Revolutionizing Science Education: Assessing Students’ Attitude and Critical Thinking Skills towards Computer-Assisted Instruction

Margerie H. Concha, Alrien Jane A. Martinez, and Arman P. Nuezca
Science Education Department, Central Mindanao University, University Town, Musuan, Maramag, Bukidnon, Philippines

Abstract
The study generally aimed to investigate the level of attitude and critical thinking skills of the students exposed to computer-assisted instruction (CAI). A validated and adapted survey questionnaire was utilized in gathering data among the Grade 10 junior high school science students of Banlag Integrated School. The total enumeration sampling technique was used in determining the participants of the study. The researchers employed a descriptive-correlational research design in carrying out the investigation. Quantitative data were analyzed and interpreted using descriptive statistics and Pearson-R correlation. The results of the study revealed that the students have a moderately positive attitude toward science with the use of CAI. Furthermore, the students have moderately high critical thinking skills in the following constructs: engagement, cognitive maturity, and innovativeness. Likewise, the results show a correlation value of r=0.679 (p<0.01), indicating a highly significant correlation between the students’ attitude and critical thinking skills when students are exposed to CAI. Based on the findings of the study, it is recommended that educators may consider the use of digitized multimedia instructions such as interactive computer simulations or using augmented reality applications in teaching science and other related disciplines since the current investigation found that it develops students’ critical thinking skills and promotes positive attitudes towards the subject.

Keywords
attitude, computer assisted instruction, critical thinking skills, science teaching

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INTRODUCTION

Background of the Study

Teaching science requires a lot of experiments and visualizations. Science laboratories in every school are utilized for students to conduct experiments and put abstract and theoretical scientific concepts into action. However, not all schools have science laboratories or enough laboratory equipment to perform such tests. Thus, some teachers make use of computer-assisted instruction (CAI) to present abstract and theoretical ideas in science, allowing students to effectively visualize the concepts. Hence, the integration of CAI in the teaching and learning process fills in the gap of inadequate science facilities and equipment. Banlig Integrated School is located 19 kilometers away from the city proper of Valencia, Bukidnon. The area lacks strong internet access, limiting the use of the internet and computer-mediated learning both in school and at students' homes. Some classrooms don't have LED TVs for teachers to use, and most of the school's computers are defective. In fact, the DepEd Computerization Program, which aims to integrate ICT into the school system, provided 100 computers for junior high and senior high school students. However, all the computers are defective, and none can be used by the students, limiting some students' exposure to CAI.

The lack of avenues for scientific visualization and exploration to enhance students' understanding of learning concepts and interests leads to one of the primary causes of failure among students in science. The use of CAI in the teaching and learning process can aid students in visualizing abstract ideas, which in turn affects their attitude and influences their effort in analyzing and evaluating observations, experiences, realizations, etc. Moreover, the ability to think critically is among the main components of 21st-century learning skills to solve new problems in the modern world. Being able to think critically is an application of higher-order thinking. Critical thinking can improve the ability to think rationally and clearly, and it is important for whatever we choose to do. According to Santos (2017), critical thinking is an important component in science education. The poor critical thinking skills of students can also be linked to poor guidance for the implementation of activities in the classroom and poor teaching strategies. In the assessment of the Programme for International Student Assessment (PISA) last year, it was reported that Filipino students in science have low performance, with the Philippines ranking 78 out of 79 participating countries (OCSE, 2018). On the other hand, the study of Nelly and Kiptum (2021) found that CAI is an effective tool in influencing students' attitude, which in turn improves their retention and mastery.

Considering the finding that students' attitude influences their level of critical thinking through the use of CAI, it can provide appropriate strategies and techniques that can improve the teaching-learning process, particularly in schools whose students are not deeply exposed to CAI. It can provide insights on how CAI can be adapted or tailored for rural schools in a way that facilitates the visualization and comprehension of complex scientific concepts to optimize the learning experience for students, thereby improving their overall academic performance in science.

