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STUDENTS' INQUIRY AND SCIENCE-RELATED ATTITUDE AS MEDIATED BY SELF-CONCEPT

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Abstract:
The study determined the mediating effect of self-concept on the relationship between students' inquiry and science-related attitudes of students. This study used a quantitative research design that covered mediation analysis and descriptive survey methods. A stratified random sampling technique was used in this study, with a sample of 300 students drawn from the STEM and GAS senior high school departments of chosen public schools in the Davao Oriental division. To gather data, the researcher used an adapted survey questionnaire, which was modified to suit the context of the research study. Results showed that students' inquiry, self-concept, and science-related attitudes were high or often manifested. There was also a significant relationship between students' inquiry and science-related attitudes, students' inquiry and self-concept, and self-concept and science-related attitudes. Further, there was a significant but partial result of the Medgraph using the Sobel z-test of self-concept on the relationship between students' inquiry and science-related attitudes. There was a significant partial mediation between these variables. The study demonstrated a significant partial mediation of self-concept on the relationship between students' inquiry toward science-related attitudes of senior high school students.

UN's Sustainable Development Goals (SDG) No. 4 Quality Education.

Keywords: science education, student inquiry, science-related attitudes, self-concept, mediation, Philippines

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1. Introduction

Because of current educational issues such as the low proficiency of Filipino students in science, negative attitudes towards science, science illiteracy, and low performance in the subject, our society must cultivate individuals who can address these issues in the future. This is the scenario of most science classrooms in the Department of Education (DepEd) today. Our division is no exception to the current phenomenon of students with low performance and negative interest in science. Most of our students find retaining interest and their attitudes towards science hard. According to the PISA 2022 result, students in the Philippines got below the OECD average score of 356 in science, and almost no students are considered top performers (OECD, 2023). As a science teacher, I find this statistic quite alarming. Although this performance indicator does not conclude and measure the totality of students' attitudes toward learning science, this must be given immediate action by authorities.

Science-related attitudes drive students to fulfillment and career satisfaction. Acquiring positive attitudes towards learning science exhibits excellence in education and scientific explorations or discoveries. Studies have shown that scientific attitudes are necessary (Zaki, 2022). And so, science teachers should improve the quality of instruction and master the arts of teaching science dynamically and experientially. Because attitudes and interests affect either positively or negatively, as well as enhance or slow students learning. Students' positive views about science are crucial both in the academy and the economy (Mao, Cai, He, Chen & Fan, 2021; Abed & Ali, 2022). The student's development of science-related attitudes helps mold intelligent and socially adaptive individuals (Zaki, 2022). Students with superb scientific attitudes will grow with superb rational thinking (Pracagool & Arsaiboon, 2021). Also, improved students' future skills, critical thinking & problem-solving skills, are essential these days (Setiani, 2023). Thus, science-related attitudes are considered a well-studied issue among generations up to this day, considering its contributions to the modern workforce (Tai *et al.*, 2022; Adejimi, Nzabalirwa, & Shivoga, 2022; Mehmood, Arif, & Anwer, 2023; Zaki, 2022).

While empirical research surrounding students', inquiry has grown over the past five years, I see a need for more studies with senior high school STEM and GAS students in the Davao Oriental division to maximize their full science potential, as they will soon enroll in college as a stepping stone to their careers. Also, I see a need to research how student science-related attitudes develop given that students are either exposed or not to inquiry learning. There remains a lack of comprehensive study involving the three variables, much more with the mediating role of self-concept on the association between students' inquiry and science-related attitudes of the senior High school students in public schools in Davao Oriental. The lack of literature and research involving the three variables in one study would be sufficient reason to pursue the study. The conduct of this research, therefore, provides tangible and relevant data that will uncover the learning needs of every student in a science class that affects the positive or negative acquisition of science-related attitudes.

This study identifies Davao Oriental GAS and STEM senior high school students' inquiry and science-related attitudes as mediated by self-concept. Its specific objectives are: Firstly, to measure the level of students' inquiry in science through the following stages such as exploring, questioning, identifying a statement to test, using the investigation plan, collecting data for evidence, communicating results of an investigation, researching for scientific knowledge related to the investigation and extending investigations. Secondly, to determine the level of science-related attitude in adopting the scientific attitudes, attitude to scientific inquiry, and enjoyment of science lessons. Thirdly, to describe the level of self-concept among senior high school students in six content domains such as physical, moral, personal, family, social, and academic. In addition, this study also seeks to determine the significant relationship between students' inquiry and science-related attitude, students' inquiry and self-concept, and self-concept and science-related attitude. Lastly, to determine the significance of mediation of self-concept on the relationship between students' inquiry and science-related attitude.

To answer the problem objectively, the following null hypotheses will be tested at a 0.5 significant level: 1. There is no significant relationship between students' inquiry and science-related attitude, students' inquiry and self-concept, and self-concept and science-related attitude; 2. There is no mediating effect of self-concept on the relationship between students' inquiry and science-related attitudes.

2. Literature Review

Student inquiry is a method where students learn by conducting experiments and posing questions, with the teacher acting solely as a facilitator (Rau, 2022). This approach greatly benefits students from different backgrounds, for it will foster personal development and offer advanced learning. Also, this approach supports student-centered learning as a very effective approach for our modern learners. This is supported by numerous studies that revealed that inquiry-based instruction had a beneficial connection to students' involvement and academic success (Rau, 2022; Ruiz, Cobos, & Lopez, 2022; Belo, 2021; Sonsun, Hemtasin & Thongsuk, 2023; Start, Henriksen & Jegstad, 2023; Setiani, 2023; Rubio & Conesa, 2022); and Berhanu & Sheferaw, 2022). Students get involved through individual and group activities in science classrooms that accelerate their performance, curiosity, and thinking ability.

Additionally, students' 21st-century skills undeniably increase when inquiry learning is implemented (Abaniel, 2020). Students under inquiry learning are competitive enough inside and outside the classroom setting. They are honed in the skills necessary to adapt to this globally changing world. In a study conducted by Mukandayisenga, Opanga & Nsengimana (2021), teachers reported regular class attendance after IBL implementation compared to before. Through inquiry-based learning, learners are encouraged to create knowledge rather than memorize it.

Inquiry-based learning best describes the constructivist approach where learning is naturally made by the students and not transmitted directly from the classroom teacher (Berie, Damtie, & Bogale 2022). Students become more autonomous in their learning

while the teacher is the sole facilitator in an IBL classroom Smith (2021) added. There is a need for inquiry-based learning; thus, it is necessary to equip teachers to implement it effectively (Harmon, 2023; Okmen, Sahin & Kilic, 2022). Indeed, the participation of teachers in an inquiry-based learning professional development program encourages science teachers to use this strategy, from which students greatly benefit. As Eaves (2021) stated, teachers are the most important part of implementing a successful academic curriculum. Teachers are the backbone of success both in academe and society.

Also, the Philippines has been battling to improve its academic achievements for the past years. In another study by Cabrales & Pacala (2023), the nation experienced a weakening in science education due to poor reading comprehension that contributed to declining interest in science and failure in science education. With so many hindrances to achieving success in the science education sector, it is important to pay attention to this problem before it's too late, Cabrales & Pacala (2023) added. The education sector proposes the K-12 curriculum to upgrade this academic learning (Bibon, 2022). Accordingly, the delivery of the instruction had a direct relationship to learners' academic achievement. Instructional delivery is one of the factors that can affect active learning (Bibon, 2022).

Responsible citizenship toward sustainability served as the end goal of every country's educational system. A study conducted by Georgiou & Kyza (2023) affirmed that researchers find ways towards effective implementation of inquiry-based teaching and learning to uplift sustainability education. Their research findings indicate that students under inquiry-based learning strategy exceed their peers in terms of perceptions towards science, values, and attitudes. When students learned through inquiry, active learning was optimized while they tended to explore, learn, and re-learn. Also, this approach supports student-centered learning- a very effective approach for our modern learners. This is supported by numerous studies that revealed that inquiry-based instruction had a beneficial connection to students' involvement and academic success (Rau, 2022; Ruiz, Cobos, & Lopez, 2022; Belo, 2021; Sonsun, Hemtasin & Thongsuk, 2023; Start, Henriksen & Jegstad 2023; Setiani, 2023; Rubio & Conesa, 2022); and Berhanu & Sheferaw, 2022). Students get involved through individual and group activities in science classrooms that accelerate their performance, curiosity, and thinking ability.

