Certainty of Knowledge and Performance of Physics among Secondary School Students in Tharaka-Nithi County, Kenya

*John Karauri Mbaka Dr. Benjamin Mugambi Kanga Dr. Ruth Mutunge Mwanzia
Dr. James M. Murungi
Chuka University, Kenya
*Email of the Corresponding Author: jkaraurim@gmail.com

Abstract

The study aimed to investigate the extent to which students' epistemological beliefs in the dimension of certainty of knowledge acquisition relate to performance in physics. The study used a mixed-methods research approach that included philosophical analysis, a descriptive survey, and a correlational analysis. The sample size comprised 310 form two students, 60 physics teachers, and 20 heads of the science department. Quantitative data was analyzed using descriptive and inferential statistics. Qualitative data was analyzed through a thematic approach. The study revealed a positive correlation between sophisticated beliefs in the certainty of knowledge and performance in physics. The researcher concluded that sophisticated beliefs in certainty of knowledge contribute towards better performance in physics. The study suggests the implementation of strategies aimed at fostering the development and adoption of sophisticated epistemological beliefs in the certainty of knowledge among students to enhance their performance in physics. The outcome of this study can inform educational policymakers, curriculum developers, and teachers in Kenya to design interventions that promote the development of students' epistemological beliefs in certainty of knowledge to stimulate performance in physics.

Keywords: Certainty of knowledge, Epistemological belief, Knowledge acquisition, Physics performance, Secondary school
DOI: 10.7176/JEP/14-28-02
Publication date: October 31st 2023

1. Introduction

Physics, as a scientific discipline, plays a vital role in advancing understanding of the physical world, fostering logical thinking skills among young individuals, driving technological progress, nurturing scientific attitudes, and addressing societal challenges (Musasia et al., 2016). Out of all the science subjects, physics offers the greatest opportunity for discoveries, because it functions as a bedrock destined for the cognition of primal forces behind scientific inventions (Ugwuanyi et al., 2020). Physics education also aims at enabling the learner to achieve the skills of problem-solving and decision-making. It also offers the learners with a rational inquiry that helps them respond to the extensive and fundamental changes in information, health care and technology for economic development (Zhang et al., 2017). Physics knowledge in addition promotes the accumulation of national wealth that accelerates the development of a country through the sale of technology (KICD, 2017). At tertiary institutions, the training in computer science and engineering courses requires physics as one of the prerequisites subjects. Thus, the hub for the development of any society should be vested in the knowledge of physics because its principles cut across other science subjects.

Regardless of the definite significance of physics in various sectors, many students hold a belief that the subject is problematic and too theoretical (Calmer, 2019). Scholars in Physics education have presented recommendations and suggestions for strategies to boost or eliminate the insight that Physics is a challenging and abstract science. Part of the strategies put in place is the advocacy of the use of exploratory learning strategies and making the subject compulsory in lower grades of secondary school (CEMESTEA, 2014). Developed countries such as the USA and Germany for a considerable period have directed their attention toward enhancing the performance of science with a key focus on physics (Calmer, 2019). Nevertheless, these countries still experience low enrollment and inadequate performance in physics (Provasnik & Malley, 2019). In Australia, Kennedy et al. (2014) disclosed that the percentage of candidates doing physics was progressively declining year after year. Some factors the researchers identified for the unremitting decline in the performance of physics in Australia were personal relevance, interest, the abstract nature of physics, and the cultural characteristics of the learners (Provasnik & Malley, 2019). Despite the anticipated advantages and prospects of constructivist education in enhancing science subjects' performance, the teaching of physics in Rwandan schools experiences low student enrollment, subpar academic achievement, and a negative attitude from learners. (Mbonyiryivuze et al, 2021). The poor performance indicates the essentiality of inquiry about connection between epistemological beliefs held by the students and physics in performance.

In Kenya, enrolment and achievement in physics across different education tiers are minimal (Murei, 2016). Students also maintain a conviction that physics is uninteresting and entails challenging assignments that are conceptual and hypothetical (Muchai, 2016). Despite the efforts made to promote the significance and advantages of physics and the extensive research conducted using the principles of pragmatic epistemology to enhance its performance, the poor performance remains unchanged. The average score in physics for the period of 2018-2022 in KCSE was (34.73%) out of the possible maximum score of 100 percent (KNEC, 2021). In Tharaka-Nithi County, the overall performance of physics in KCSE falls short of the national level (Tharaka-Nithi County Education Office, 2021). The poor results persist even though educators have been consistently implementing strategies suggested by CEMESTEA (2014), such as laboratory scientific inquiry, experimentation, and project work, which are believed to enhance the effectiveness of physics education. This implies that solely frequently used scientific inquiry methods may not sufficiently explain deficiencies in learning and grasping physics concepts. The current research explored the link between students' beliefs about the certainty of knowledge and their performance in physics within secondary schools in Tharaka Nithi County, Kenya.