Literature Review

On Students' Attitude

Student’s Attitude towards Science. Estipular and Roleda (2018) presented that students’ learning greatly depends on how the lessons are presented since they will have more interest. Moreover, they can comprehend and understand it correctly if the students are able to understand the underlying science concepts such as formulating their own hypotheses and predicting their own results which harnesses higher thinking among students. Anwar and Bhutta (2014) presented that most students consider science as a boring and difficult subject and their interest in the particular subject decreases as they move to higher grades of education. This is mainly due to the fact that most students believe that it is not important to life; rather, they feel like it’s not about the people but about things.

Factors Affecting Students’ Attitude in Science. According to Kenar et al. (2015), social-environmental variables such as parents, classmates, friends, and socioeconomic status can affect kids’ attitudes toward learning science. The attitude of students in learning science is mainly influenced by their teachers’ traits and conduct. In addition, the study of Fulmer et al. (2019) projected that the positive attitude of students in science is influenced by the teacher’s delivery of instructions which in turn affects their persistence in the field. It denotes that the utilization of student-centered instruction where the students can interact, cooperate, and be involved in class builds up positive attitudes among students.

The Relationship of Student’s Attitude and Academic Achievement. According to Melad (2022), the student with a positive attitude towards the subject gives the course extra effort. For example, their goal is to complete their assignments diligently, invest time and energy into the coursework, engage in extensive reading or focused preparation for every exam, and strive to be present for every class. Also, students who have a bad attitude get bored with the course, are unable to appreciate the advantages of the subject, are unable to concentrate in class, are more inclined to interrupt the flow of the lesson, and are more likely to be absent. On the other hand, students performed better when they had a favorable attitude about the class.

On Students’ Critical Thinking

The Role of Critical Thinking in Science Education. According to Darrm (2015) in scientific methods such as observation, exploration in process, critical thinking is present. In gaining the ability to research, think, resolve, and question in a scientific way, it is important to develop critical and reflective thinking skills. The same idea is also presented by Santos (2017), wherein all processes in the scientific method or research involve the use of critical thinking since it is the foundation of constructing a reliable body of knowledge. In turn, this makes the importance of critical thinking in science education unquestionable.
According to Moreira et al. (2014), the adoption of classroom procedures or activities based on critical thinking concepts and criteria is considered as having significant potential to benefit science education. Activities focused on questioning, which are observed in two directions, are some of the particular approaches that were discovered as similarities across different writers.

**The Importance of Critical Thinking.** The study of Fitriani et al. (2019) presented that 21st-century learning should prioritize the students’ acquisition of the scientific attitudes and critical thinking skills since these are among the most important knowledge and skills. Furthermore, one of the educational goals of today’s educational system is to build critical thinkers. Critical thinking skills are important for effective problem-solving.

**On Computer-Assisted Instruction**

**Defining Computer-Assisted Instruction.** The use of Computer-Assisted Instruction has played a role in the effective understanding of scientific abstract and theoretical concepts which students find difficult to comprehend. This way, students can acquire visual materials and presentations to learn those concepts. The use of CAI has been practiced in science education all over the world. Studies have shown that computer-assisted teaching aids in increasing students’ interest in science lessons. Thus, it showed that students have acquired positive attitudes in science learning (Tekbeyik et al., 2008).

**On the Country’s Science Education**

**Challenges in Science Education in the Philippines.** According to Pajes et al. (2021), the use of computers in teaching science improves their method of teaching. However, most teachers are not ICT literate, which means they are not skillful enough in navigating various computer applications. This causes them not to effectively prepare and create computer-based instructional materials, multimedia, and documents. Moreover, according to the Department of Science and Technology (2011), the quality of science education in the Philippines mainly depends on the quality of science teachers. Teachers who incorporate engaging activities to the students produce scientifically interested students since they are able to inquire and find solutions to problems. However, Philippine schools only have a small number of qualified science teachers, a lack of proper science equipment, and quality textbooks. Apart from that, schools only receive little support from administrators. Thus, addressing the issues about large classes is difficult to solve. With the aforementioned challenges, it requires a great effort for committed teachers to produce collaborative, reflective, and lifelong learners.