Moreover, science-related attitudes are linked to the learning process. Meaningful learning leads to acquiring science-related attitudes (Mehmood, Arif, & Anwer, 2023). Learning must be engaging, the one that will encourage every learner to explore, investigate, and create. Learning should be active, not boring and stagnant. Then, shifting to a new science curriculum that adapts modernity and interactive learning strategies is advantageous (Elliniadou & Sofianopoulou, 2021). Student inquiry is a student-centered learning strategy that potentially improves science-related attitudes (Adejimi, Nzabalirwa, & Shivoga, 2022; Toma, 2020).

Researchers found that the highest standard of education attained by students depends greatly on teaching-learning approaches made by classroom teachers (Ahmad, Sultana & Jamil, 2022; Elliniadou & Sofianopoulou, 2021; Steidtmann, Kleickmann & Steffensky, 2022; Palines & Dela Cruz, 2021; Adejimi, Nzabalirwa & Shivoga, 2022).

Teachers as learning facilitators and classroom managers impact students' learning. Students must be guided as they listen, absorb, and relay the lessons. Science learning shall be fun and full of scientific ideas that answer 21st-century complexities (Elliniadou & Sofianopoulpo, 2021). Besides, researchers nowadays prove that inquiry-based learning greatly improves students' positive attitudes toward science compared to traditional teaching-learning approaches (Berie, Damtie & Bogale, 2022). Improved students' future skills, critical thinking & problem-solving skills, are essential these days (Setiani, 2023). Thus, students' inquiry allows the best learning experience for every student in science.

Correspondingly, science teachers should adapt IBL in teaching approaches to accommodate learners needs and enhance active learning (Pempho, Opanga & Nsengimana, 2022; Şensoy & Güneş, 2023; Öztürk, Kaya & Demir, 2022). Teachers must attend conferences and seminars that tackle new teaching pedagogy, specifically IBL strategies, and learn how this approach will be successfully implemented in every science classroom. This was also supported by (Brumann, Ohl, & Schulz, 2022; Tsivitanidou, Yiannis, & Andri, 2021), who proposed that IBL requires an advanced level of skills of teachers that will equally support the advanced skills development of students. By doing so, teachers grow professionally, and students' learning abilities grow in connection with the current trends in education.

Despite much research on the effects of student inquiry on science-related attitudes, Şensoy & Güneş (2023) claimed that training could be provided to teachers about inquiry because profound understanding and acquiring knowledge like real scientists are critical in every science class. By doing so, students are capable of thinking critically, experimenting, investigating, and developing positive attitudes toward science, which is consistent with Öztürk, Kaya & Demir's (2022) findings that inquiry-based learning had an impact on learning outcomes considering improved critical thinking skills, reasoning and affective skills of students. Thus, the inquiry-based approach is congruent with individual overall development Öztürk, Kaya & Demir (2022) explained. Therefore, inquiry-based learning is integral in every science classroom and today's scientific advances. Science inquiry skills shall be practiced to nurture future scientists in the field.

Furthermore, parents and teachers should design a positive learning environment where students engage in hands-on minds-on activities that ignite higher-order thinking skills (Areepattamannil *et al.*, 2023). By doing so, students, when achieving something remarkable, might feel confident, boost their self-esteem, and increase their overall level of self-concept. Students must understand the significance of science in their lives. As such, they will value science and its contributions to society which later optimizes a higher level of self-concept. Hence, policymakers shall implement inquiry-based learning that helps increase interest in learning science. In particular, science clubs and science programs that stimulate actual and hands-on learning are organized in every school because this will help improve students' self-concept, as Areepattamannil *et al.* (2023) recommended.

Nonetheless, a positive self-concept affects the positive academic results of students. Wang & Yu (2023), emphasized in their study that academic self-concept improved educational outcomes. Indeed, self-concept is crucial for students to cope with different educational stages. Then, Aguilar (2022) pointed out that a sense of belongingness and harmonious teacher-student communication inside the classroom increases students' innate value about themselves. In particular, classrooms should have a welcoming and accepting ambiance in which every individual student can showcase their skills and talents. And that teachers religiously monitor their classrooms so that, students feel loved and supported (Aguilar, 2022). Thus, teachers play a major role in promoting a positive classroom environment, and students serve as active recipients who complement knowledge and complete the educational process.

Lastly, as Bibon (2022) emphasized, science is considered one of the most challenging subjects in the country. This report was further supported by the result of the recently concluded PISA 2022, in which students in the Philippines' average score dropped by one point compared to the previous 2018 PISA result. The Philippines ranked third-lowest in science, out of the 81 participating countries (OECD, 2023). Beyond the school, there should be vigorous efforts to change public perception of the essence of science in Filipino society's development. Indeed, Filipino students were vulnerable to poor science learning (Bernardo *et al.*, 2023). As such, Tujyijama & Ntivuguruzwa (2023) stated that some students do not relate the knowledge acquired from the subjects because they do not know how, where, and when it is applicable in real-life situations.

Thus, there is indeed a need for students to relate and appreciate the lesson concerning the development of science-related attitudes. Mamuda & Peni (2022) commended that students should have highly favorable attitudes toward science-oriented career subjects. Students' poor performance results in a lack of information, a lack of self-confidence, and not being able to appreciate the relevance of science in society. In addition, Abed & Abu-Ali (2022) stated in their study that one of the critical reasons for falling patterns of attitudes towards science is the gap between "what science is" and what is taught in "science classroom" and "how it is taught". Many students nowadays have developed negative attitudes toward science, starting from their lower academic level (Rupnow, 2020). Therefore, a skillful teacher makes a difference in every student's heart. This is also supported by Mutya *et al.*'s (2023) research, which concluded that even if students have an optimistic view toward science and yet miss the appropriate understanding and skills or have poor study habits, their school performance may still need to be addressed.

3. Method

3.1 Research Respondents

The senior high school students of STEM (Science and Technology, Engineering and Mathematics) and GAS (General Academic Strand) departments in the selected public schools in the Division of Davao Oriental were chosen as respondents in the study. The researcher obtained 400 as the total population. The number of respondents was

determined using Slovin's formula, and it consisted of 300 students, predominantly from Grade 11 & 12 STEM and GAS, who were 18 years old and above only. The 300 respondents came from the 6 districts of the Division of Davao Oriental, namely, Governor Generoso South, Governor Generoso North, San Isidro South, Lupon West, Lupon East, and Manay district, contributing 50 respondents each.

A stratified random sampling procedure was utilized in the sample size selection. This study used a stratified random sampling technique, the population was divided into strata or smaller sub-groups. The sample population of this study was classified into strata according to characteristics like sex, age, and strands chosen. Then, samples from each sub-group were chosen through a simple random sampling technique (Purna Singh, Vadakedath & Kandi, 2023).

The respondents were chosen according to the following criteria: public senior high students aged 18 and up and residents of the province. A respondent was enrolled in a STEM and GAS strand in the school year 2022-2023. Thus, SHS students under the age of 18, and enrolled in courses not related to STEM and GAS were not qualified. On the contrary, the qualified respondent who refused to answer the questionnaire had the full right to do so, thus, the willingness of every respondent to participate was the utmost goal of the researcher.

3.2 Materials and Instruments

The study used a modified survey questionnaire. The survey questionnaire has been divided into four (4) sections. The first section was the respondents' sociodemographic profile. The second section was the Self-Concept Scale, an adapted questionnaire initially using the Tennessee Self-Concept Scale: Second Edition English, which William H. Fitts and W.L. Warren developed. The TSCS assesses students' self-concept levels in six content areas (Alrehaili, 2015). The third section was the Students Inquiry Questionnaire, developed by (Madden, 2011). This questionnaire was utilized to measure nine science inquiry stages. Lastly, section four is a modified instrument developed initially by B.J. Fraser, a Test of Science-Related Attitude (TOSRA) questionnaire that measured the three distinct levels of science-related attitudes (Kostenbader, 2015).

All questionnaires are adapted, obtained from the internet, and modified to match the study’s setting. The respondents' responses were measured using a five-point Likert scale. The five gradable categories and corresponding rating scales, descriptions, and interpretations are listed below. This served as a basis for evaluating the data collected among the levels of all variables.

Range of Means	Description	Interpretation
4.20-5.00	Very High	This means that students' science-related attitudes were always manifested.
3.40-4.19	High	This means that students' science-related attitudes were oftentimes manifested.
2.40-3.39	Moderate	This means that students' science-related attitudes were sometimes manifested.
1.80-2.59	Low	This means that students' science-related attitudes were rarely manifested.
1.00-1.79	Very Low	This means that students' science-related attitudes were never manifested.