2. Literature Review

The dimension of epistemological belief in the certainty of knowledge proposed by Schommer (1993) comprises a range of beliefs that knowledge is composed of fixed, concrete pieces of information contributing to the formation of a belief that knowledge comprises complex and changing information. At the naive level of a conviction that knowledge is certain, individuals generally presume that truth is unquestionably true and absolute (Sin, 2014). Individuals who hold a sophisticated belief in the certainty of knowledge have the conviction that knowledge is tentative, continuously evolving, and changes in the context in which it exists (Andrea et al., 2021). When it comes to learning physics, individuals with naive beliefs hold the perspective that physics concepts embody a fixed set of unchangeable facts that require memorization (Ding, et al., 2017). Epistemological belief in the certainty of knowledge is generally presented at hierarchical levels. In education, students who hold the epistemological belief in certainty knowledge are likely to view knowledge as a component of true or false facts (Lising & Elby, 2005). Studies display that particular domain epistemological beliefs can affect teaching and learning approaches and consequently students' academic performance. Studies on effective teaching and learning of sciences have indicated that employing traditional concepts in science education generally has a negative effect on students' performance. Comparatively, those who prefer to speculate about instruction and learning in non-traditional ways are inclined to feel that knowledge is uncertain and changeable. (Bay et al., 2015). Regarding the realm of advanced beliefs concerning the certainty of knowledge, information appears to move from simplistic views of knowledge to the point of accepting that personal opinions and personal construction are important components in procuring knowledge. As such, the belief in the certainty of knowledge can play a crucial role in determining student academic performance. To validate or invalidate this claim, the current study assessed the connection amongst attributes of belief in the certainty of knowledge and performance of physics in secondary schools.

Sen et al. (2014) used a structural modeling equation to evaluate the relationships between the performance of learners, motivation, learning practices, and epistemological views in learning in Turkey. The research outcomes unveiled that students individuals holding naive epistemological beliefs deeming that knowledge is certain and immutable portrayed poor performance. In another study, Yenice (2015) investigated the degree of scientific epistemological beliefs exhibited by eighth-grade students in Turkey. The research's findings pointed out that 8th-grade students' believed that scientists may always reach the correct answer and that they can agree on a single truth. However, these studies were carried out in post-secondary school institutions and did not include the relationship between certainty of knowledge and performance of physics among secondary school students. In another study, Bodin and Winberg (2012) researched the dominion of beliefs and emotions on strategies for solving numerical problems in physics in Sweden. The study demonstrated the significant influence of students' epistemological beliefs in shaping their learning capabilities from a realistic problem-solving situation. In Turkey, Ogan-Bekiroglu and Sengul-Turgut (2011) investigated the connection between students, epistemological beliefs, and the mechanisms of conceptual change in learning physics. The study demonstrated a positive correlation between students' epistemological beliefs and their learning progress in the field of physics. The study further revealed that sophisticated beliefs in the certainty of knowledge were essential but not sufficient for conceptual change in physics. Jikamshi, et al. (2016) conducted a study in Nigeria to explore how epistemological principles and a learning aspiration mindset predict the adoption of a deep knowledge acquisition approach. The study findings indicated a notable positive correlation between the certainty of knowledge and the adoption of a deep approach to acquiring knowledge. However, in Jikamshi et al. (2016) there is no analysis of the relationship between certainty of knowledge and scholastic achievement in a given learning context. The current study investigated the relationship between beliefs in the certainty of knowledge and performance of physics among secondary school students.

Extensive research has been conducted to explore stances and epistemological doctrines in physics courses at undergraduate and high school levels. (Dehui & Zwickl, 2018; Prasadini et al., 2018; Yenice, 2015). The studies have generally exposed that individuals possessing naive dogmata regarding the inevitability of knowledge perceive that only some knowledge can be newly explored and that only a small percentage of already known facts are capable of changing. In addition, students who hold naive epistemological beliefs concerning the certainty of knowledge do not exhibit a critical approach toward what they read, and they are likely to be influenced by authority in learning. The beliefs in the structure of scientific knowledge presented in a given instructional strategy may have a link between learning and performance. The predominant body of research on epistemological principles concerning certainty in knowledge has generally been constrained to classroom-like contexts with little emphasis on the performance of individual subject areas. Researchers have confined most of their studies to how learning strategies generally affect the epistemological beliefs of students and their comprehension of scientific concepts. There is no documented information in the form of research on the examination of the relationship between epistemological beliefs in the certainty of knowledge and performance of physics in secondary school especially in Tharaka-Nithi County, Kenya. The present study explored the correlation between the dimension of epistemological belief regarding the certainty of knowledge and physics performance in secondary schools located in Tharaka-Nithi County.

3. Methodology

A descriptive survey and a correlational analysis were both employed as part of the mixed-methods research strategy for this study. The descriptive survey approach was a good fit for this study due to its applicability in permitting the gathering of quantitative data from closed-ended items in the questionnaire for descriptive analysis. A correlational research design was employed to assess the level of association between epistemological beliefs and physics performance. A correlational study methodology was suitable for evaluating the degree to which epistemological views and physics performance were related. The formula suggested by Verma (2021) was used to get the sample size of 390 participants. Samples were taken from schools that were categorized into county, sub-county, extra-county, and national divisions. The researchers selected 20 public secondary schools and 310 students from each of the school categories using a proportional sample approach. The investigator employed purposive sampling to choose 60 physics teachers and 20 heads of the science department. The researcher used the drop-pick method to dispense and amass questionnaires from the participants of the study. The science department heads of the selected schools were subjected to interviews. A focus group discussion involved the participation of eight students from each school. A thematic approach was used to analyze the qualitative data gathered from the focus group interviews with students and the interviews with heads of the science department. Descriptive statistics employed measures of central tendency, such as the mean, standard deviation, and coefficient of variation, to analyze the quantitative data. Spearman's rho correlation (r) was utilized to assess both the strength and direction of the relationship between the variables investigated in the study.

