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Epistemic Principles and Performance of Physics among Secondary School Students

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Abstract: *Secondary school physics education is a critical stage in shaping students' understanding of the physical world. However, there is a recognized gap in understanding of relationship between epistemic principles and performance of physics among secondary school students in Kenya. Addressing this gap is essential for informing strategies that align with students' epistemic orientations and consequently, enhance performance of physics in secondary school. The study explored the relationship between epistemic principles and performance of physics among secondary school students. Mixed research comprising a sample size of 310 form two students was adopted. Descriptive statistics show that empiricist tendencies prevail, indicating a preference for hands-on learning. Participants, on average, moderately disagree with the rationalist idea that knowledge and success in physics depend on innate capabilities. Inferential statistics show that empiricist beliefs positively linked to physics success while rationalist beliefs were negatively linked to physics success. Study recommends promoting hands-on, experiential learning in physics, encourage open discussions and group activities for diverse perspectives, foster a growth mindset by emphasizing cultivability of skills, and challenge stereotypes to motivate students in viewing challenges as opportunities for success in physics education.*

Keywords: *Epistemic principles, physics performance, secondary school students, philosophical inquiry*

1. Introduction

Secondary school physics education contributes to scientific literacy, enabling students to understand and critically evaluate scientific information. In an era dominated by technological and scientific advancements, an informed citizenry is essential for making decisions on issues such as climate change, public health, and energy resources. Physics forms the basis of technological innovations that drive contemporary society. Secondary school physics education lays the groundwork for future engineers, scientists, and innovators who contribute to advancements in fields like electronics, telecommunications, renewable energy, and medical technologies. Physics education at the secondary level fosters critical thinking and problem-solving skills (Twahirwa & Twizeyimana, 2020). Students learn to approach complex challenges systematically, breaking them down into manageable components. These skills are valuable not only in scientific endeavors but also in various professions and everyday life. A solid foundation in secondary school physics opens up diverse career pathways. Students equipped with physics knowledge are well-prepared for careers in science, technology, engineering, and mathematics (STEM) fields, contributing to economic development and competitiveness in a globalized world. Understanding physics principles is fundamental to advancements in healthcare (Imran & Mehmet, 2022). Secondary school physics education introduces students to the physics of medical imaging, diagnostics, and therapeutic technologies. This knowledge is foundational for future healthcare professionals and researchers. Secondary school physics education is accordingly pivotal in shaping the knowledge, skills, and perspectives of individuals in contemporary society. The significance of physics extends beyond academic achievement, influencing societal progress, technological innovation, and the cultivation of responsible and informed citizens capable of addressing the challenges and opportunities of the modern world.

In spite of the significance of physics, its teaching frequently results in inadequate academic performance on a global scale. In the United States, a noteworthy academic concern in 2019 manifested within the realm of ninth-grade science, particularly evident in the content and cognitive dimensions pertaining to physics. It was observed that students exhibited a discernible decline in performance compared to the proficiency levels observed in 2015 (Richardson et al., 2020). This decline in performance deserves attention from scholars and calls for a thorough investigation into possible factors contributing to this decline. In France and Italy, the results from international assessments like TIMSS and PISA indicate a persistent and declining trend in the academic performance of students in science and physics (Tofig, 2017). Some factors such as outdated curriculum, ineffective teaching methods, insufficient educational resources, and the need for improved teacher quality have been identified (Suna et al., 2019). In Australia, there is a consistent decline in candidates and performance in physics among the major sciences in high schools (Shields, 2015). Factors identified for this decline include personal relevance, interest, the abstract nature of physics, and cultural characteristics (Jasmina, 2019). Azam (2018) suggests interactive teaching and emphasizes understanding physics concepts over rote memorization to address these challenges. Despite these recommendations, the performance of physics remains below average (Assem et al., 2023). There is a need to shift focus from instructional strategy studies to mindset research to offer potential solutions for persistent poor performance in physics.