The questionnaires were refined and contextualized to make them appropriate to the local context. Four professional validators assessed the construct validity of questionnaires with a good rating of 4.71 for content validity and regarded it as reliable and a perfect tool for study. The researcher conducted pilot testing and got a .963 Cronbach's Alpha test score in the mediating variable self-concept, student's inquiry as an independent variable got a .965 and a .968 Cronbach's Alpha test score for the dependent variable science-related attitudes.

3.3 Design and Procedure

This study used the quantitative descriptive research design to show the correlation between variables (Nwabuko, *et al.*, 2024). Additionally, this study employed a descriptive survey method that measures variables and describes the relationship between students' inquiry and science-related attitudes of students by incorporating the mediating variable self-concept. This current study used a quantitative descriptive survey method since it would determine the significant association between variables. Furthermore, this method is essential in providing students with facts, data, and information.

To guarantee the study's success, data collection protocols were followed. Before the study was conducted, a permission letter issued by the Dean of Professional Schools was sent to the Davao Oriental division school superintendent. Included in the said letter was the first endorsement letter and letter addressed to the school principals. The researcher received a letter of consent from the Davao Oriental division superintendent. With the Superintendent's approval, the researcher ensured that specific rules and conditions stipulated in the letter were followed. The researcher personally handed the letter to the School Principals of the research locale.

Following consent from the School Principal, the researcher obtained permission from the participants' teacher-adviser and sent the questionnaire online. The study participants answered the survey questionnaires through Google Forms. Thus, 100% retrieval was secured. The researcher retrieved all the responses from the participants right after the administration through Google Forms and Microsoft Excel.

3.4 Data Analysis

The following statistical procedures were utilized for an exact interpretation and discussion of the data: Frequency- was used to provide a visual presentation of data distribution on self-concept, students' inquiry, and science-related attitudes. Mean- describe the students' self-concept, student's inquiry, and science-related attitudes. Standard deviation- measure the dispersion of data samples in a population. Pearson r- measures the correlation of the three variables. Medgraph uses the Sobel z-test- to determine if self-concept mediated the correlation between students' inquiry and science-related attitudes of senior high school students. Sobel's z-test was utilized to evaluate the significance of the mediation. Path Analysis- ascertains how self-concept mediated the link between students' inquiry and science-related attitudes.

3.5 Ethical Considerations

This research study was carried out under the certification number UMERC-2021-186, in full compliance with the ethical standards and procedures established by the University of Mindanao Ethics Committee.

4. Results and Discussion

4.1 Level of Student Inquiry (SI) of the Senior High School Students

Table 1 below shows the respondents' data on their level of *students' inquiry* in science. The table revealed an overall mean score of 3.93, described as *High* and an overall standard deviation of 0.476. Respondents' high ratings for most items could represent the basis for the high level. This indicates that most of the respondents' responses were oftentimes manifested in most cases, and most of the Students' Inquiry levels clustered closely around the mean.

Table 1: Level of Student Inquiry (SI) of the Senior High School Students

Indicator	**SD**	**Mean**	**D.E.**
Exploring	0. 580	3.95	High
Questioning	0.626	3.76	High
Identifying a statement to test	0.653	3.77	High
Designing a procedure for an investigation	0.537	3.90	High
Using the investigation plan	0.518	4.18	High
Collecting data for evidence	0.554	3.93	High
Communicating results of an investigation	0.610	3.93	High
Researching for scientific knowledge related to the investigation	0.578	4.01	High
Extending investigations	0.627	3.98	High
Overall	**0.476**	**3.93**	**High**

Among the nine indicators of students' inquiry, *Using the investigation plan*, 4.18 or *High* got the highest mean score which had the lowest standard deviation of 0.518; while *Identifying a statement to test*, 3.77 or *High,* and Questioning, 3.76 or *High,* considered

indicator with the lowest mean value that had a standard deviation of 0.653 and 0.626 respectively.

It is worth noting that *Using the Investigation Plan* had the highest mean score of 4.18, meaning that Students' Inquiry are often manifested. These numbers implied that senior high school students under STEM and GAS Strand found *Using the Investigation Plan* helpful for substantial queries from observations and testing answers in science class. This also indicates that students are keen observers, as they draw hypotheses based on their prior scientific knowledge. They generate knowledge and create their explanations. *Using the Investigation Plan* is the most beneficial thing every science student should know. This served as a first-step guide on science-related topics every student should focus on. Thus, it encouraged curiosity and more expansive imagination in students. Indeed, every great discovery starts with one single investigation plan. The science field caters to almost everything that surrounds us. Thus, it demands a scientific investigation plan as much as possible.

The results of the current study were consistent with those of Northern (2021), who claimed that inquiry-based learning encouraged deeper learning and motivation by which the more we can get students to ask questions, the deeper their learning. We teachers should create a classroom environment that motivates wonder and curiosity. Activities should be meaningful enough and applicable to real-world possible explorations. Students will be more eager to participate and make themselves at ease in learning science metacognitively. Further, *identifying a statement to test* was essential in students' inquiry learning. The ability to identify a statement to investigate will not be possible without igniting a student's curiosity firsthand. If passive activities are held inside the classroom, learners automatically become passive. This conforms with Abu Khurma & El Zein's (2024) findings, which found that teaching styles, inquiry instruction, and opportunities to plan investigation were all relevant while teaching students inquiry skills. Indeed, developing a well-equipped and critical-thinker student shall be the product of an inquiry-based learning classroom.

4.2 Level of Science-Related Attitudes of the Senior High School Students

Table 2 below displays the level of *science-related attitude* of students in chosen public schools in the Division of Davao Oriental. The data has an overall mean of 3.98, or a *High level,* and a standard deviation of 0.520, suggesting that a majority of respondent's attitudes cluster tightly around the mean. The high level resulted in the respondents giving all indicators a high rating. High ratings were given by the respondents in all indicators. This implied that the respondent's *science-related attitude* was oftentimes manifested in the items of *enjoyment of science lessons*, *attitude to scientific inquiry*, and *adoption of scientific attitudes*.

The displayed overall mean was taken from the calculated mean scores of all items of science-related attitudes. These are as follows: 4.04 or High for *Adoption of scientific attitudes* with a standard deviation of 0.508, 3.99 or High for *students Enjoyment of science lessons* with a standard deviation of 0.583, and 3.90 or High for *Attitude to scientific inquiry* with 0.582 standard deviation.

Table 2: Level of Science-Related Attitudes of the Senior High School Students

Indicator	SD	Mean	D.E.
Adoption of scientific attitudes	0.508	4.04	High
Attitude to scientific inquiry	0.582	3.90	High
Enjoyment of science lessons	0.583	3.99	High
Overall	**0.520**	**3.98**	**High**

The STEM and GAS senior high school students of Davao Oriental often manifested all three indicators of science-related attitudes. Also, most respondents' science-related attitudes cluster closely around the mean, reflecting consistency in responses as shown in the standard deviation value. Based on the data above, the indicator *Attitude to Scientific Inquiry* yielded a high level. However, it still gained the lowest mean score of 3.90 out of three indicators, which means that this is the science-related attitude that needs to be given focus on by both teachers and students. Students' lack of curiosity and motivation to learn beyond the classroom setting is a natural problem. They needed a higher level of eagerness to investigate and explore and to create logical explanations based on the evidence they found in the science field. Thus, teachers must take this into account.

In addition, *Adoption of Scientific Attitudes* gained the highest mean score of 4.04 implying that the majority developed and acquired attitudes similar to real scientists. They already had good sets of scientific behavior learning science. They are explorers, eager to go the extra mile of research to prove a hypothesis. Thus, the optimum facilitative skills of teachers make a more significant impact on students. Also, they find science lessons enjoyable and exciting, as evidenced by the Enjoyment of Science Lessons indicator, which has a mean of 3.99, equivalent to *high*. The subject can expand their perspective and lead them to think outside the box while maximizing science learning outside the classroom. Science allows exploration and creativity; this made the subject loved by science enthusiasts.

Moreover, similar findings of Erika, Kurniawan & Hanum (2020) affirm that students already acquired a scientific mindset, meaning they had an innate good scientific attitude. Due to their curiosity, students are willing to use their time upgrading their science learning to the optimum. Because of this, the students' adoption of scientific attitudes went to the top of the priority lists. Students in STEM and GAS classes already developed attitudes like natural scientists, and with sufficient guidance, everyone's desires and positive attitudes toward science would grow profoundly. The results are made stronger by the analyses of the study of Sharma & Yadav (2023), which proved that students with more positive scientific attitudes performed better in science subjects than those with less positive attitudes prone to lower academic achievements. They highlight the importance of choosing strategies that enhance learners' scientific curiosity, critical thinking, and inquiry levels. Indeed, developing science-related attitudes broadens each student's imagination and uplifts innate higher goals of science explorations.