**Theoretical Framework**

This study is anchored on the concept of the model of reflective thinking introduced by the philosopher and educator John Dewey, who considered critical thinking to be the ultimate intellectual objective of education by identifying it as a scientific attitude of the mind. This shows the importance of having critical thinking skills as it equips students with open-mindedness, in the sense of being willing to investigate problems to which one already has an answer but to which more information or reasoning may cause one to answer otherwise. Another is the constructivist theory, wherein constructivist knowledge cannot be forced or transmitted intact from one’s mind to another’s mind. Under this theory, learners create knowledge and the process of learning is differentiated by putting a great degree of responsibility in their own hands rather than the teacher. Because they enable independent, customized, exploratory, and discovery learning, computers are ideal for this form of learning.

In terms of the role of computers in educational instruction, Vygotsky’s social constructivism advocates the use of these tools that may “enrich and broaden both the scope of action and the scope of thinking of the child” via scaffolding and offering guided pointers. With all of the technological advancements, the personal computer has become a flexible instrument for gaining a variety of educational experiences. Moreover, the work of John Dewey, Lev Vygotsky, and Maria Montessori shows that teachers are expected to provide or supply a variety of teaching materials and tactics for various learners based on the notion of customized instruction based on the student’s capacity. This viewpoint implies that teachers have the ability to improve learning environments through activity-based learning with the use of computer technology. In addition, computers offer enormous potential for instruction in all educational settings, from elementary schools to colleges. The assessment of the students’ attitude and critical thinking skills in this study was used for this purpose in the form of computer-assisted instruction (CAI).

**Statement of the Problem**

The main purpose of the study was to find out if there is a significant relationship between a student’s attitude and critical thinking skills towards learning science by utilizing Computer-Assisted Instruction (CAI). Specifically, the study aims to answer the following questions:

1. What is the level of the students’ attitude towards science under CAI?
2. What is the level of the students’ critical thinking skills under CAI in terms of:
   a. engagement;
   b. cognitive maturity;
   c. innovativeness?
3. Is there a significant relationship between the students’ attitude and critical thinking skills in science?

**Hypothesis of the Study**

As the researcher progresses with the extensive data gathering and analysis, the following hypothesis is proposed:

**H0:** The students’ attitude has no significant relationship with their critical thinking skills towards Computer-Assisted Instruction in science learning.
METHODS

Research Design
The descriptive-correlational design was utilized in the study to assess if there is an existing relationship between the attitude and critical thinking skills of students towards Computer-Assisted Instruction (CAI) in learning science. Hence, this design will provide a description of the relationship and the strength of association of the two aforementioned variables without any external intervention or control rather than determining the direct cause-effect relationship. With given consent, a survey was conducted among the participants of the study to gather relevant information in determining the said relationship.

Sample and Sampling Technique
The participants include a total of ninety (90) Grade 10 students enrolled in the school year 2022-2023 at Banlag Integrated School, Valencia City. The participants were selected through total enumeration sampling, wherein all students in the Grade 10 curriculum were included as participants of the study. The students were chosen as the participants since they incorporate the use of Computer-Assisted Instruction (CAI) through an Interactive PowerPoint presentation, which includes animations, hyperlinks, self-scoring games, and picture puzzles in the First Quarter of Science 10 - Earth Science. The experience of the participants in the use of CAI in the process of learning allows researchers to determine whether their attitudes in science learning correlate with their ability to think critically.

Research Instrument
This study will use two (2) survey questionnaires: Attitude Questionnaire and Critical Thinking Questionnaire. Both adopted questionnaires are of the Likert type. Both questionnaires used a 5-point Likert scale to measure each statement, with the responses assigned:

Student’s Attitude in Science Questionnaire
The first questionnaire was used to determine the students’ attitude towards Computer-Assisted Instruction (CAI) in learning science. It was adapted from the 2011 Trends in International Mathematics and Science Study (TIMMS), developed by the International Association for the Evaluation of Educational Achievement (IEA). Some modifications of the original questionnaire were made by Mirana (2019) from the study “Attitude towards Science and Process Skills of Junior High School Students.” These modifications include turning negative sentences, specifically those containing “not,” into positive ones. For instance, in the original questionnaire, the statement was “Science is not one of my strengths,” while the modified one states “Science is one of my strengths.” The questionnaire consists of fifteen (15) statements with a Cronbach alpha of 0.868.