In Nigeria, Abubakar (2020) highlighted a concerning trend of diminishing enrollment in physics-related courses, particularly at high school and the higher education level. The decline in student interest in physics and related disciplines appears to be closely linked to the instructional methods and educational materials employed by physics teachers in classrooms (Akanbi et al., 2018). In South Africa, there is an ongoing concern about students' insufficient academic performance in physics, especially within the broader field of Science, Technology, Engineering, and Mathematics (Ramaila& Reddy, 2020). This issue demands attention to encourage pedagogic innovation, essential for the meaningful development of scientific skills. The persistent underperformance of students in the field of physical sciences, as reflected in the National Senior Certificate examination results in South Africa, has been a longstanding issue (Department of Basic Education (DBE), Republic of South Africa, 2016). To address the persistently poor performance in physics among South African students, several strategies have been proposed. These include the implementation of innovative pedagogical approaches to make the subject more engaging and accessible. However, Ogegbo et al. (2019) noted that in comparison to global standards, data from the Trends in Mathematics and Science Study (TIMSS) indicate that South African learners consistently fall below the expected international proficiency levels. Despite the implementation of various strategies to address the persistent poor performance in physics among students, the continued challenges may imply that there’s need to focus on students beliefs and their relationship to performance of physics.

The Tanzanian government and stakeholders addressed poor performance and low enrollment in science classes by introducing competency-based education (CBE) with a focus on scientific inquiry (United Republic of Tanzania, 2021). Professional development for teachers was recommended to improve science learning outcomes. Adopting learner-centered strategies, aligned with progressivism theory, involved activity-based approaches like experimentation and problem-solving were also recommended. Despite these efforts, Physics ACSEE results indicate persistently low student interest and poor performance (Rwegasha, 2012). In Kenya, there’s an issue with physics enrollment and performance. Students find physics challenging and perceive it as uninteresting and impractical (Wesonga&Aurah, 2019). Despite efforts to highlight its benefits and pragmatic epistemology, a negative perception persists, leading to growing disinterest in science subjects. This perception results in low enrollment, poor scientific inquiry skills, unfavorable attitudes, and subpar academic performance in physics. The overall mean score for physics in the KCSE from 2017 to 2020 was only 34.73%, indicating a significant challenge even in schools with high-achieving students opting for physics. Further investigation is needed to understand the potential link between elements like epistemic beliefs and physics performance.

2. METHODOLOGY

This study utilized a mixed-methods approach, involving a descriptive survey and correlational analysis, to explore the link between epistemological beliefs and physics performance. The choice of a descriptive survey method was based on its capability to collect quantitative data through closed-ended items. The correlational research design aimed to evaluate the connection between epistemological beliefs and physics performance, with the sample size determined using Israel's formula, resulting in 310 participants. Schools were classified into national, extra-county, county, and sub-county categories, and 20 public secondary schools with 310 students from each category were selected proportionately. The drop-pick method facilitated the distribution and collection of questionnaires. Statistical Package for Social Sciences (SPSS) version 26 analyzed coded quantitative data. Descriptive statistics, such as mean, and standard deviation were used to examine quantitative data, and the relationship between variables was determined through Spearman's rho correlation (r).

3. Results and Discussion

The study of the relationship between epistemic beliefs and performance in physics involved examining the underlying assumptions, epistemological perspectives, and ontological implications related to how individuals perceive their ability to learn and excel in the field of physics. One aspect of the analysis involved exploring epistemological theories that discuss the nature of knowledge and how it is acquired. The aspects of empiricism versus rationalism were examined. These facets of epistemology offered insights into how students believed they gain knowledge in physics, whether through sensory experiences, reason, or the active construction of knowledge based on prior experiences.

3.1. Empirical Principles and Performance of Physics

The participants were tasked with specifying their depth of consensus with several affirmations, which measured relationship between empirical principles physics performance. The findings are displayed in Table 1.