4.3 Level of Self-Concept of the Senior High School Students

Table 3 below shows an overall mean of 3.99, classified as *High*, and a standard deviation of 0.476. This table displays the mean score for the self-concept level of students. The result suggests that most respondents' *Self-Concept* is closely related to the mean, reflecting consistency in responses. Respondents' high rating in most items was the basis for the high level. This suggests that the respondent's self-concept was often manifested in most cases.

Table 3: Level of Self-Concept of the Senior High School Students

	SD	Mean	D.E.
Overall Self-Concept	**0.476**	**3.99**	High

The overall *Self-Concept* of STEM and GAS students in Davao Oriental yielded a high level, which means that *Self-Concept* was one essential factor that impacted academic performance. Self-concept either slows down or boosts up the performance of students in science. Each student must acquire a higher level of *Self-Concept*. Their confidence and beliefs in themselves affected their science learning. Self-concept comprises their wholeness and the way they connect with others. The result in Table 3 is congruence with Tus's (2020) study; the level of self-concept increases depending on the extensive educational experience a student gains; it can be concluded that family, friends, and teachers affect the development of self-concept in every student. Therefore, students' self-concept level is enhanced not solely by the school environment and learning activities but also by the presence of family, the teachers, and the society where they belong. Indeed, teachers cannot directly stimulate curiosity or the growth of students' self-concept level in the classroom instead, teachers may guide, nurture, and support through maintaining a positive learning environment. The results supported the claim of Amponsah, Mahama & Wadieh (2022) that teachers could provide activities that would nurture and guide students to explore and meet opportunities.

Further, parents, as the first teacher at home, greatly influenced the development of self-concept. Parents' way of upbringing contributes to the child's development of overall self-concept. This also conforms to Verma & Wagani's (2023) findings that parents should provide a safe environment to their children at home so that they achieve a high level of self-concept and perform better academically. The kind of attachment between parents and their kids affects overall self-development. Therefore, a supportive parent, globally competitive teachers, a student-friendly school with ample physical facilities, and a society that promotes equality contribute to the overall self-concept of an individual.

4.4 Correlations Analysis Results

4.4.1 Significance of the Relationship between Levels of Student Inquiry and Science-Related Attitudes of Senior High School Students

Presented in Table 4 below is the significance of the correlation between senior high school STEM and GAS Students' Inquiry and Science-Related Attitudes in Davao

Oriental. The overall values demonstrated a positive and significant association between students' inquiry and their science-related attitudes with a probability value of <.01 and an *r-value* of 0.709, or a high positive correlation. This relationship is significant at 0.05 level. This implies that the higher the student's inquiry, the higher the science-related attitudes. As a result, the null hypothesis that there is no significant relationship between students' inquiry and science-related attitudes was rejected.

Table 4: Significance of the Relationship between Levels of Student Inquiry and Science-Related Attitudes of Senior High School Students

	Science-Related Attitudes			
Students Inquiry	**Adoption of Scientific Attitudes**	**Attitude to Scientific Inquiry**	**Enjoyment of Science Lessons**	**Overall Science-Related Attitudes**
Exploring	0. 531* (0.000)	0.479* (0.000)	0.549* (0.000)	0.557* (0.000)
Questioning	0.561* (0.000)	0.505* (0.000)	0.569* (0.000)	0.584* (0.000)
Identifying a statement to test	0.505* (0.000)	O.444* (0.000)	0.493* (0.000)	0.514* (0.000)
Designing a procedure for an investigation	0.581* (0.000)	O.548* (0.000)	0.580* (0.000)	0.611* (0.000)
Using the investigation plan	0.582* (0.000)	0.454* (0.000)	0.568* (0.000)	0.571* (0.000)
Collecting data for evidence	0.625* (0.000)	0.557* (0.000)	0.617* (0.000)	0.642* (0.000)
Communicating results of an investigation	0.542* (0.000)	0.507* (0.000)	0.555* (0.000)	0.573* (0.000)
Researching for scientific knowledge related to the investigation	0.572* (0.000)	0.513* (0.000)	0.543* (0.000)	0.580* (0.000)
Extending investigations	0.530* (0.000)	0.485* (0.000)	0.551* (0.000)	0.560* (0.000)
Overall Students Inquiry	0.687* (0.000)	0.614* (0.000)	0.686* (0.000)	**0.709* (0.000)**

*Significant at 0.05 significance level.

The table showed that the R-value and p-value between the correlation of exploring and science-related attitudes were 0.557 or *Moderate positive correlation*, and <0.01 probability value, or significant. In addition, the R-value and p-value of the correlation between questioning and science-related attitudes were 0.584; identifying a statement to test was 0.514, designing a procedure for an investigation was 0.611, using the investigation plan was 0.571, collecting data for evidence was 0.642, communicating results of investigation was 0.573, researching for scientific knowledge related to investigation was 0.580, and extending investigations was 0.560. All indicators of students' inquiry had a Moderate positive correlation to science-related attitudes. All indicators had <0.01 probability value or significance at 0.05 level. Data implied that *student inquiry* was considered an important indicator of science-related attitudes.

From the results, it is clear that students' inquiry learning was relevant in every science classroom that aimed to promote globally competitive sets of students. Teachers should be knowledgeable enough to facilitate inquiry so that students gain higher-order thinking skills toward having science-related attitudes. The result presented in Table 4 supported the previous research results of Brau (2020), who claimed that knowledge is acquired through personal reflection and active formulation of ideas from the mind. As such, it is through students' inquiry that active participation and accumulation of ideas are enhanced. Students are active participants in the learning process. They do hands-on, mind-on activities with curiosity and eagerness in inquiry learning.

Also, the current study is congruent with Bizimana, Mutangana & Mwesigye's (2022) findings that teachers' teaching methods, parents, and peer characteristics played a major role in changing students' attitudes toward science. Indeed, the development of science-related attitudes is affected by many factors, and science teachers' teaching quality and methodologies greatly impact their development.

Furthermore, this study confirms similar findings of Rau (2022), affirming that inquiry-based learning helps improve students learning in different areas, encourages self-growth, and guides students to become well-rounded learners looking into the future. The findings are also consistent with the assertions of Sandoval's (2021) study, confirming that frequent implementation of inquiry-based learning will increase motivation and positive attitudes toward science, potentially leading them to choose science-related careers. It should be noted that science affects everything that surrounds us, much more the economy.

4.4.2 Significance of the Relationship between Levels of Student Inquiry and Self-Concept of Senior High School Students

Table 5 shows the test results of the relationship between Students' Inquiry and Self-Concept. It could be gleaned that the indicators of students' inquiry and self-concept showed a calculated R-value of 0.599 or Moderate positive correlation and a probability value of <0.01, indicating a significance at 0.05 level.

This suggests that self-concept increases with the level of students' inquiry. As a result, the null hypothesis of no significant relationship between students' inquiry and self-concept was rejected.

As shown in the table, the R-value and p-value of the correlation between *exploring* and overall self-concept were 0.587, *questioning* was 0.455, *identifying a statement to test* was 0.531, *designing a procedure for an investigation* was 0.597, *using the investigation plan* was 0.456, *collecting data for evidence* was 0.525, *communicating results of investigation* was 0.460, *researching for scientific knowledge related to investigation* was 0.411 and *extending investigations* was 0.364. All indicators had <0.01 probability value or significance at 0.05 level. This proves that increasing students' inquiry will probably boost their self-concept. Data implied that students' inquiry is a significant indicator of self-concept.

Table 5: Significance of the Relationship between Levels of Student Inquiry and Self-Concept of Senior High School Students

Students Inquiry	**Self-Concept**
	Overall Self-Concept
Exploring	0.587* (0.000)
Questioning	0.455* (0.000)
Identifying a statement to test	0.531* (0.000)
Designing a procedure for an investigation	0.597* (0.000)
Using the investigation plan	0.456* (0.000)
Collecting data for evidence	0.525* (0.000)
Communicating results of an investigation	0.460* (0.000)
Researching for scientific knowledge related to the investigation	0.411* (0.000)
Extending investigations	0.364* (0.000)
Overall Students Inquiry	**0.599*** **(0.000)**

*Significant at 0.05 significance level.

The results generated a positive correlation between variables in the study. Students' inquiry and their level of self-concept were significantly correlated. As a result, the null hypothesis, which stated that there was no significant relationship between students' inquiry and their self-concept, was rejected.