4. Findings and analysis

Normality

Data that is considered appropriate for parametric tests should have a normal distribution, and linear relationship and should have come from multiple groups with the same variance (Uhlmann, 2018). Failure to meet these major assumptions for parametric data analysis and nonparametric tests is deemed suitable for hypothesis testing. The Kolmogorov-Smirnov (K-S) test was employed to ascertain the normality of the data. The null hypothesis conjectured that data mirrored a normal distribution. The outcomes of normality assessment are displayed in Table 7.

Table 1: One-Sample Kolmogorov-Smirnov Test

		Certainty	Performance
N		310	310
Normal Parameters[a,b,c]	Mean	2.9801	3.0038
	Std. Deviation	0.50459	0.58816
Most Extreme Differences	Absolute	0.123	0.118
	Positive	0.123	0.118
	Negative	-0.081	-0.109
Test Statistic		0.123	0.118
Asymp. Sig. (2-tailed)		0.000[c]	0.000[c]

a. Test distribution is Normal
b. Calculated from data
c. Lilliefors Significance Correction

The evidence displayed in Table 1 indicates that K-S tests for beliefs in the certainty of knowledge were N (304) = 0.123, P = 0.000 and for the performance in physics was N (310) = 0.07, P = 0.000. Information in Table 1 reveals that all the variables had a probability value that was less than 0.05 significance level. This suggests that the data collected for certainty of knowledge, source of knowledge, and performance of physics deviates from a normal distribution. The hypothesis of normality, which assumes that data is normally scattered was invalid. Hypothesis testing for the variables of this study was therefore carried out through nonparametric tests which does not necessitate that data should be approximately normally dispersed.

Beliefs in Certainty of Knowledge

The dimension of epistemological doctrines about the certainty of knowledge encompassed a spectrum ranging from a belief in fixed and distinct facts to a belief in complex and variable information. The questionnaire included items designed to gauge the extent to which students held naive or sophisticated notions of certainty of knowledge in relation to performance in physics.

Students Responses on Naive Beliefs in Certainty of Knowledge

The participants of the inquest were asked to express the scope of conformity they exhibit with various declarations regarding the association between naive perceptions of the certainty of knowledge and performance in physics. The collected data are showcased in Table 1.

Table 2: Descriptive of Students' Naive Beliefs in Certainty of Knowledge

Statement	N	Mean	S.D	S.E
I feel that there are ideas in physics that will never change	310	3.99	1.032	0.059
I am sure that there is only one correct answer for a physics problem	310	3.80	1.052	0.060
I feel that most ideas in physics are already known and do not change.	310	3.62	1.194	0.068
I feel that most ideas in physics are already known and do not change.	310	3.82	1.068	0.061
I am convinced that some facts in physics can never change	310	3.94	1.034	0.059
I feel that physics consists of facts that have already been discovered	310	3.94	1.117	0.064
Overall Mean	310	3.85	1.083	0.062

Based on the investigative determinations put forth in Table 1, it was found that correspondents generally conceded that there are ideas in physics that will never change (Mean = 3.99, SD = 1.032, S.E = 0. 059) and that most ideas in physics are already known and do not change (Mean = 3.62, SD = 1.194, S.E = 0. 068). The students in the focus group indicated the following:

There are ideas in physics that will never change. For instance, laws and principles taught in physics were discovered a long time ago and have been comprehensively verified and confirmed through experiments. As such, we do not believe that they could be overturned anytime soon.

The respondents also agreed that most ideas in physics are already known and do not change (Mean = 3.62, S.D = 1.068, S.E = 0. 061) and that some facts in physics can never change (Mean = 3.94, S.D = 1.034, S.E = .059). In addition, respondents agreed that physics consists of facts that have already been discovered (Mean = 3.94, S.D = 1.117, S.E = 0. 064). During the focus group discussion, the students expressed the following:

Once something in physics is established as a fact, it remains unchanged unless new evidence emerges. Physics ideas are based on fundamental laws and concepts that are unlikely to change

These results allude to the idea that students deemed that physics comprises fixed and absolute actualities. The respondents also agreed that there is only one correct answer for a physics problem (Mean = 3.80, SD = 1.052, S.E = 0. 060). Information in Table 1 indicates an overall mean score (Mean = 3.85, S.D = 1.083, S.E = 0.062) for the parameters used to quantify the standard of students' naive belief in the certainty of knowledge.

Students Responses on Sophisticated Beliefs in Certainty of Knowledge

The study sought information on sophisticated epistemological beliefs in the certainty of knowledge. The participants were requested to express their level of agreement with specific statements regarding sophisticated beliefs in the certainty of knowledge in relation to their performance in physics. This information is shown in Table 2.