Students’ Critical Thinking Skills in Science Questionnaire
The second questionnaire was used to determine the students’ critical thinking towards Computer-Assisted Instruction (CAI) in learning science. The questionnaire is known as UF-EMI: Critical Thinking Disposition Assessment (Appendix A), developed by a team of researchers at the University of Florida, used to measure the disposition of critical thinking of a population. The questionnaire has a Cronbach alpha of 0.951. It consists of twenty-six (26) questions divided into three constructs: Engagement with a Cronbach alpha of 0.871, Cognitive Maturity with 0.855, and Innovativeness with 0.859. The Engagement construct corresponds to eleven (11) questions, for Cognitive Maturity, eight (8) questions, and for Innovativeness, seven (7) questions. The following rating scale was used for both questionnaires to better understand the indicators of the students’ attitude and critical thinking skills:

Data Gathering Procedure
A letter of permission was written and sent to the Dean of the College of Education and the School Principal of Banlag Integrated School to request consent to allow Grade 10 students enrolled in the school year 2022-2023 to participate in the study, including the class advisers for the two sections. Also, a letter of consent was sent to the participants and attached to the questionnaires. With the given permission, the Attitude towards Science Questionnaire and the Critical Thinking Disposition Assessment were administered to the participants. The students completed the questionnaires in a supervised setting, with their adviser supervising them. Their adviser also provided instructions on how the questionnaires should be filled out. In addition, any questions the students had regarding some confusions about the statements were raised to their teacher.
Data Analysis
The collected data were analyzed using descriptive statistics with the Statistical Package for Social Sciences Computer Version (SPSSx/PC). The Pearson-R Correlation was used to identify the significant relationship between the students’ attitude and their critical thinking skills. In determining the relationship between the two variables, the following interpretation was utilized: 0.00 to + 0.20, indicating a slight correlation; + .21 to + 0.40, a low correlation; + .41 to + 0.60, a moderate correlation; + .61 to + 0.80, a high correlation, and + .81 to + 1.00, a very high correlation.

Ethical Considerations
The practice of research ethics in this study was essential in adhering to ethical norms to preserve the dignity, rights, and well-being of study participants. The application of important research ethics in this research activity includes fair and truthful research planning and implementation, respect for society and others, and avoiding misconduct of scientific procedures. Informed consent was administered to the participants to provide them with information about the study. According to Denzin and Lincoln (2011), the foundation of ethical research is informed consent. The term is made up of two keywords: “informed” and “consent.” The participants were thoroughly informed of the researcher’s expectations and how the collected data would be used. The participants signed a clear written consent to participate in the study. This consent also indicated the participants’ rights to access and withdraw their information. The informed consent procedure was considered as a contract between the researcher and the subjects.

The permission form and information sheet were well-written and clear. If the information sheet and consent form were confusing, it would lead to an unclear agreement of consent, which may affect the data quality due to distrust and would not provide adequate protection for the researcher and participants (Miles & Huberman, 1994).

RESULTS AND DISCUSSION

Level of Students’ Attitude in Science
The level of students’ attitude depicts the measure of the positive and negative feelings of students towards learning science under CAI with regards to the subject’s difficulty, self-efficacy, relevance, value, and general impression. The first table (Figure 2) shows the level of students’ attitude in science under Computer-Assisted Instruction.