This study conforms to the result of Areepattamannil *et al.* (2023), that a positive learning environment where students engage in hands-on, minds-on activities ignites higher-order thinking skills in students that possibly boost their self-confidence and self-esteem as well as increases their overall level of self-concept. Inquiry-based classrooms help maintain an exciting learning environment for students searching for knowledge, longing for scientific-based answers, and future creative individuals in our society. A high-level student inquiry is equivalent to a high-level self-concept. This is further reinforced by the results of Anderson's (2023) study that classroom setups should be homey to students, the one that ignites their interest and unique sets of skills. Demonstrating higher-order thinking skills and showing talents indicate a higher level of self-concept.

4.4.3 Significance of the Relationship between Self-Concept and Science-Related Attitudes of Senior High School Students

Table 6 shows a correlation between senior high school students' *Self-Concept* and *Science-Related Attitudes*. The self-concept and science-related attitudes indicators showed a

computed R-value of 0.533 at the 0.05 level, with a probability value of <0.01. This implies that the higher the respondents' self-concept, the higher their science-related attitudes. As a result, the null hypothesis of no significant relationship between self-concept and science-related attitudes was rejected.

As evident in the table above, the R-value and p-value of the correlation between *Adoption of scientific attitudes* and *self-concept* were 0.499, attitude to scientific inquiry was 0.463, and enjoyment of science lessons was 0.528. It revealed a positive and significant relationship between the indicators of Self-Concept and Science-Related Attitudes. All indicators had <0.01 probability value, or significance at 0.05 level. Data implied that self-concept is a significant indicator of science-related attitudes.

Table 6: Significance of the Relationship between Self-Concept and Science-Related Attitudes of Senior High School Students

	Science-Related Attitudes			
Self-Concept	Adoption of Scientific Attitudes	Attitude to Scientific Inquiry	Enjoyment of Science Lessons	**Overall Science-Related Attitudes**
Overall Self-Concept	0.499* (0.000)	0.463* (0.000)	0.528* (0.000)	**0.533* (0.000)**

*Significant at 0.05 significance level.

This part highlighted the mediating variable self-concept influencing SHS STEM and GAS students' science-related attitudes. The results above showed a significant relationship between students' Self-concept and Science-Related Attitudes. The higher the participants' science-related attitudes, the higher their self-concept. This implies that the teacher must target the development of students' positive attitudes to science because it would significantly affect their overall self-concept.

A similar pattern of results was obtained in the study of Kang, Keinonen & Salonen (2021), which found that academic self-concept impacted science academic success. Teachers need to emphasize science in action that allows students to explore and make meaning to their own experiences. Also, positive self-concept among students was an important issue, an individual's thinking can enter a specific stream for a better chance of reaching personal and educational goals. This is congruent with the study of Sarfika *et al.* (2023), claiming that there was a need for attention from stakeholders, including mental health nurses, to strictly implement motivations to promote positive self-concept among adolescents, considering the sociodemographic background, moral behavior, and academic proficiency as some of the factors that affect the level of self-concept. By doing so, students' development of positive science-related attitudes will rise naturally. Teacher–student positive relationships must be maintained so that there will be growth in the numbers of future Filipino citizens who are not just science achievers but science and technology pioneers. Lastly, higher self-concept levels contribute to science-related attitude development. When an individual student experiences a sense of belongingness and a sense of self in all aspects of his individuality, it will reflect on his academic excellence in science.

4.5 Path Analysis

X = Students Inquiry
Y = Science-related Attitudes
M = Self-concept

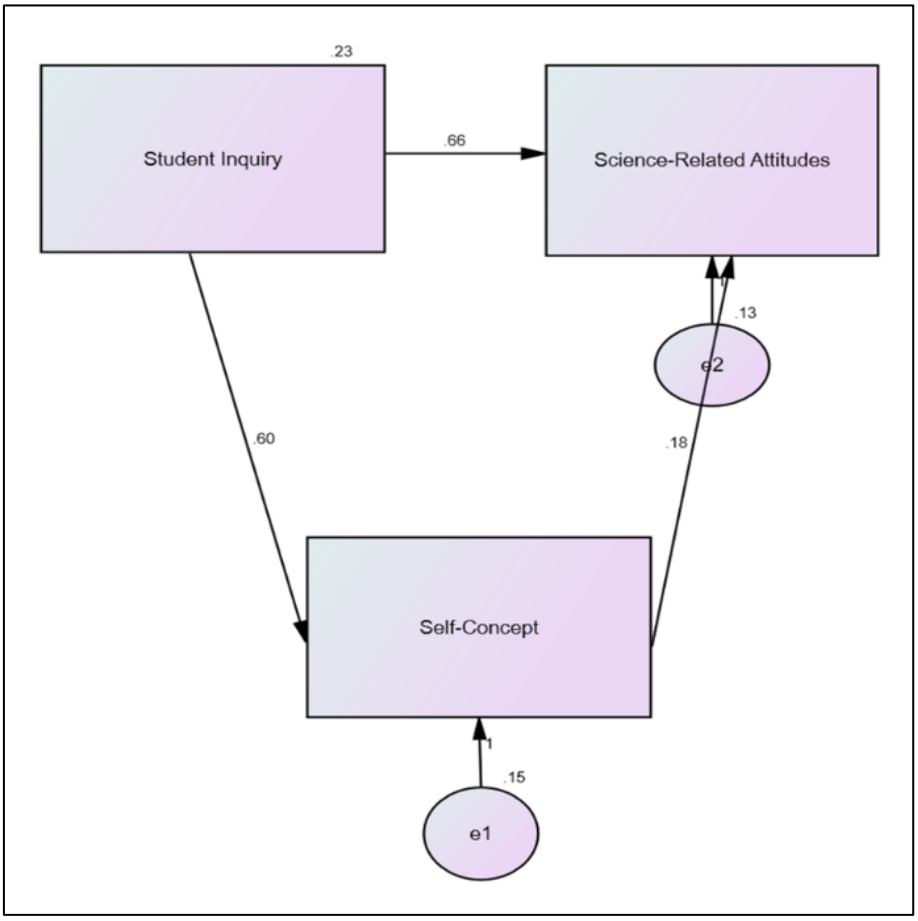

Figure 1: Mediation Model

Using Path Analysis, the result showed that path SI (X) to SC (M); SI (X) to SRA (Y); and SC (M) to SRA (Y) are significant with sign unchanged, implying that, SC partially mediates the relationship between SI and SRA. Figure 1 shows that for every unit of increase in student inquiry, there is an equivalent 0.60 unit increase in M (SC). Also, for every unit of increase in Self-Concept, there is a 0.18 equivalent increase in Science-Related Attitudes. Moreover, for every unit of increase in student inquiry, there is an equivalent 0.66 unit of increase in Science-Related Attitudes. In summary, following the path SI-SC-SRA, for every unit increase in student inquiry, there is a 0.66 unit increase in Science-Related Attitudes. This implies that Science-Related Attitudes could be enhanced by Students' Inquiry strategies in science but should passed through enhanced self-concept, hence, higher level self-concept of students mediates student's inquiry for enhanced science-related attitudes.

Table 7: Regression Weights

	Estimate	**S.E.**	**C.R.**	**R**	**Label**
SC ← SI	.599	.046	12.936	***	
SRA← SI	.665	.055	12.180	***	
SRA ← SC	.183	.055	3.361	***	
Variances	**Estimate**	**S.E.**	**C.R.**	**P**	
SI	.226	.019	12.227	***	
e1	.145	0.12	12.227	***	
e2	.129	0.11	12.227	***	

The mediation analysis result showed that students' science-related attitudes and level of inquiry are partially mediated by their self-concept. This suggests that students' self-concept can partly describe how students' inquiry may alter their science-related attitudes, especially in their science classes and activities. The independent variable, students' inquiry, and the mediating variable, self-concept are both regressed about the dependent variable, science-related attitudes. This results in a partial mediation of the self-concept on the correlation between students' inquiry and science-related attitudes of students. Thus, this research's hypothesis 2 is rejected. The correlation between students' inquiry and science-related attitudes is significantly mediated by self-concept. With this result, it is not claimed that students' inquiry level can influence science-related attitudes because self-concept is considered only a partial mediator.

5. Conclusions

Conclusions were made in light of the findings regarding students' inquiry and science-related attitudes and the mediating effect of self-concept.

The findings demonstrated a favorable high level of student inquiry among STEM and GAS strand senior high school students in Davao Oriental. Likewise, there was a high level of students' science-related attitudes. In addition, there was a high level of students' self-concept.

Further, this study also found significant correlations between the three variables: students' inquiry and science-related attitudes of students, students' inquiry to self-concept, and self-concept to students' science-related attitudes. Thus, it is clear that students' inquiry and science-related attitudes have a positive relationship. In the case of mediation, the study found that students' inquiry and science-related attitudes of students are partially mediated by their self-concept.