Table 3: Descriptive of Students' Sophisticated Beliefs in Certainty of Knowledge

Statement	N	Mean	S.D	S.E
I believe that information in physics books can sometimes change	310	2.55	1.142	0.066
I understand that problems in physics can be solved using more than one method	310	1.81	1.100	0.063
I accept that there are no fixed answers to physics problems	310	2.42	1.205	0.069
I believe that physics ideas discovered by scientists can be challenged by anyone	310	1.97	1.159	0.066
I trust that a physics problem can be approached using different ways	310	1.80	1.031	0.059
Overall Mean	310	2.11	1.127	0.065

Stemming from the research findings proffered in Table 2, it can be observed that the respondents articulated dissenting views about assertions that information in physics books can sometimes change (Mean = 2.55, SD = 1.142, S.E = 0. 066). The respondents expressed disagreement with the notion that physics concepts discovered by scientists can be challenged or altered by anyone (Mean = 2.55, SD = 1.142, S.E = 0.066). Results of the study further show respondents disagreed that physics problems can be solved using more than one method (Mean =

1.81, SD = 1.100, S.E = 0. 063). Respondents also disagreed that there were no fixed answers to physics problems (Mean = 2.42, SD = 1.205, S.E = 0. 069). During the focus group discussion, the respondents indicated the following:

> *Scientists have already spent too much time and resources on experiments and have come up with theories to explain these experiments. Examining the experimental nature of teaching and learning physics they believed there was only one solution to given physics problems.*

The respondents also disagreed that ideas in physics can come from anyone, not just scientists (Mean = 1.97, S.D = 1.159, S.E = 0. 066) and they strongly disagreed that physics problems can be approached using different ways (Mean = 1.80, S.D = 1.031, S.E = 0.059). The data presented displays an overall mean score (Mean = 2.11, S.D = 1.127, S.E = 0.065) for the variables used to assess the extent of students' intricate conviction in the inevitability of information in relation to their performance. These findings reflect that a predominant group of participants expressed disagreement with avowals that evaluated affiliations amid students' sophisticated convictions and performance in physics.

Teachers' Responses on Students' Naive Beliefs in Certainty of Knowledge

The research instrument contained items aimed at gathering information from teachers about the level of students' naive belief in the certainty of knowledge. Table 3 unveiled the findings.

Table 4: Descriptive of Teachers' Naive Beliefs in Certainty of Knowledge

Statement	N	Mean	S.D	S.E
Students are convinced that there are ideas in physics that will never change	60	3.82	1.017	0.131
Most of the students are sure that there is only one correct answer for a physics problem	60	3.62	1.027	0.133
Students stick to procedures in physics experiments	60	3.58	1.197	0.155
Students are convinced that some facts in physics can never change	60	3.82	1.017	0.131
Students believe that physics consists of facts that have already been discovered by scientists	60	3.88	1.075	0.139
Overall Mean	60	3.74	1.067	0.138

According to the data presented in Table 3, the participants indicated their agreement regarding the perception that students are convinced that there are ideas in physics that will never change (Mean = 3.82, SD = 1.017, S.E = 0. 131) and that most of the students are sure that there is only one correct answer for a physics problem. (Mean = 3.62, SD = 1.027, S.E = 0. 133). In addition, the respondents agreed that students stick to procedures in physics experiments (Mean = 3.58, S.D = 1.197, S.E = 0.155) and that students are convinced that some facts in physics can never change (Mean = 3.82, S.D = 1.017, S.E = 0. 131). The respondents also agreed that students' belief that physics consists of facts already discovered by scientists (Mean = 3.88, S.D = 1.067, S.E = 0. 138). During interviews, the HODs indicated the following:

> *Students believe that physics comprises facts that have been extensively tested and validated. While there may be refinements and discoveries, students believe that the core principles of physics will always remain relatively stable.*

The results presented in Table 3 demonstrate an average midpoint score (Mean = 3.74, S.D = 1.067, S.E = 0.138) for the statements assessing the degree of naive beliefs in the certainty of knowledge and its impact on physics performance. This suggests that the majority of the physics instructors involved in the study conformed to the metrics used to gauge students' naive assumptions about the certainty of their knowledge. The HODs informed the study that most of the students believe that ideas in physics remain and there would be little or no alterations to the already-known facts in physics. Some HODs highlighted that students believe that concepts taught in physics have remained the same for many years and their correctness has been verified.

Teachers' Sophisticated Beliefs in Certainty of Knowledge

The study also gathered information from the teachers regarding students' advanced beliefs regarding the certainty of knowledge. The viewpoints of the study partakers are presented in Table 4.

Table 5: Descriptive of Teachers' Sophisticated Beliefs in Certainty of Knowledge

Statement	N	Mean	S.D	S.E
Students admit that information in physics books can sometimes change	60	2.33	1.244	0.161
Students reason that problems in physics can be solved in more than one method	60	2.75	1.202	0.155
Students acknowledge that there are no absolute answers to physics problems	60	1.98	1.142	0.147
Students feel that ideas in physics can come from anyone, not just scientists	60	2.47	1.200	0.155
Students think that a physics problem can be approached in different ways	60	2.17	1.304	0.168
Overall Mean	60	2.34	1.218	0.157

The data unveiled in Table 29 demonstrate that respondents expressed disagreement with the statement that students admit that information in physics books can sometimes change (Mean = 2.33, S.D = 1.244, S.E = 0.161). The respondents also disagreed that students acknowledge that there are no absolute answers to physics problems (Mean = 1.98, S.D = 1.142, S.E = 0.147) and that students reason that physics problems can be solved in more than one method (Mean = 2.75, S.D = 1.202, S.E = 0.155). This implies that teachers held the perspective that students had a belief that information in physics is precise and immutable. The respondents disagreed with the statements that students feel that ideas in physics can come from anyone, not just scientists (Mean = 2.47, S.D = 1.200, S.E = 0.155) and disagreed that students think that a physics problem can be approached in different ways (Mean = 2.17, S.D = 1.304, S.E = 0.168). During interviews with the HODs, the following themes were generated:

Students believe that physics problems have clear-cut solutions that can be obtained through a specific set of steps. These steps follow the logical progression of applying the relevant equations and principles. While there may be some variation in the order or techniques used, ultimately, there is a single best approach to solving each problem.