Figure 2
Level of Students’ Attitude Towards Science Under Computer-Assisted Instruction

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>MEAN</th>
<th>DESCRIPTIVE RATING</th>
<th>QUALITATIVE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>My teacher thinks I can do well in science with difficult materials</td>
<td>3.06</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>I need science to learn other school subjects</td>
<td>3.83</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>I usually do well in science.</td>
<td>3.78</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>Science is easier for me than any other subject.</td>
<td>3.70</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>I learn things quickly in science.</td>
<td>3.70</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>Science is one of my strengths.</td>
<td>3.89</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>Science is easier for me than for many of my classmates.</td>
<td>3.58</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>I read about science in my spare time.</td>
<td>3.39</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>I am good at working out difficult science problems.</td>
<td>3.38</td>
<td>Undecided</td>
<td>Moderately positive</td>
</tr>
<tr>
<td>Total Mean</td>
<td>3.86</td>
<td>Undecided</td>
<td></td>
</tr>
</tbody>
</table>

As reflected in the table, the overall score of student attitude is 3.86, indicating a moderately positive attitude. Six indicators scored “Positive”: “Science does not make me confused and nervous” (4.49), “I wish I had to study science” (4.26), “I learn many interesting things in science” (4.26), “I think learning science will help me in my daily life” (4.23), “I enjoy learning science” (4.21), and “Science is interesting” (4.11).
The remaining nine statements scored “Moderately Positive”: “My teacher thinks I can do well in science with difficult materials” (3.96), “I need science to learn other school subjects” (3.83), “I usually do well in science” (3.78), “Science is easier for me than any other subject” (3.70), “I learn things quickly in science” (3.70), “Science is one of my strengths” (3.69), “Science is easier for me than for many of my classmates” (3.58), “I read about science in my spare time” (3.39), and “I am good at working out difficult science problems” (3.38). The results imply the significance of students’ interest and curiosity as displays of positive attitudes in their science classes.

The result indicating a moderately positive attitude among students does not conform with the study of Antwi et al. (2015), which found that computer-assisted lessons build a positive attitude in students. In light of this finding, it also does not coincide with the results of Ercan et al. (2014), which state that the utilization of web-based materials in learning science has a positive effect on attitude since students are exposed to the usage of technology compared to a traditional approach. Moreover, Cunha (2014) stated that the positive involvement of students in using computer simulations in the classroom depends on the teacher's mediation, particularly on how the instruction is delivered. Similarly, successful teacher mediation corresponds to the development of students’ positive involvement.

**Level of Students’ Critical Thinking Skills in Science**

The descriptive analysis of students’ level of critical thinking skills follows through its three constructs mainly: Engagement, Cognitive Maturity, and Innovativeness.

**Engagement**

The level of critical thinking skills of students in terms of engagement is revealed in Table 2 (Figure 3). The table depicts an overall mean score of 3.84 for this construct, which shows a moderately high engagement in the following indicators: “I keep on working on things until I get them right” (3.99), “I look for opportunities to solve problems” (3.98), “I ask good questions when trying to clarify a solution” (3.96), “I am able to apply my knowledge to a wide variety of issues” (3.90), “I am interested in many issues” (3.83), “I present issues in a clear and precise manner” (3.82), “I am able to relate to a wide variety of issues” (3.81), “I am a good problem solver” (3.72), “I am able to explain things clearly” (3.70), and “I am confident that I can reach a reasonable conclusion” (3.51). One indicator scored a high engagement: “I enjoy finding answers to challenging questions” (4.01). The results indicate the importance of students’ participation and involvement in building their determination and confidence to learn and look for solutions in solving science problems.

**Figure 3**

*Level of Students’ Critical Thinking Skills in Terms of Engagement*

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>MEAN</th>
<th>DESCRIPTIVE RATING</th>
<th>QUALITATIVE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy finding answers to challenging questions</td>
<td>4.01</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I keep on working on things until I get them right</td>
<td>3.99</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I look for opportunities to solve problems</td>
<td>3.98</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I ask good questions when trying to clarify a solution</td>
<td>3.96</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am able to apply my knowledge to a wide variety of issues</td>
<td>3.90</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am interested in many issues</td>
<td>3.83</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I present issues in a clear and precise manner</td>
<td>3.82</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am able to relate to a wide variety of issues</td>
<td>3.81</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am a good problem solver</td>
<td>3.72</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am able to explain things clearly</td>
<td>3.70</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am confident that I can reach a reasonable conclusion</td>
<td>3.51</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td><strong>Total Mean</strong></td>
<td>3.84</td>
<td>Undecided</td>
<td><strong>Moderately High</strong></td>
</tr>
</tbody>
</table>

In this respect, the study of Shcheglova et al. (2019) revealed that the active participation of the students during the class accounts for their ability to assess the need for good reasoning and problem-solving. Similar findings were presented by Ostafin and Kassman (2012), indicating that the students’ mindful attention to the present moment in class affects their ability to solve problems. Moreover, the study of Rafael (2020) states that the factors that lead to students’ engagement in science with the use of CAI include the large number of students in the class and limited space in the classroom. In addition, the teaching methods used in delivering the instruction affect their engagement and capture their attention during science class.