Table1. *Responses on Empirical Principles and Physics Performance*

Statement	N	M	S.D
I believe that actively engaging with physics conducting experiments contributes to my overall success in physics	310	3.59	1.349
I feel confident in my ability to explore and experiment with physics concepts to improve my performance in the subject	310	3.35	1.309
I enjoy conducting physics experiments to enhance my knowledge	310	3.93	1.266
I believe that experimentation is essential for learning and mastering physics concepts	310	4.03	1.068
Overall Mean Score	310	3.73	1.248

Information in Table 1 show that on average, the participants express a moderate level of agreement (Mean = 3.59) with the idea that actively engaging with physics through experiments contributes to their overall success in the subject. However, the responses exhibit a relatively wide range of perspectives (Standard Deviation = 1.349), with some participants strongly valuing the importance of conducting experiments while others holding reservations or differing viewpoints. The participants, on average, demonstrate a moderate level of confidence (M = 3.35) in their ability to explore and experiment with physics concepts to improve their performance. The responses show considerable variation (S.D = 1.309), indicating significant differences in participants' levels of confidence when it comes to conducting experiments in physics. On the subject of enjoying physics experiments as a means to enhance knowledge, the participants, on average, moderately agree (M = 3.93). The responses demonstrate a relatively narrow dispersion (S.D = 1.266), suggesting that participants generally share a similar level of enjoyment in conducting experiments. When it comes to recognizing the importance of experimentation for learning and mastering physics concepts, the participants, on average, agree to a considerable extent (M = 4.03). The responses display a relatively low dispersion (S.D = 1.068), indicating a shared belief among participants about the significance of experimentation in physics learning. The overall findings (M = 3.73, SD = 1.248) signifies that, on average, participants moderately agree with the statements concerning the value of actively engaging with physics through experiments.

The overall analysis of the items measuring empirical principles and performance of physics from a philosophical perspective suggests that the participants, on average, exhibit empiricist tendencies by recognizing the value of direct engagement and experimentation in learning physics. The recognition of empiricist tendencies suggests that participants value hands-on, experiential learning methods in physics. This has implications for educational practices, encouraging educators to emphasize practical, laboratory-based approaches to teaching physics. This finding aligns with that of Twahirwa and Twizeyimana (2020) who found that engaging in hands-on activities remains a promising method for instructing science subjects, with a particular emphasis on teaching Physics in secondary school settings. The overall responses' dispersion suggests that while there is a general consensus on the importance of experimentation, there is a diverse range of opinions among the participants. The variation in responses indicates a widespread acknowledgment of the significance of experimentation, but it also implies a considerable diversity of opinions among the participants. This suggests that while there is a shared understanding of the value of experimentation, individual perspectives and attitudes toward this approach may differ significantly.

Philosophical issue of whether the findings were influenced by confirmation bias would arise, where participants may be more likely to endorse empiricist beliefs because they align with commonly accepted views in the field of physics. Studies in effective science learning posits that integration of practical work in physics education not only enhances understanding and skills but also fosters a holistic and meaningful learning experience (KICD, 2016; Oliveira & Bonito, 2023). Consequently, educationalists recommends and advocates for regular use of experiments in the process of teaching and learning of physics. Conversely, this enthusiastic recommendation raises considerations about potential bias towards experiments in the participants' responses. However, the results of this study emanated from a diverse and representative sample of participants from different schools and experiences in physics to minimize the impact of a homogenous group that might share pre-existing beliefs. Anonymous responses and neutral questioning were also adopted to reduce the likelihood of individuals providing answers that align with perceived expectations and obtaining more genuine and unbiased reflections of their beliefs.