The overall mean score of 2.34, dispersion magnitude within 1.218, and a standard error of 0.157, for the selected statements measuring students' sophisticated epistemological beliefs in the certainty of knowledge, suggests that most students did not possess a sophisticated trust in the irrefutable nature of knowledge of physics. The low mean score indicates a lower level of agreement or endorsement of the statements related to sophisticated trust in the conviction of knowing.

Correlation of Certainty of Knowledge and Performance of Physics

A Spearman's correlation assessment was executed to examine associations amid naive belief in the certainty of knowledge, sophisticated belief in the certainty of knowledge, and performance in Physics. Table 5 displays the results.

Table 6: Correlations of Certainty of Knowledge and Performance of Physics

		Performance physics	Naive Belief ofCertainty Knowledge	inSophisticated ofBelief Certainty of Knowledge
Performance of Physics	Spearman's rho	1		
	Sig. (2-tailed)			
	N	310		
Naive Beliefs in Certainty of Knowledge	Spearman's rho	-0.029	1	
	Sig. (2-tailed)	.620		
	N	310	310	
Sophisticated Beliefs in Certainty of Knowledge	Spearman's rho	0.033	-0.169**	1
	Sig. (2-tailed)	0.566	0.003	
	N	310	310	310

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

The research findings in Table 5 indicate a weak positive correlation and a statistically insignificant relationship between sophisticated beliefs in certainty of knowledge and performance in physics (correlation coefficient r = 0.033; p-value = 0.566 > 0.01). This means that there is little to no meaningful association between these variables based on the data analyzed. The research results reveal a weak and statistically insignificant negative correlation between naive beliefs in certainty of knowledge and performance in physics (correlation coefficient r = -0.029; p-value = 0.620 > 0.01). This suggests that there is no meaningful association between these variables based on the data analyzed. In other words, students' naive beliefs in the certainty of knowledge do not appear to have a significant impact on their performance in physics.

Regression of Certainty of Knowledge and Performance of Physics

The study pursued to assess whether the collected data on independent variables satisfied assumptions of ordinal regression. To achieve this, the investigator first undertook a parallel lines assessment to examine the association between the predictors and the ordinal outcome variable. The null hypothesis tested in this study assumed that the slope coefficients for the different response categories were equal. The outcomes of the hypothesis testing are displayed in Table 6.

Table 7: Certainty of Knowledge Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	131.915			
General	131.423	0.492	2	0.782

Link function: Logit.

Information in Table 6 shows the null hypothesis was accepted because the p-value = 0.782 is greater than 0.05. The implication of accepting the null hypothesis in the ordinal regression model is devoid of notable differences in the location parameters (slope coefficients) across the response categories. Therefore, the impact of the independent variables on the outcome variable is considered similar across all groups or levels, suggesting a uniform pattern of association. This suggests that there is an equal likelihood of epistemological beliefs in the certainty of knowledge falling into different categories of performance of physics. This makes the data suitable for ordinal logistics analysis.

To assess the association between epistemological beliefs in the certainty of knowledge, and physics performance the researchers examined the following hypothesis:

H_{02}: There is no statistically significant relationship between beliefs in the certainty of knowledge and performance of physics among secondary school students in Tharaka-Nithi County

The extent of the relationship was examined through nonparametric procedures of data analysis because the data collected did not follow a normal distribution. The data also did not satisfy the basic requirements for parametric tests. The nominal regression analysis was conducted with a confidence level of 95% (α=0.05). Naive beliefs in the certainty of knowledge and sophisticated beliefs in the certainty of knowledge were regressed against the performance of physics. The overall significance of the model was assessed through various model-fitting measures, including goodness-of-fit statistics, pseudo-R-square, and parameter estimates. These measures provided information about how well the model fits the data, the explanatory power of the model, and the estimated effects of the model's parameters. The adequacy of the model was assessed using the Chi-Square statistics. The outcomes of this evaluation are found in Table 7.

Table 8: Certainty of Knowledge Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	180.786			
Final	122.013	58.773	32	0.003

Link function: Logit.

The data presented in Table 7 demonstrates a substantial enhancement in the adequacy of the final model compared to the null model, as indicated by the statistical significance [χ^2 (32) = 58.773, $p < 0.05$]. This suggests that the final model provides a significantly better fit to the observed data compared to the null model, indicating the presence of meaningful interactions between the variables under investigation. The model was therefore fit for the predictions of the effects of variations dependent variable on the independent variable.

Information was sought to establish whether the model demonstrates a satisfactory fit for the data. The Deviance and Pearson statistics are displayed in Table 33.

Table 9: Goodness-of-Fit for Certainty of Knowledge

Model	Chi-Square	df	Sig.
Pearson	46.013	48	0.555
Deviance	43.999	48	0.637

Link function: Logit.