Finally, the result affirms that acquiring and improving science-related attitudes are the prime benefits of students' inquiry learning, which supports the constructivist learning theory. By enhancing students' prior knowledge and creating responses to problems based on their new perspective, students can increase their metacognition and become educated. This also supports Bandura's Social Cognitive Learning Theory, which emphasizes the importance of the social environment in learning. An individual student learns alone but learns better when he is with peers, teachers, parents, and any other

person with whom he interacts. Thus, a student's learning abilities and character are influenced by their social environment. Likewise, as students' views and feelings about themselves influence academic performance, boosting their self-concept is essential for acquiring science-related attitudes and overall success. Therefore, students' inquiry will significantly lead to a more positive attitude toward science, wherein students participate and involve themselves in varied learning activities in addition to their innate competence and overall self-concept.

6. Recommendations

The results of this study demonstrate a significant association between the three variables: self-concept, students' inquiry, and science-related attitudes. Accordingly, the results would hopefully encourage students, particularly the Senior High School students under STEM and GAS strands, to focus on their studies and actively participate in all science activities inside & outside the classroom and laboratories to improve their inquiry skills. Students shall be willing to explore, ask questions, communicate their investigation, and do scientific research. Undoubtedly, students need to focus on improving their skills in formulating questions. Creating science investigation-type questions shall be practiced in every science class. I encourage students to experiment with open-mindedness and creativity. To this end, they can focus on simple innovations to arrive at new research questions and proposals that will open the door to curiosity.

Likewise, as senior high school student's level of inquiry progresses, their science-related attitudes tremendously improve. Positive science-related attitudes were beneficial in the personal, academic, and career aspects. Adopting scientific attitudes brings out the best in students; it further develops rational thinking that investigates just to come up with the exact pieces of evidence. This study exposes that attitudes toward scientific inquiry must be paid attention to enhance STEM and GAS students' science-related attitudes in Davao Oriental. Students will execute simple to complex levels of experimentation daily to be equipped with new methods to explain daily phenomena in science that are impossible in a lecture-based classroom.

Further, as the level of self-concept develops, science-related attitudes also advance. Moreover, a higher level of self-concept will result in a higher level of science-related attitudes. Indeed, teachers, parents, and the community influence the sense of self every individual student acquires, which then affects their capability to extend investigations to prove scientific evidence. Surely, positivity in dealing with students is relevant to their overall upbringing. They shall be learners with a positive outlook congruent to their higher-level self-concept toward skills development suitable to their chosen future science-related careers.

The science teachers are advised to allocate time to preparing activities that improve students' inquiry skills and pursue continuing professional development toward being better facilitators of student-centered science learning. By doing so, they can produce globally competitive learners who acquire optimal science-related attitudes and are scientifically literate with higher self-concepts. Additionally, to improve

students' self-concept and positive attitudes toward science, parents are encouraged to support their children's personal and educational growth. They must supervise the development of one's self-concept at home because it affects one's academic performance. Positive parenting will be implemented to motivate students to excel academically in science subjects toward choosing science-related careers.

Finally, it is suggested that future researchers may conduct parallel studies using other variables about science-related attitudes. This study may provide information about what is behind nurturing students' development of science-related attitudes.

Conflict of Interest Statement

The authors declare no conflicts of interest.

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References

Abed, Osama & Ali, Mohammad (2022). Attitudes of Fourth and Eighth Grade Jordanian Students toward Science: A Cross-Sectional Study. *Multicultural Education* 8. 54-63. http://dx.doi.org/10.5281/zenodo.7117638

Abaniel, A. (2020). Enhanced conceptual understanding, 21st-century skills, and learning attitudes through an open-inquiry learning model in physics. *Journal of Technology and Science Education, 11*(1). https://doi.org/10.3926/jotse.1004

Abu Khurma, O., & El Zein, F. (2024). Inquiry skills teaching and its relationship with UAE secondary school students' critical thinking: Systematic review of science Teachers' perspectives. *Eurasia Journal of Mathematics, Science and Technology Education, 20*(2), https://doi.org/10.29333/ejmste/14155

Abun, D., Antonio, G., Alipio, C., & Reginaldo, L. (2023). The effect of students' attitude Toward research on the intention to conduct research. *Divine Word International*

Journal of Management and Humanities, 2(2), pp. 268-287. http://dx.doi.org/10.62025/dwijmh.v2i2.26

Adejimi, S., Nzabalirwa, W., & Shivoga, W. (2022). Enhancing students' attitudes towards biology using consensus and cooperative reflective journal writing educational strategies. *Problems of Education in the 21st century. Vol. 80*, No. 2, 2022. https://doi.org/10.33225/pec/22.80.242

Aguilar, E. (2022). Perceptions of academic self-concept: Testimonios of junior high school Latinas (Order No. 29164555). Retrieved from https://digitalcommons.lmu.edu/cgi/viewcontent.cgi?article=2161&context=etd

Ahmad,S., Sultana, N., & Jamil, S. (2022). Students' attitude towards biology in Secondary schools in Islamabad, Pakistan. *International Journal of Educational Research and Innovation (IJERI), 17*, 243-256. https://doi.org/10.46661/ijeri.4711

Alrehaili, N. (2015). The relationship between self-concept and academic achievement. State University of New York. Retrieved from https://soar.suny.edu/handle/20.500.12648/73?show=full

Amposah, M., Mahama, I., & Wadieh, E. (2022). An examination of curiosity and Academic self-concept among students of category "A" Senior high school in the Central Region of Ghana. *Participatory Educational Research (PER). Vol 9*(4), pp. 367-378, July 2022. http://dx.doi.org/10.17275/per.22.95.9.4

Anderson, C. R. (2023). Traditional versus modern teaching methods amongst special education students and enhancing students' self-concept: A comprehensive literature review Retrieved from https://www.proquest.com/openview/6a2fd82f499fd1236d0f0ef23271e967/1?pq-origsite=gscholar&cbl=18750&diss=y

Areepattamannil, S., Khurma, O., Ali, N., Hakmani, R., & Kadbey, H. (2023). Examining the relationship between science motivational beliefs and science achievement in Emirati early adolescents through the lens of self-determination theory. *Large Assessment in Education*. https://doi.org/10.1186/s40536-023-00175-7

Behanu, M. & Sheferaw, H. (2022). The effectiveness of guided inquiry-based learning strategy on learning physical and chemical changes. *African Journal of Chemical Education – AJCE 12*(2) Retrieved from https://www.ajol.info/index.php/ajce/article/view/229359

Bennett, A. R. (2023). There's a method to my madness: A qualitative study of secondary science teachers' perceptions and planning of inquiry in urban classrooms (Order No. 30249188). Retrieved from https://scholarshare.temple.edu/handle/20.500.12613/8561

Bernardo, A., Cordell, M., Calleja, M., Teves, J., Yaps, S., & Chua, U. (2023). Profiling low-proficiency science students in the Philippines using machine learning. Humanities and Social Science Communications https://doi.org/10.1057/s41599-023-01705-y

Berie, Z., Damtie, D., & Bogale, Y.N. (2022). Inquiry-Based Learning in Science Education: A content analysis of research papers in Ethiopia (2010-2021). *Hindawi Educational Research International*. Vol. 2022. https://doi.org/10.1155/2022/6329643

Belo, R. (2021). Effects of inquiry-based learning on the performance of the learners: A literature review. *GSJ: Volume 9*, Issue 7. Retrieved from https://www.globalscientificjournal.com/researchpaper/Effects_of_Inquiry_based_Learning_on_the_Performance_of_the_Learners_A_Literature_Review.pdf

Bhusal, P. (2024). Empowering middle school students: The role of a summer research academy in advancing environmental health education. Retrieved from https://www.proquest.com/docview/3061604719/89F61C6131214425PQ/2

Bibon, M.B. (2022). Teacher;s instructional practices and learner's academic achievements in science. *Contemporary Mathematics and Science Education, 3*(1), ep22007. https://doi.org/10.30935/conmaths/11816

Bizimana, E., Mutangana, D., & Mwesigye, A. (2022). Enhancing students' attitude towards biology using concept mapping and cooperative mastery learning instructional strategies; implication on gender. LUMAT General Issue Vol 10 No. 1, 242- 266. https://doi.org/10.31129/LUMAT.10.1.1728

Bonet, B. (2021). Exploring middle school science teachers' self-efficacy with inquiry-based learning: A case study. Retrieved from https://www.proquest.com/openview/a9692fdd01b4d0a2efd83f024b3eb0f5/1?pq-origsite=gscholar&cbl=18750&diss=y

Brau, B. (2020). *Constructivism. The Students' Guide to Learning Design and Research*. EdTech Books.