From an epistemological perspective, findings on relationship between empirical beliefs and performance of physics suggest a preference for learning through direct interaction with the subject matter and real-world applications rather than relying solely on theoretical or abstract reasoning. The emphasis on empiricism aligns with the idea that knowledge in physics is derived from tangible experiences and experimental exploration, contributing to a more practical and experiential approach to understanding the subject. One possible philosophical issue that could arise from these findings is the question of the nature of knowledge itself. Empiricism asserts that knowledge is derived from sensory experience, and this finding supports that notion. However, it also raises the question of whether knowledge gained through experiments is more reliable or valuable compared to other methods of acquiring knowledge. A study by Antwi et al. (2021) recommends that physics educators should incorporate hands-on activities as a teaching method and should also be incentivized to integrate practical exercises when teaching various concepts. Implementing these recommendations could potentially have positive effects on the overall performance of students in physics. Furthermore, the findings highlight the importance of experiential learning in physics education. Empiricism emphasizes the active engagement with the world and the idea that knowledge is gained through personal experience. The moderate agreement with the value of engaging with physics through experiments suggests that participants recognize the significance of hands-on learning in understanding and applying physics concepts. While participants show moderate agreement on the role of experimentation, responses also reveal varying perspectives. These insights can be valuable for educators and learners, emphasizing the importance of fostering empiricist beliefs in physics education to enhance students learning experiences and performance in the subject.

3.2. Rationalist Principles and Performance of Physics

The participants were tasked with specifying their depth of consensus with several affirmations, which measured relationship between rationalist principles and performance physics among secondary school students. The findings are displayed in Table 2.

Table2. *Responses on Rationalist Principles and Physics Performance*

Statement	**N**	**M**	**S.D**
I believe that learning physics is more about discovering inherent capabilities rather than developing new skills through practice.	310	2.484	0.071
I believe that effort and hard work have little impact on one's performance in physics	310	2.049	0.058
I believe that my capacity to acquire knowledge in physics is limited by my inborn intellectual capabilities	310	1.921	0.052
I believe that individuals are born with a fixed level of ability for physics, which cannot be significantly changed through effort	310	2.349	0.066
I believe that success in physics is primarily determined by one's natural talent.	310	2.145	0.058
Overall Mean Score	310	2.189	0.061

Information in Table 2 show that on average, the respondents tend to slightly agree that learning physics is more about discovering inherent capabilities rather than developing new skills through practice (M = 2.484). The responses are relatively consistent across the participants, as indicated by the low standard deviation (S.D = 0.071). In terms of effort and hard work's impact on performance in physics, the respondents, on average, mildly disagree (M = 2.049), and there is a relatively consistent trend in this belief among the participants (S.D = 0.058). Regarding their capacity to acquire knowledge in physics, the respondents, on average, slightly disagree that it is limited by their inborn intellectual capabilities (M = 1.921), with a relatively consistent pattern in the responses (S.D = 0.052). Similarly, the respondents, on average, moderately disagree that individuals are born with a fixed level of ability for physics that cannot be significantly changed through effort (M = 2.349), and the relatively low standard deviation (S.D = 0.066) indicates consistency in the responses. When it comes to success in physics being primarily determined by one’s natural talent, the respondents, on average, mildly disagree (M = 2.145), and the low standard deviation (S.D = 0.058) suggests a relatively consistent trend in the responses. Considering all the statements, the overall mean score indicates that, on average, the respondents have a slightly disagreeing stance regarding the belief that inherent capabilities play a more significant role in learning physics than developing new skills through practice (M = 2.189). The relatively low standard deviation (S.D = 0.061) suggests that the responses are relatively consistent among the participants.