**Cognitive Maturity**

The data gathered from the students’ level of critical thinking skills in terms of cognitive maturity are shown in Table 3 (Figure 4). As what can be seen on the table, the total mean score of the student’s cognitive maturity is 3.93,
depicting a moderately high cognitive maturity, namely: “I try to consider the facts without letting my biases affect my decisions” (3.92), “I am likely to change my opinion when I am given new information that conflicts with my current opinion” (3.82), “I consider how my own biases affect my opinions” (3.80), and “I can get along with people who do not share my opinions” (3.52). Four of the indicators scored “High”: “I listen carefully to the opinions of others even when they disagree with me” (4.33), “I believe that most problems have more than one solution” (4.06), “I try to find multiple solutions to problems” (4.00), and “I try to find multiple solutions to problems” (4.00). The results suggest the relevance of the student’s active responsibility for their own learning by listening and exploring different views and ideas in making decisions and solving problems.

**Figure 4**

**Level of Students’ Critical Thinking Skills in Terms of Cognitive Maturity**

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>MEAN</th>
<th>DESCRIPTIVE RATING</th>
<th>QUALITATIVE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I listen carefully to the opinions of others even when they disagree with me.</td>
<td>4.33</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I believe that most problems have more than one solution.</td>
<td>4.06</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I ask many questions when making a decision.</td>
<td>4.02</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I try to find multiple solutions to problems.</td>
<td>4.00</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I try to consider the facts without letting my biases affect my decisions.</td>
<td>3.92</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I am likely to change my opinion when I am given new information that conflicts with my current opinion.</td>
<td>3.82</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I consider how my own biases affect my opinions.</td>
<td>3.80</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I can get along with people who do not share my opinions.</td>
<td>3.52</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>Total Mean</td>
<td>3.93</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
</tbody>
</table>

In light of this finding, Ayish & Deveci (2019) reported that the openness of students to various perspectives is a skill that enables students to become actively responsible for their own learning. In addition, Chen (2015) posited that the use of technology paired with the teaching strategies used by the teacher fostered open-mindedness among students.

**Innovativeness**

Table 4 (Figure 5) reveals the students’ critical thinking skills in the construct of innovativeness. As presented on the table, the overall mean score of the students’ innovativeness is 3.77, depicting “Moderately High” in the indicators: “I will go out of my way to find the right answers to a problem” (3.89), “I search for the truth even when it makes me uncomfortable” (3.81), “I ask lots of questions in a learning environment” (3.76), “I enjoy solving problems” (3.63), “I strive to be well-informed” (3.60), and “I enjoy learning even when I am not in school” (3.33). One indicator scored “High”: “I enjoy learning about many topics” (4.10). The results imply the role of having a good learning environment for interactions, discussions, inquiry, and research in fostering intellectual curiosity among students.

**Figure 5**

**Level of Students’ Critical Thinking Skills in Terms of Innovativeness**

<table>
<thead>
<tr>
<th>INDICATORS</th>
<th>MEAN</th>
<th>DESCRIPTIVE RATING</th>
<th>QUALITATIVE DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy learning about many topics.</td>
<td>4.10</td>
<td>Agree</td>
<td>High</td>
</tr>
<tr>
<td>I will go out of my way to find the right answers to a problem.</td>
<td>3.89</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I search for the truth even when it makes me uncomfortable.</td>
<td>3.81</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I ask lots of questions in a learning environment.</td>
<td>3.76</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I enjoy solving problems.</td>
<td>3.63</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I strive to be well informed.</td>
<td>3.60</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>I enjoy learning even when I am not in school.</td>
<td>3.33</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
<tr>
<td>Total Mean</td>
<td>3.77</td>
<td>Undecided</td>
<td>Moderately High</td>
</tr>
</tbody>
</table>