The data unveiled in Table 33 present that the results of both the Pearson chi-square test [χ^2 (48) = 46.013, p-value = 0.555 > 0.05] and the Deviance chi-square test [χ^2 (48) = 43.999, p-value = 0.637 > 0.05] were not statistically significant. The observed p-values for Pearson and Deviance statistics are greater than the set significant level (α = 0.05) designating that the results were statistically non-remarkable. This suggests the non-existence of strong evidence to reject the null hypothesis, indicating that the observed data does not significantly deviate from the expected values. This suggests that the model adequately represents the relationship between these variables and provides a good fit for the observed data.

Beliefs in the certainty of knowledge were regressed against the performance of physics and Pseudo R-squared values were generated. The findings are displayed in Table 34.

Table 10: Pseudo R-Square for Beliefs in Certainty of Knowledge

Parameter Measure	**Pseudo R-square**
Cox and Snell	0.275
Nagelkerke	0.275
McFadden	0.053

Link function: Logit.

The results in Table 34 show that the Pseudo R-square for Nagelkerke was 0.275 and that of McFadden was 0.053. The Pseudo R-square values provide insights into the explanatory power of the logistic regression model. In this study, the Nagelkerke Pseudo R-square was 0.275, indicating that approximately 27.5% of the variance in the performance of physics could be explained by the beliefs in Certainty of knowledge included in the model. The McFadden Pseudo R-square was 0.053, suggesting that around 5.3% of the disparity in the performance of physics could be accounted for by beliefs in Certainty of knowledge included in the model.

The study determined the significance of each variable within the model. The parameter estimates, which indicate the association between the performance of physics and beliefs in the certainty of knowledge, are displayed in Table 35.

Table 11: Parameter Estimates of Certainty of Knowledge

Variables		B	SE	Wald	df	Sig.	Exp(B)
Threshold	[Performance = 1]	-2.487	0.643	14.970	1	0.000	0.083
	[Performance = 2]	-1.566	0.632	6.134	1	0.013	0.209
Location	Naive Belief in Certainty of Knowledge	-0.215	0.138	2.407	1	0.121	0.807
	Sophisticated Belief in Certainty Knowledge	0.057	0.114	0.248	1	0.619	1.059

Link function: Logit.

The logistic regression analysis results presented in Table 35 showed that the naive belief in the certainty of knowledge variable had a non-significant negative prediction for performance in physics (B = -0.215, SE = 0.138, p-value = 0.121 < 0.05). This suggests that there was a negative association between holding naive beliefs in certainty of knowledge and performance in physics; however, this relationship did not reach statistical significance. Further interpretation of this finding is that for each additional unit increase in the naive belief in the certainty of knowledge, there is an expected decrease of 0.807 in the log odds of a student being classified into a higher category of performance in physics. The findings from Table 35 manifest that there was a positive association between sophisticated beliefs in certainty of knowledge and performance in physics. However, this relationship was found to be statistically insignificant (B = 0.057, SE = 0.114, p-value = 0.619 > 0.05). The value of Exp (B=1.059) suggests that in the event of an increment of one unit on sophisticated beliefs in the certainty of knowledge, there is a potential upsurge of 1.059 in the log odds of being in a higher level of performance of physics.

6. Discussion

The results of the study indicated that the respondents believed that physics knowledge cannot evolve or change even when put under the tests. Students also expressed a belief that scientists have meticulously proved definite processes of solving problems in physics and therefore they cannot be dethroned. Tsai et al. (2011), learners who hold the belief that problem-solving procedures in physics are unchanging tend to maintain less refined standpoints on learning, such as rote memorization of facts. This can impact negatively students' proficiency in resolving problems and hinder the refinement of their creativity. The majority of the respondents expressed the belief that information obtained from physics textbooks is reliable and unquestionably accurate. This finding suggests that the participants believed that physics knowledge contained in physics textbooks comprises certain and definite facts. This assertion corresponds to naive belief in the certainty of knowledge. According to Ozlem (2015), there is a negative relationship between students' naive epistemological beliefs regarding the certainty of knowledge and the development of their learning abilities. Furthermore, students' beliefs in the certainty of knowledge were found to have an impact on accuracy in evaluating their comprehension of scientific facts. This indicates that holding naive beliefs that knowledge is certain can have an impact on students' understanding and acquisition of information, which could lead to poor academic performance.

The focus group discussion and interviews unveiled that the respondents expressed the belief that ideas in physics are rigid and unchanging. This finding aligns with the research conducted by Guo, Hao, and Deng (2022) which found that a significant number of high school students held naive beliefs in subjects related to science. Guo et al. further revealed that data obtained from students who believe that scientific knowledge comprises static facts cannot apply and develop reflective thoughts henceforth, poor academic performance. The research conducted by Bodin and Winberg (2012) demonstrated a correlation indicating that refined certainty beliefs of knowledge were linked to positive outcomes and an enhanced capacity to learn from realistic problem-solving scenarios. When students recognize that scientific knowledge is uncertain and requires continuous adjustment and improvement through scientific inquiry, they are predisposed to explore the philosophies behind scientific phenomena. This might occur through self-regulated inquiry, developing inquisitiveness, and a sophisticated appreciation for physics ideas, which could propel students toward improving their performance. Lin and Chan (2018) revealed that individuals who hold beliefs that scientific knowledge comprises fixed facts exhibited poor performance and scored low in the measures of insightful contemplation. The belief in fixed knowledge may stifle creativity and innovation in physics. It may discourage individuals from exploring alternative ideas or proposing novel theories that deviate from the accepted framework. A belief in fixed knowledge may result in a lack of adaptability to new contexts or technological advancements. Physics is a field that interacts with other scientific disciplines and constantly evolves. Not being open to revising or expanding existing knowledge may hinder the application of physics principles in solving the emerging problems of the contemporary world.