The overall mean score of 2.189 suggests that, on average, the participants slightly disagree with the notion that inherent capabilities play a more significant role. This challenges the traditional philosophy of rationalism, which posits that knowledge is innate and can be accessed through reason alone. The relatively low standard deviation of 0.061 indicates that there is a high level of agreement among the participants. This consistency suggests that the disagreement with the belief in inherent capabilities is not an isolated viewpoint but rather a shared sentiment among the respondents. The findings indicate that the participants, on average, show a moderate to mild disagreement with the beliefs that knowledge acquisition is limited by inborn intellectual capabilities, and that success in physics is primarily determined by natural talent. They also express a mild disagreement with the idea that effort and hard work have little impact on their performance in physics. Additionally, the respondents slightly disagree with the belief that learning physics is more about discovering inherent capabilities rather than developing new skills through practice. The low standard deviations suggest that there is a degree of agreement and consistency among the respondents in their views. The findings presented reveal an intriguing perspective on the role of inherent capabilities versus skill development in learning physics.

Overall, the results show that the participants tend to believe in the importance of effort and development in learning and performing in physics, rather than relying solely on innate abilities or fixed talent. The low standard deviations among the participants indicate a degree of agreement and consistency in their views. This consensus suggests that the findings are robust and that there is a shared perspective among the participants regarding the role of effort, hard work, and skill development in physics education and performance. The findings not only underscore the significance of individual effort and commitment in the pursuit of physics knowledge but also highlight a departure from deterministic beliefs that success is primarily predetermined by innate abilities. This shared perspective among participants contributes to a constructive educational atmosphere, where students are more likely to engage in proactive learning behaviors and view challenges as opportunities for growth. The findings concurs with that of Assem et al. (2023) who found that students entering a physics course with the mindset that only naturally gifted individuals can excel in problem-solving tend to fare worse compared to their peers who believe in effort and the gradual nature of learning.

The overall findings challenge the traditional notion of knowledge as something that is inherent and fixed. Instead, they imply that knowledge is dynamic and can be acquired through active engagement with the subject matter. This raises questions about the origin and nature of knowledge and invites further exploration into the processes of learning and understanding. The role of experiments in shaping understanding becomes a central point of discussion. If inherent capabilities were deemed to be more significant, there would be less emphasis on experimentation and observation. However, the findings suggest that participants value the experiential aspect of learning, indicating that hands-on engagement and practical application are crucial for comprehending physics concepts. The participants' disagreement with the belief in inherent capabilities implies that they recognize the value of practice and skill development. This challenges traditional pedagogical approaches that prioritize theoretical knowledge over practical application. It suggests that educators should incorporate more experiential learning opportunities to enhance students' understanding of physics.

The implications of the overall results underscore a prevailing belief among participants in the significance of effort and developmental aspects in the context of learning and performing in physics. This contrasts with a reliance on innate abilities or fixed talent. The low standard deviations observed among the participants suggest a notable level of agreement and consistency in their perspectives. This collective mindset towards valuing effort and growth-oriented learning may have positive implications for fostering a conducive and encouraging learning environment in physics education. The findings imply that the participants, as a collective, reject notions that limit knowledge acquisition to inborn intellectual capabilities or attribute success in physics solely to innate talent. Instead, there is a recognition that sustained effort and the cultivation of skills play pivotal roles in mastering the subject. The low standard deviations indicate a remarkable degree of agreement and consistency in these views among the participants.

3.3. Correlation of Empiricist and Rationalist beliefs with Performance of Physics

The study sought to examine determine the relationship epistemic beliefs of knowledge acquisition and performance of physics among secondary schools students in. A Spearman's correlation was run to determine the relationships between empiricist and rationalist beliefs of knowledge acquisition and performance of Physics. The results are shown in Table 3.