Brumann, S., Ohl, U., & Schulz, J. (2022). Inquiry-based learning on climate change in upper secondary Education: A design-based approach. *Sustainability 14*, no. 6:3544. https://doi.org/10.3390/su14063544

Cabalang, E. & Cabalang, M. (2022). Inquiry-based learning as a strategy for teaching Earth and Life Science among Grade 11 learners. *International Journal of Scientific Research in Multidisciplinary Studies*. Vo. 8, Issue 1, pp. 01-05. Retrieved from http://dx.doi.org/10.13140/RG.2.2.27285.19688

Cabrales, F. & Pacala, P. (2023). Science education in the Philippines Countryside: a phenomenological study. *Indonesian Journal of Education 8*(4). Retrieved from http://dx.doi.org/10.33222/ijetl.v3i1.2677

Cermik, H. & Fenli-Aktan, A. (2020). Primary school students' attitude towards science. *International Journal of Educational Methodology, 6*(2), 355-365, https://doi.org/10.12973/ije. 6.2.355

Crone, E. A., Green, K. H., van de Groep, I. H., & van der Cruijsen, R. (2022). A neurocognitive model of self-concept development in adolescence. *Annual Review of Developmental Psychology, 4*, 273-295. Retrieved from https://doi.org/10.1146/annurev-devpsych-120920-023842

De la Fuente, J., Kauffman, D. & Boruchovitch, E. (2023). Editorial: Past, present and Future contributions from the social cognitive theory (Albert Bandura). *Front. Psychol*. 07 August 2023 https://doi.org/10.3389/fpsyg.2023.1258249

Douma, I., de Boer, A., Minnaert, A., & Grietens, H. (2022). The I of students with ID or SEBD: A systematic literature review of the self-concept of students with ID or

SEBD. *Educational Research Review, 36*(1) Retrieved from http://dx.doi.org/10.1016/j.edurev.2022.100449

Elliniadou & Sofianopoulou (2021). Students' attitudes towards science, where we go from here. Department of Informatics and Telematics, Harokopio University of Athens (Greece). https://doi.org/10.36315/2021end108.

Eaves, F.R. (2021). The effectiveness of the inquiry-based learning method in the private independent school environment. Graduate theses and Dissertations Retrieved from https://scholarworks.uark.edu/etd/4029

Erika, E., Kumiawan, E., & Hanum, A. (2020). Student's attitudes based on adoption of scientific attitudes and interest in expanding time learning science. *Lensa: Jurnal Kependidikan Fisika, 8*(2), 70-75. DOI: https://doi.org/10.33394/j-ikf.v8i2.2952

Garn, A., Centeio, E., Somers, C., Moore, E., Kulik, N., & McCaughtry, N. (2019). Reciprocal effects model of Children's physical activity, physical self-concept and enjoyment. *Psychology of Sport and Exercise* Vo. 45, Retrieved from https://doi.org/10.1016/j.psychsport.2019.101568

Georgiou, Y., & Kyza, E. A. (2023). Fostering chemistry students' scientific literacy for responsible citizenship through socio-scientific inquiry-based learning (SSIBL). *Sustainability, 15*(8), 6442. doi: https://doi.org/10.3390/su150864

Harmon, K. (2023). The impact of Inquiry-based learning professional development has on science and agricultural teachers' intent to use animal science concepts as a context for teaching science. Theses, Dissertations, & Student Scholarship: Agricultural Leadership, Education & Communication Department, 121. https://digitalcommons.unl.edu/aglecdiss/121

Hubner, N., Wagner, W., Zitzmann, S., & Nagengast, B. (2022). How causal is a Reciprocal effect? Contrasting traditional and new methods to investigate the reciprocal effects model of self-concept and achievement https://doi.org/10.31234/osf.io/f3e8w

Kang, J., Keinonen, T., & Salonen, A. (2021). Role of interest and self-concept in predicting science aspirations: Gender study. *Research in Science Education, 51* (Suppl 1), 513-535. Retrieved from https://link.springer.com/article/10.1007/s11165-019-09905-w

Kania, N., & Juandi, D. (2023). Does self-concept affect mathematics learning achievement? *Journal of Education and Learning (Edu Learn), 17*(3), 455-461. Retrieved from http://dx.doi.org/10.11591/edulearn.v17i3.20554

Kemunto, N. & Oyoo, S. (2023). Relationship between academic self-concept and academic achievement among secondary school students in Kisumu East Sub-County. *International Journal of Social Science and Humanities Research.* https://doi.org/10.5281/zenodo.8328241

Kirilmazkaya, G. & Usta, M. (2022). Effect of Science teaching supported with scientific stories on students' academic success, attitudes, motivation. *International Online Journal of Education and Teaching (IOJET),* 9(4), 1838-1851. Retrieved from https://eric.ed.gov/?id=EJ1353377

Kostenbader, T. (2015). Analyzing Students' Attitudes towards Science During Inquiry-Based Lessons. California State University, Long Beach. Retrieved from

https://www.proquest.com/openview/962c06bcc510ffaa9d0db9299be284b3/1?pq-origsite=gscholar&cbl=18750

Luce, S. M. (2024). Guided inquiry approach to chemistry instruction to improve the self-efficacy levels of students with individualized education programs. Retrieved from https://www.proquest.com/docview/3057608075/E023E872326A468EPQ/2

Madden, K. (2011). The use of inquiry-based instruction to increase motivation and academic success in a high school biology classroom. Montana State University. Bozeman Montana. Retrieved from https://scholarworks.montana.edu/items/f4a1bf1c-5887-4a13-af18-deb2b44edca9

Mamuda, S. & Peni, S.A. (2022). Attitudes of students towards physics learning in some selected senior secondary schools in Birnin Kebbi, Kebbi State, Nigeria. *Journal of Advanced Education and Sciences*, *2*(4): 37-41. Retrieved from https://www.dzarc.com/education/article/view/190

Mao P, Cai Z, He J, Chen X, & Fan X (2021). The relationship between attitude toward science and academic achievement in science; A three-level Meta-Analysis, *Front, Psychol. 12;* https://doi.org/10.3389/fpsyg.2021.784068

Mcleod, S. (2023). Albert Bandura's social learning theory. Retrieved from https://www.simplypsychology.org/bandura.html

Mehmood, N., Arif, M., & Anwer, M. (2023). Relationship of students' attitude towards science with their learning approach: A gender and socioeconomic status (SES)based study. *Journal of Sciences Review, 3*(2), 1176-1189. https://doi.org/10.54183/jssr.v3i2.369

Mukandayisenga, S., Opanga, D., & Nsengimana, V. (2021). Teachers' perception on the effectiveness of inquiry-based learning towards student's achievements in Biology: The case of schools of Rwanda. *African Journal of Educational Studies in Mathematics and Science Vol.* 17, No. 2, 2021. https://dx.doi.org/ajesms.v17i2.8

Mutya, R., Alcantara, G., Sala, A., Carascal L., Terana, C. & presbetiro, M. (2023). Students' attitudes, study habits, and academic performance in using self-learning modules. *Journal Pendidikan IPA Indonesia 8*(2). https://10.15294/jpii. v12i3.43957

Naseri, S. (2022). A Narrative Inquiry into the Experiences of Children and Parents with Technology: What Are Real and Unreal Worlds? University of Saskatchewan Saskatoon Retrieved from https://harvest.usask.ca/bitstream/handle/10388/13860/

Northern, S. J. (2021). Examining the effects of a curriculum-based professional learning community on teacher efficacy toward inquiry-based science instruction. Available from ProQuest Central. Retrieved from https://digitalcommons.wku.edu/diss/204/

Nwabuko, Ogbonna & Iwu, Lilian & Njoku, Patrick Uchenna & Nwamoh, Uche (2024). An Overview of Research Study Designs in Quantitative Research Methodology. *American Journal of Medical and Clinical Research & Reviews. 3*. 1-6. 10.58372/2835-6276.1169. https://doi.org/10.58372/2835-6276.1169

OECD Future of Education and Skills 2030 (2023). Conceptual Learning Framework. Retrieved from https://www.oecd.org/en/about/projects/future-of-education-and-skills-2030.html

Okmen, B., Sahin, S., & Kilic, A. (2022). Effectiveness of layered inquiry-based learning model. *Van Yuzuncu Yil University Journal of Education 19*(3); p. 799-826. Retrieved from https://doi.org/10.33711/yyuefd.1134812

Öztürk, B., Kaya, M., & Demir, M. (2022). Does inquiry-based learning model improve learning outcomes? A second-order meta-analysis. *Journal of Pedagogical Research*, 6(4), 201-216. https://doi.org/10.33902/JPR.20221748 1