Correlation analysis indicates that there exists a non-significant and weak relationship between sophisticated beliefs in the certainty of knowledge and performance in physics. The weak positive correlation suggests that as the level of sophisticated beliefs in the certainty of knowledge increases, there is a slight tendency for performance in physics to also increase, but this association is not statistically significant. Naive belief in the certainty of knowledge had a negative and non-significant relationship with performance in physics. The lack of a positive correlation suggests that a tendency to overestimate the certainty of knowledge may reduce physics performance.

Students who possess inflexible beliefs regarding the certainty of knowledge may struggle to adapt to new information, revise their understanding, or explore alternative explanations. The results of this study align with the findings of an inquiry pursued by Ogan-Bekiroglu and Sengul-Turgut (2011) which revealed that holding naive beliefs in the certainty of knowledge was associated with lower performance in physics and a weaker understanding of physics concepts. Recognizing and accepting the inherent uncertainty in scientific knowledge is crucial in fostering

Sophisticated belief in the certainty of knowledge was a positive but non-significant predictor of performance in physics. This suggests that students who have more sophisticated beliefs about the certainty of knowledge are susceptible to exhibit higher performance in the study of physics than their peers who have more naive beliefs regarding the certainty of knowledge. The finding that there was a statistically insignificant relationship implies devoid strong or significant association between the variables being examined. Naive belief in the certainty of knowledge was a negative and insignificant predictor of performance in physics. The lack of significance suggests that the belief in the certainty of knowledge does not have a notable impact on the performance in physics. It indicates that other factors or variables may have a more substantial influence on students' performance in the subject. This finding aligns with the research conducted by Yusuf (2017) on the epistemological beliefs about the nature of science, which also indicated that students with naive beliefs that scientific knowledge was certain and definite experienced a decline in their performance. Students who hold a naive belief in the certainty of the information in physics may experience poor performance in their academic endeavors. Students who hold a naive conviction in the certainty of knowledge allude that physics comprises an assortment of actualities and procedures that should be memorized and reproduced. This is as opposed to the view of physics as a dynamic field that requires critical thinking and problem-solving skills. The rote learning that can arise from a naive belief in the certainty of physics knowledge may hinder students' capacity to apply physics concepts to real-world situations or solve unfamiliar problems.

7. Conclusion

The overall mean points unveiled that a large portion of respondents assented to parameters used to determine the relationship between naive beliefs in the certainty of knowledge and performance of physics. The respondents disagreed with the statements used to determine the relationship between sophisticated beliefs in certainty of knowledge and performance in physics. The results of the interviews indicated that students had a moderate belief that physics comprises students had naive beliefs in the certainty of knowledge. The correlation between naive beliefs in the certainty of knowledge and performance in physics was found to be negative and statistically insignificant, while the relationship between sophisticated beliefs in the certainty of knowledge and performance in physics was positive and statistically insignificant. Ordinal regression analysis revealed that naive belief in the certainty of knowledge was an insignificant negative precursor to physics performance. Sophisticated belief in the certainty of knowledge had a noteworthy positive forecaster of physics performance.

8. Recommendations

There is a need to promote students' sophisticated beliefs in the certainty of knowledge to enhance physics performance. Teachers should encourage hands-on activities, and evaluative thinking, and emphasize the dynamic nature of scientific knowledge to foster students' understanding. Encourage a growth mindset among students by emphasizing that intelligence and mastery of physics are not fixed traits to improve students' beliefs about the certainty of knowledge acquisition.

References

Bay, E., Vural, O. F., Demir, S., & Bagceci, B. (2015). An analysis of the candidate teachers’ beliefs related to knowledge, learning and teaching. *International Education Studies*, *8*(6). https://doi.org/10.5539/ies.v8n6p75

Bodin, M., & Winberg, M. (2012). Role of beliefs and emotions in numerical problem-solving in university physics education. *Physical Review Special Topics - Physics Education Research*, *8*(1). https://doi.org/10.1103/physrevstper.8.010108

Calmer, J. M. (2019). Teaching physics within a next-generation science standards perspective. *Pedagogical Research*, *4*(4). https://doi.org/10.29333/pr/5868

CEMESTEA. (2014). *Secondary INSET: Fundamentals for Effective Teaching.* Nairobi.

Dehui, H., & Zwickl, B (2018). Examining students' views about the validity of experiments: From introductory to Ph.D. students. *Physical Review Physics Education Research*, *14*(1). https://doi.org/10.1103/physrevphyseducres.14.010121

Guo, X., Hao, X., Deng, W., Ji, X., Xiang, S., & Hu, W. (2022). The relationship between epistemological beliefs, reflective thinking, and science identity: a structural equation modeling analysis. *International Journal of STEM Education*, *9*(1). https://doi.org/10.1186/s40594-022-00355-x

Jikamshi, M., Chong A, M., Roslan, S., & Ismail, H. (2016). Dimensions of epistemological beliefs, learning goal orientation, as predictors of deep knowledge acquisition approach among pre-service teachers in Nigeria. *Mediterranean Journal of Social Sciences*, *7*(4). https://doi.org/10.5901/ mjss.2016.v7n4p165

Kennedy, J., Lyons, T., & Quinn, F. (2014). The Continuing Decline of Science and Mathematics Enrolments in Australian High Schools. *Teaching Science, 60*(2), 35-46.