Table3. *Correlation analysis of Epistemic Beliefs and Performance of Physics*

		Performance	Rationalism	Empiricism
Performance	Spearman's rho	1.000		
	Sig. (2-tailed)	.		
	N	310		
Rationalism	Spearman's rho	.071	1.000	
	Sig. (2-tailed)	.217	.	
	N	310	310	
Empiricism	Spearman's rho	.246	.057	1.000
	Sig. (2-tailed)	.000	.318	.
	N	310	310	310

The correlation between performance and rationalism belief is positive but weak (0.071). However, the p-value (0.217) is greater than the conventional significance level of 0.05, indicating that this correlation is not statistically significant. In other words, there is no strong evidence to suggest that there is a meaningful relationship between performance and rationalism in this dataset.The lack of a significant correlation may also underscore the importance of context in philosophical debates. It is possible that in certain contexts or domains, Rationalism may be more strongly correlated with performance, while in others, it may not. This raises questions about the contextual relevance and applicability of philosophical theories. The correlation between performance and empiricism is positive and statistically significant. The Spearman's rho coefficient of 0.246 suggests a moderate positive relationship between these two variables.

The p-value being less than 0.001 indicates that this correlation is highly unlikely to have occurred by random chance. Therefore, there is strong evidence to suggest that there is a meaningful and positive relationship between performance and empiricism in this dataset.The weak correlation between performance and rationalism may reflect the complex nature of human cognition. While Rationalism posits that innate ideas and reason are central to knowledge acquisition, it appears that, in this dataset, rationalistic tendencies do not strongly correlate with actual performance. This challenges the idea that a rationalistic approach is inherently superior for achieving high performance.Philosophers such as René Descartes and Immanuel Kant have championed rationalism as a powerful means of acquiring knowledge (O'Grady, 2019). However, positive relationship between empiricism beliefs suggests that relying solely on rationalistic approaches may not necessarily lead to better performance in practice. It highlights the importance of considering empirical factors, such as real-world experience and observation, alongside rational thought.

The finding that there was a positive correlation between empiricism beliefs and performance of physics aligns with the broader trend in philosophy that encourages philosophers to engage with empirical evidence and empirical research methods (Lutz & Tuboly, 2021). While philosophy has historically been characterized by abstract reasoning and conceptual analysis, this result highlights the potential benefits of incorporating empirical data and scientific methodology into philosophical investigations. This finding raises questions about the effectiveness of rationalism as a sole approach to achieving high performance. Philosophically, it underscores the need to consider a more holistic view of human cognition and behavior. It suggests that relying exclusively on deductive reasoning and a priori knowledge, as advocated by rationalism, may not be sufficient for achieving excellence in various domains.

The positive and statistically significant correlation between performance and empiricism suggests that, within the context of this dataset, there is a meaningful relationship between relying on empirical evidence and achieving better performance. From an epistemological standpoint, this finding aligns with empiricism as an epistemic theory that emphasizes the importance of sensory experience and observation in acquiring knowledge. Empiricists argue that knowledge is primarily derived from empirical evidence, and this correlation provides empirical support for this perspective. The moderate strength of the correlation coefficient (Spearman's rho of 0.246) implies that while there is a relationship between performance and empiricism, it is not an extremely strong one. Philosophically, this observation can lead to a nuanced discussion. It suggests that while empirical evidence is valuable, it is not the sole determinant of performance or success. Other factors, such as reasoning, intuition, and individual differences, also play a role. This nuanced perspective aligns with a more comprehensive epistemology that considers both empirical and rational elements in the acquisition of knowledge.

The result also raises questions related to philosophical skepticism, which often challenges the reliability of sensory experience and empirical evidence. The positive correlation suggests that, despite philosophical skepticism's arguments, empiricism can still be a valuable and effective way to navigate the world. The correlation between Performance and Empiricism raises questions about the epistemological foundation of knowledge and the extent to which empirical evidence contributes to our understanding of the world. Philosophers such as John Locke, George Berkeley, and David Hume have historically championed empiricism as a way to gain knowledge. This finding could be seen as lending empirical support to the empiricist perspective, suggesting that individuals who prioritize sensory experience may excel in certain performance-related tasks (Ayer & Winch, 2013). The moderate strength of the correlation (0.246) suggests that while there is a connection between Performance and Empiricism, it is not an overwhelmingly strong one. This raises questions about the complex interplay between rationalism and empiricism in human decision-making and performance. Philosophers have explored the tension between rationalism and empiricism for centuries. Rationalism emphasizes the role of reason and a priori knowledge (knowledge independent of experience), while empiricism emphasizes sensory experience. This correlation could suggest that a balanced approach that combines empirical observation with rational analysis might be conducive to better performance.