The obtained result is in parallel with the study of Jirout et al. (2018), which concludes that the learning environment can influence the curiosity among students. This environment includes the climate inside the classroom, instructional teaching methods, and interactions with the teacher and their peers, encouraging students to explore. Furthermore, the study of Singh & Manjaly (2022) presented that the curiosity of students can be induced through an effective delivery of information, which improves the student’s learning levels in school.
Overall Critical Thinking Skills of Grade 10 Students in Science

The overall critical thinking skills of secondary school students are just fair and a lot of improvement is still needed. In addition, it was presented that an effective teaching pedagogy such as incorporating a problem-based approach enables students to think deeply, clearly, independently, and rationally so that they can formulate significant solutions, opinions, and conclusions. Furthermore, Reddington (2012) emphasized that using activities wherein students can participate and are directly involved is the most effective way to improve critical thinking skills. These activities should anchor on the usage of higher-level thinking skills of students such as using inquiry in class.

Correlation Between Students’ Attitude and Critical Thinking Skills

Table 6 (Figure 7) presents the correlation analysis of students’ attitude and critical thinking skills. The results of the correlation analysis reflected that attitude has a significant relationship with students’ critical thinking in science with the use of CAI, where r=0.679 (p<0.01). This shows that the students’ positive attitude and interest towards the subject allow students to analyze, evaluate, compare, and conceptualize within the context of the subject matter.

The study of Kiyosawa et al. (2018) supports this idea, wherein the student’s attitude, alongside their skills, fosters critical thinking skills in education. Thus, when teachers encourage students to actively engage in intellectual dialogues and inquiry, the students become critical thinkers. On the other hand, in the study of Fulmer et al. (2019), it was revealed that the positive attitude of students in science is related to the teacher’s delivery of instructions, which in turn affects their persistence in the field. It indicates that the provision of student-centered instruction where students can interact, cooperate, and be involved in class generates a positive attitude for the students.

In light of this, the study of Nu’azzah (2021) supports that the critical thinking skills of students allow them to construct explanations and additional ideas to build a reasonable conclusion even if they are given difficult problems that need in-depth thinking. This suggests that the extent to which the student perceives the difficulty, relevance, including the general impression towards the subject, influences their ability to intellectually reflect and determine the significant connections of various concepts in the subject matter. Thus, when students are given difficult science problems, they engage in thorough thinking and analysis of concepts to find solutions since they possess curiosity, enthusiasm, and engagement during science class.

Conclusion and Recommendations

The attitude of Grade 10 students at Banlag Integrated School toward science under Computer-Assisted Instruction (CAI) is moderately positive. With this in mind, science teachers may explore and use different CAI strategies aside from interactive PowerPoint and PHET simulation-based activities to cultivate highly positive attitudes among students in teaching science. Alongside effective delivery of instruction, this may increase students’ participation and enthusiasm for science learning. By doing so, these strategies may bridge the gap between inadequate materials and facilities for science laboratories, enabling students to effectively visualize the abstract and theoretical concepts of science, thus developing their positive outlook toward the subject.
The critical thinking skills of students exposed to Computer-Assisted Instruction in science, in terms of engagement, cognitive maturity, and innovativeness, are moderately high. Among the three constructs, cognitive maturity obtained a high mean value, while innovativeness had the lowest. Hence, science teachers may incorporate digital materials with student-centered methods such as project-based learning or group activities to improve critical thinking skills. Instead of traditional discussions, they could utilize science simulations that challenge students to apply higher-order thinking skills. This interactive, engaging strategy may improve comprehension and develop critical thinking skills. Essentially, it is about integrating digital technologies with dynamic, engaging activities to encourage students to think deeply, critically, and logically.