KICD. (2017). *Basic Education Curriculum Framework: Nurturing Every Learner's Potential.* Nairobi: Government Printer.

KNEC. (2021). *Kenya Certificate of Secondary Education Analysis Report*. Government Printer.

Lin, F., & Chan, C. (2018). Promoting elementary students' epistemology of science through computer-supported knowledge-building discourse and epistemic reflection. *International Journal of Science Education*, *40*(6), 668–687. https://doi.org/10.1080/09500693.2 018.1435923

Mbonyiryivuze, A., Yadav, L. L., & Amadalo, M. M. (2021). Students' attitudes towards physics in nine years of basic education in Rwanda. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(2), 648. https://doi.org/10.11591/ijere.v10i2.21173

Muchai, A. (2016). *Effects of Practical Work on Students' Achievements in Physics at Secondary School Level in Murang'a East Sub-County, Kenya.* Unpublished PhD Thesis.

Murei, G. (2016). Impacts of low enrolment in secondary schools physics to the attainment of Kenyan vision 2030: A case study of Nandi North Sub County. *Educational Research*, *7*(3), 88–94. https://doi.org/10.14303/er.2016.134

Musasia, M., Ocholla, A., & Sakwa, T. (2016). Physics practical work and its influence on students' academic achievement. *Journal of Education and Practice*, *7*(28), 129–134.

Ogan-Bekiroglu, F., & Sengul-Turgut, G. (2011). Students' general and physics epistemological beliefs: a twofold phenomenon. *Research in Science & Technological Education*, *29*(3), 291–314. https://doi.org/10.1080/02635143.2011.594790

Ozlem, S., & Dagyar, M. (2015). High school students' epistemological beliefs, conceptions of learning, and self-efficacy for learning biology: A study of their structural models. *EURASIA Journal of Mathematics, Science and Technology Education*, *11*(5). https://doi.org/10.12973/eurasia.2015.1375a

Prasadini, L., Hamid, J. A., Khatibi, A., & Azam, S. M. F. (2018). The impact of scientific epistemological beliefs of Sri Lankan senior secondary students on their approaches to learning science: A structural equation modeling analysis. *Asian Journal of Contemporary Education*, *2*(2), 60–69. https://doi.org/10.18488/journal.137.2018.22.60.69

Provasnik, S., & Malley, L. (2019). *The U.S.A.'s performance on the 2015 TIMSS advanced mathematics and physics assessments*. National Center for Education Statistics. https://nces.ed.gov/pubsearch

Schommer, M. (1993). Epistemological development and academic performance among secondary students. *Journal of Educational Psychology*, *85*(3), 406–411. https://doi.org/10.1037/0022-0663.85.3.406

Sen, S., Yilmaz, A., & Yurdagul, H. (2014). An Evaluation of the Pattern between Students' Motivation, Learning Strategies and Their Epistemological Beliefs: The Mediator Role of Motivation. Science Education International, 25(3), 312–331.

Sin, C. (2014). Epistemology, sociology, and learning and teaching in physics. *Science Education*, *98*(2), 342–365. https://doi.org/10.1002/sce.21100

Tsai, C., JessieHo, H. N., Liang, J., & Lin, H. (2011). Scientific epistemic beliefs, conceptions of learning science and self-efficacy of learning science among high school students. *Learning and Instruction*, *21*(6). https://doi.org/10.1016/j.learninstruc.2011.05.002

Ugwuanyi, C., Okeke, C., Nnamani, P., Obochi, E., & Obasi, C. (2020). The relative effect of animated and non-animated PowerPoint presentations on physics students' achievement. *Cypriot Journal of Educational Sciences*, *15*(2), 282–291. https://doi.org/10.18844/cjes. v15i2.4647

Uhlmann, L., Jensen, K., & Kieser, M. (2018). Hypothesis testing in Bayesian network meta-analysis. *BMC Medical Research Methodology*, *18*(1). https://doi.org/10.1186/s12874-018-0574-y

Verma, P. (2021). *Determining Sample Size and Power in Research Studies: A Manual for Researchers*. Springer Verlag, Singapor.

Yenice, N. (2015). An analysis of science student teachers' epistemological beliefs and metacognitive perceptions about the nature of science. *Educational Sciences: Theory & Practice*, *15*(6). https://doi.org/10.12738/estp.2015.6.2613

Yusuf, Y., & Zorlu, F. (2021). Investigation of the relationship between pre-service science teachers' 21st-century skills and science learning self-efficacy beliefs with structural equation model. *Turkish Journal of Science Education*, *18*(1), 1–16. https://doi.org/10.36681/tused.2021.49

Zhang, P., Ding, L., & Mazur, E. (2017). Peer instruction in introductory physics: A method to bring about positive changes in students' attitudes and beliefs. *Physical Review Physics Education Research*, *13*(1). https://doi.org/10.1103/physrevphyseducres.13.010104