3.4. Hypothesis Testing

The pseudo R-square values offer insights into the explanatory power of the logistic regression model. The Cox and Snell pseudo R-square is 0.363, suggesting that approximately 36.3% of the variance in physics performance is explained by the epistemic beliefs included in the model. The Nagelkerke pseudo R-square, accounting for the scaling factor, is consistent with a value of 0.364. This reinforces the idea that the model has good explanatory power, explaining 36.4% of the variance. The McFadden pseudo R-square, although lower at 0.075, indicates that the model explains 7.5% of the variability in physics performance compared to a null model.

The study sought to establish the significance of individual variables in the model. The generated parameter estimates showing the relationship between performance of physics and the beliefs in certainty of knowledge were presented in Table 4.

Table4. *Parameter Estimates of Epistemic Beliefs and Physics Performance*

		B	SE	Wald	df	Sig.	Exp(B)
Location	Rationalist Beliefs	-0.158	0.132	1.443	1	0.230	0.854
	Empiricist Beliefs	0.226	0.086	6.932	1	0.008	1.254

The results reveal significant implications for the relationship between empiricist beliefs and performance in the context of physics. With a coefficient of 0.226 and a statistically significant p-value of 0.008, the findings suggest that individuals holding stronger empiricist beliefs are associated with a notable increase in the odds of positive outcomes in physics performance. The odds ratio of 1.254 further highlights that for every one-unit increase in empiricist beliefs, there is a 25.4% increase in the odds of achieving a favorable outcome in physics. These results underscore the potential importance of fostering empiricist perspectives, emphasizing hands-on experience, observation, and experimentation, as a means to enhance success and proficiency in physics-related tasks. The findings regarding rationalist beliefs in the context of physics performance indicate a non-significant negative association. While the coefficient of -0.158 suggests a decrease in the log-odds of positive performance with an increase in rationalist beliefs, the lack of statistical significance (p = 0.230) implies that this observed change may occur by random chance. The odds ratio of 0.854 further suggests that, for every one-unit increase in rationalist beliefs, the odds of achieving a positive outcome decrease by a factor of 0.854, although this decrease is not deemed statistically meaningful. Consequently, the results imply that rationalist beliefs alone may not be a robust predictor of physics performance in this study, and caution is warranted in attributing any substantive impact based on the observed non-significant association.

4. Summary of Findings

Descriptive statistics show that empiricist tendencies prevail, indicating a preference for hands-on learning. Educational implications include emphasizing practical approaches in physics teaching. Participants, on average, moderately disagree with the idea that knowledge and success in physics depend on innate capabilities, challenging traditional rationalism. Inferential statistics show that empiricist beliefs positively linked to physics success (B = 0.226, p = 0.008, odds ratio: 1.254). Rationalist beliefs show non-significant negative association with physics performance (B = 0.158, p = 0.230, Exp(B) = 0.854). In practical terms, fostering empiricist perspectives may prove beneficial for enhancing proficiency in physics-related tasks, highlighting the importance of hands-on experience and observation.

5. Recommendations

Educators are encouraged to incorporate a variety of hands-on, experiential learning methods in physics instruction. Encouraging open discussions and group activities can provide students with a platform to share their diverse perspectives on the value of experimentation. Promote a growth mindset in physics education by emphasizing that intelligence and skills can be cultivated through dedication and hard work. Integrate mindset-focused strategies to motivate students to see challenges as chances for growth rather than overwhelming obstacles. Challenge stereotypes in physics education by emphasizing that success is attainable through hard work and commitment, irrespective of perceived natural talent.

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