Palines, K. & Dela Cruz, R. (2021). Facilitating factors of scientific literacy skills development among Junior high school students. *Lumat General Issue*. *Vol 9* No. 1(2021), 546-569. https://doi.org/10.31129/lumat.9.`.1520

Prachagool, V., & Arsaiboon, C. (2021). Scientific attitudes of young children through literature-based and project-based learning organizations. *JPBI (Journal Pendidikan Biologi Indonesia), 7*(3), 288-294. https://doi.org/10.22219/jpbi. v7i3.16646

Pribadi, B. (2023). Implementing the constructivist approach of the face-to-face tutorial program in the academic writing course. *Academics: Journal of Educational Technology*. https://doi.org/10.34005/akademika.v12i01.2470

Rau, A. N. (2022). Effects of Inquiry-Based Learning on Science Students [Master's thesis, Bethel University]. Spark Repository. Retrieved from https://spark.bethel.edu/etd/885

Rubio, A., & Conesa, I. (2022). Inquiry-based learning in primary education. *Journal of Language and Linguistic Studies*, 18(2), 623-647. Retrieved from https://eric.ed.gov/?id=EJ1347976

Ruiz, C., Cobos, T., & Lopez, A. (2022). Effects of an inquiry-based science education training program on pre-service teachers. A mixed methods case study. *Eurasia Journal of Mathematics, Science & Technology Education, 18*(2), https://doi.org/10.29333/ejmste/12578

Rupnow, J. (2020). Improving student attitudes towards science through active, collaborative learning. A Master's Thesis. Retrieved from https://mlc-wels.edu/library/wp-content/uploads/sites/14/2020/08/Rupnow-Field_Project-Final.pdf

Sandoval, C. (2021). Fanning the flame: Investigating guided inquiry-based learning in the secondary science classroom. Retrieved from https://core.ac.uk/outputs/429688024/?source=2

Sarfika, R., Saifudin, Y., & Oktavianto, E. (2023). Self-concept among Indonesian adolescents in coastal areas: A cross-sectional study. *Belitung Nursing Journal*, Volume 9, Issue 3. https://doi.org/10.33546/bnj.2662

Schunk, D. & DiBenedetto, M. (2023). Albert Bandura's legacy in education. *Theory into Practice, 62*:3, 205-206, https://doi.org/10.1080/00405841.2023.2226560

Şensoy, A., & Güneş, M. H. (2023). Guided inquiry-based learning practices. Rehberlikli Araştırma-Sorgulamaya Dayalı Öğrenme Uygulamaları] Bart Üniversitesi Egitim Fakültesi Dergisi, 12(3), 471-487. doi: https://doi.org/10.14686/buefad.795391

Setiani, R. (2023). Research trend of inquiry learning in elementary school in the last 10 years: To determine the opportunities in the future. *Studies in Learning and Teaching*, *4*(1), 144-156. https://doi.org/10.46627/silet.v4il.214

Shabbir, M. A.; Asif, I.; & Saeed A.; Mahr, M. (2021). Student's attitude towards science and its relationship with achievement score at an intermediate level. *Journal of Elementary Education* Vol. 25, No. 2, pp. 61-72. Retrieved from https://www.researchgate.net/publication/352646815_Students'_Attitude_towards_Science_and_its_Relationship_with_Achievement_Score_at_Intermediate_Level

Sharma, S. & Yadav, S. (2023). Scientific attitude of secondary school students in relation to their achievement in science. *International Journal of All Research Education and Scientific Methods (IJARESM).* https://doi.org/10.56025/ijaresm.2023.119231636

Slapničar, M., Ribič, L., Devetak, I., & Vinko, L. (2024). Inquiry-based chemistry education activities in a non-formal educational setting for gifted students. *CEPS Journal: Center for Educational Policy Studies Journal, 14*(1), 143-169. doi: https://doi.org/10.26529/cepsj.l706

Smith, N. (2021). Can my use of guided inquiry-based science education enhance my pupils learning of and attitude toward science? Master thesis, National University of Ireland Maynooth. Retrieved from https://mural.maynoothuniversity.ie/15142/

Sorjonen, K., Ingre, M., Melin, B., & Nilsonne, G. (2023). Questioning the reciprocal effect model of academic self-concept and achievements: A reanalysis of a meta-analysis of longitudinal studies and a stimulation. *Sage Open*, *14*(4). https://doi.org/10.1177/21582440241292826

Steidtmann, L., Kleickmann, T., & Steffensky, M. (2022). Declining interest in science in lower secondary school classes: Quasi-experimental and longitudinal evidence on the role of teaching and teaching quality. *Journal of Research in Science Teaching* Vol. 60, Issue 1. p. 164-195. https://doi.org/10.1002/tea.21794

Strat, T., Henriksen, E. & Jegstad, K. (2023). Inquiry-based science education in science teacher education: a systematic review. *Studies in Science Education* 60(2) https://doi.org/10.1080/03057267.2023.2207148

Tai, R., Ryoo, J., Worley, A., Dabney, K., Almarode, J., & Maltese, A. (2022). (Re-) Designing a measure of student's attitudes towards science: a longitudinal psychometric approach 9:12 International Journal of STEM Education 12 https://doi.org/10.1186/s40594-022-00332-4

Tekin, G., & Mustu, E. (2021). The effect of research-inquiry-based activities on the academic achievement, attitudes, and scientific process skills of students in the seventh-year science course. *The European Educational Researcher, 4*(1), 109-131, https://doi.org/10.31757/euer.416

Thampinathan, S. (2022). The application of the constructivism learning theory to physician assistant students in Primary Care. *Education for health (Abingdon, England)*, *35*(1), 26–30. https://doi.org/10.4103/efh.EfH_333_20

Tiryaki, A., Yaman, M., & Tunc, B. (2022). A mixed-meta method study on the effect of constructivist approach on retention scores and evaluation of learner views. *International Journal of Scholars in Education, 5*(2), 90-100. Retrieved from https://dergipark.org.tr/en/pub/ueader/issue/74903/1164122

Toma, R. (2020). Effect of confirmation and structured inquiry on attitudes toward school science. Department of Specific Didactics, University of Burgos, Burgos, Spain. https://doi.org/10.1111/ssm.12505

Tsivitanidou, O. E., Yiannis, G., & Andri, I. (2021). A learning experience in inquiry-based physics with immersive virtual reality: Student perceptions and an interaction effect between conceptual gains and attitudinal profiles. *Journal of Science Education and Technology, 30*(6), 841-861. https://doi.org/10.1007/s10956-021-09924-1

Tujyinama, V. & Ntivuguruzwa, C. (2023). Assessing the impact of student's attitudes on their engagement and performance in physics at lower secondary schools in Rwamagana District, Rwanda, *Journal of Research Innovation and Implications in Education*, 7(1). 43-62. Retrieved from https://jriiejournal.com/wp-content/uploads/2023/02/JRIIE-7-1-005.pdf

Tus, J. (2020). Self-Concept, Self-Esteem, Self-Efficacy, and Academic Performance of the Senior High School Students. *International Journal of Research Culture Society* Vol. 4, Issue 10, http://dx.doi.org/10.6084/m9.figshare.13174991.v1

Tutal, O. & Yazar, T. (2022). Active learning promotes more positive attitudes towards the course: A meta-analysis. *Review of Education 10*; https://doi.org/10.1002/rev3.3346

Uy, R. & Azuelo, A. (2023). Students' academic self-concept in Earth Science through online process oriented guided inquiry learning approach. *International Journal Applied Science and Research*. https://doi.org/10.5693/IJASR.2022.5484

Wang, L., & Yu, Z. (2023). Gender-moderated effects of academic self-concept on achievement, motivation, performance, and self-efficacy: A systematic review. *Frontiers in Psychology, 14*, https://doi.org/10.3389/fpsyg.2023.1136141

Wang, Y. (2022). Research on the implications of constructivism to education. *Advances in Social Science, Education, and Humanities Research,* volume 664. http://dx.doi.org/10.2991/assehr.k.220504.507

Wang, H., Hong, Z., She, H., Smith, T., Fielding, J., & Lin, H. (2022). The role of structured inquiry, open inquiry, and epistemological beliefs in developing secondary students' scientific and mathematical literacies. *International Journal of STEM Education* 9:14 https://doi.org/10.1186/s40594-022-00329-z

Zaki, M. (2022). Students' scientific attitudes analysis based on Gender and Grade level. Journal of Xi'an Shiyou University, Natural Science Edition. Retrieved from https://www.xisdxjxsu.asia/V18I11-47.pdf