school.

Overall, students were confident in their abilities, though male students tended to feel more confident than female students, suggesting a chance to make the learning environment more supportive and balanced. Students were generally committed to succeeding in physics but could benefit from additional resources to strengthen their efforts.

The study found a strong link between how useful students thought physics was and their interest in it, suggesting that when students see physics as relevant to their lives and goals, their interest grows. The weakest link was between how useful they saw physics and their confidence in understanding it, indicating a need to develop both relevance and confidence in the subject.

In conclusion, teaching strategies that balance both intrinsic (interest-based) and extrinsic (grade or career-focused) motivations can boost students' engagement in physics. Recognizing whether students are motivated by grades, career aspirations, or personal interest can enable educators to build a more supportive physics learning environment, better preparing them for success in STEM fields.

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