There is a significant relationship between students’ attitude and critical thinking skills toward Computer-Assisted Instruction in learning science, thus rejecting the null hypothesis, which stated that there is no significant relationship between students’ attitude and critical thinking skills. Curriculum makers may consider the significant relationship of students’ attitude and their critical thinking skills for curriculum revision and enhancement in fostering an educationally effective environment, designing engaging instructional materials that promote higher-order thinking skills, and introducing modern teaching methods.

Furthermore, future researchers may conduct a similar study to discover the major factors that can affect students’ attitude and their critical thinking skills under CAI in an in-depth qualitative study. A qualitative study might delve further into students’ personal experiences and perspectives, analyzing how attitudes develop and how certain aspects of computer-assisted instruction affect their critical thinking skills. This is significant because it may illustrate the details, reasons behind attitudes, and depth of the learning experience, providing educators with better insights to effectively modify their method of instruction.

**Implications**

The implication of this study is that assessing the potential relationship between a student’s attitude and their critical thinking skills toward computer-assisted instruction is important because it can demonstrate whether a positive attitude toward learning science is related to increased critical thinking skills. The findings of this study could help educators develop more efficient teaching methods that foster critical thinking skills and a positive attitude in their students as they learn science. For instance, if teachers find that students with a positive attitude toward learning science also exhibit improved critical thinking skills with computer-assisted instruction, they can focus on creating a positive classroom environment and integrating more technology into their teaching. This might involve incorporating engaging and interactive online resources. Curriculum makers could consider integrating technology-driven activities that encourage critical thinking, aligning with the research findings. Essentially, it’s about blending a positive attitude with technology-enhanced learning to boost critical thinking skills in science education.

**References**


Author(s)’ Statements on Ethics and Conflict of Interest

Ethics Statement
The author/s hereby declare that research/publication ethics and citing principles have been considered in all the stages of the study. The author/s take full responsibility for the content of the paper in case of dispute.

Originality and Plagiarism Assessment
The manuscript has a similarity assessment of less than 20% in accordance with the publication ethics in terms of originality and plagiarism and the plagiarism policy of the journal.

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Author Biographies

Margorie H. Concha was born on July 13, 2002, in Bagontaas, Valencia City, Bukidnon. She completed her elementary education at Buco-Sinait Elementary School in Banlag, Valencia City, Bukidnon, in March 2013. She attended junior high school at Valencia National High School, Valencia City, Bukidnon. During her high school years, she was part of the school campus publication team as a feature writer, competing at the division and regional levels. Additionally, she was a member of a youth organization, the Interact Club of Valencia National High School. She finished her senior high school in April 2020 under the Science, Technology, Engineering, and Mathematics (STEM) strand. At present, she is an undergraduate student pursuing a Bachelor of Secondary Education major in Sciences at Central Mindanao University, with the hope of graduating in June 2024. She also aspires to become a competent licensed teacher who cultivates a generation of student leaders in the future. Email: gisttjune@gmail.com
Alrien Jane A. Martinez was born on March 15, 2000, in Dalwangan, Malaybalay City, Bukidnon. She currently resides in Poblacion, Valencia City, Bukidnon. In 2013, she completed her primary education at Malaybalay City Central School. She finished her junior high school education in 2016 at Bukidnon National High School in Malaybalay City, Bukidnon. In May 2019, she graduated with her senior high school education from Central Mindanao University in University Town, Mparan, Maramag, Bukidnon, with a strand in Accountancy, Business, and Management (ABM). She is an undergraduate student at Central Mindanao University pursuing a degree in Bachelor of Secondary Education major in Sciences, and she is expected to graduate in June 2024. Email: martinezalrien@gmail.com

Dr. Arman P. Nuezca is a faculty member of the Science Education Department, College of Education at Central Mindanao University. He earned his doctorate, masters, and bachelor's degrees from the same college. Within the undergraduate program, he teaches Astronomy, Research in Teaching, Laboratory Techniques, and Teaching Aids in Science Teaching. Additionally, he actively participates in research and extension programs within the College of Education. His findings have been published in leading academic journals. He currently serves as the Internal Relations Officer at CMU's College of Education. Email: nuezcaarman@gmail.com

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