# Project-Based Learning and Digital Literacy as Predictors of Attitude Towards Science

**King Christian C. Gillesania [1], Michelle Y. Acledan, EdD[2]**

**[1] Master of Arts in Education – Teaching Science, Professional Schools, University of Mindanao, Davao City**

**[2] Research Adviser, Professional Schools, University of Mindanao, Davao City**

**DOI: https://doi.org/10.47772/IJRISS.2026.100700349**

**Received: 15 July 2026; Accepted: 20 July 2026; Published: 01 August 2026**

## ABSTRACT

The purpose of this study was to explore how Project-Based Learning (PBL), and Digital Literacy relate to the attitudes toward science of high school senior (STEM) students in Koronadal City, Philippines. Using a correlational, nonexperimental quantitative approach, the researcher used a survey as an instrument. There were three different types of surveys that were employed; the Project-Based Learning questionnaire, the Digital Literacy Survey, and the Attitude Toward Science Inventory. A total of 511 STEM students attending various public and private high schools were selected as respondents. Pearson's r was conducted with the data collected from these participants to establish if there existed relationships among the variables under consideration. The results indicated that PBL, digital literacy, and attitudes toward science had a positive relationship among all three. Thus, PBL and digital literacy are contributing to students' motivations, confidence levels, and interests in science-related learning. Additionally, since PBL is primarily an experiential learning activity that involves collaboration, active participation, and authentic learning experiences, it allows students to learn by doing rather than just listening or reading about a topic. On the other hand, digital literacy provides students with the opportunity to find, critically evaluate, organize, analyze, synthesize, and communicate scientific information electronically. Therefore, incorporating PBL into the curriculum for STEM courses will allow for enhanced student engagement and provide teachers with additional tools and methods to teach technology-based science content.

**Keywords:** Project-based learning, Digital literacy, attitude toward science

## INTRODUCTION

A lot of senior high school students hold negative attitudes towards science. The number of students who are interested in pursuing science-related fields continues to dwindle (Cermik & Fenli-Aktan, 2020; Potvin & Hasni, 2021). Moreover, a decrease in students' desire to engage in science learning has also been reported. There are also empirical evidence showing that negative attitudes toward science amongst senior high school learners are often linked to decreased engagement in science classes, less likelihood of persisting in their pursuit of an academic career in science, and fewer plans to pursue a career in a science-related field (Mao et al., 2021). Attitude toward science is viewed as a multi-dimensional construct from a theoretical perspective including the dimension of affective responses, perceived Literacy, and value belief. Thus, attitude toward science is seen as a complex but very important dependent variable in science education research (Abramo et al., 2023). According to Self-Determination Theory, if students do not feel they have autonomy, relevance and/or digital literacy within their science classroom, then there will be a decline in their attitudes toward science (Ryan & Deci, 2020; Schukajlow et al., 2021). Therefore, to address ongoing issues with the long-term attitudinal challenges of senior high school students, the use of instructional approaches such as project-based learning and/or the teaching of competencies such as digital literacy will continue to be used as two of the most predictive variables for senior high school students' attitudes toward science in the current educational environment (OECD, 2023).

Why study attitudes toward science? It is imperative to study attitudes toward science due to consistent research demonstrating that learners' perceptions, interests and values toward science directly impact learners' engagement, academic success and likelihood of pursuing future opportunities in science-related fields (Cermik & Fenli-Aktan, 2020; Mao et al., 2021). Although previous studies provided valuable insight into the way instructional strategies and learning environments contribute to developing attitudes toward science in learners, many previous studies did so individually or focused solely on general academic outcomes rather than the specific area of attitudinal development itself (Schukajlow et al., 2021; Potvin & Hasni, 2021). Due to these limitations in prior research, there was a clear need for the current study. This study aims to build upon prior research by examining both Project-Based Learning and digital literacy as predictors of attitudes toward science developed in senior high school students, while simultaneously meeting current educational demands and the call for more holistic and learner centered research (OECD, 2023).

Prior studies indicate that active and technology supported learning environments may positively influence students' attitudes toward science. However, the relationships between Project-Based Learning and digital literacy and attitudes toward science remain underdeveloped. As previously mentioned, project-based learning is viewed as a viable method of engaging students in authentic learning experiences where students collaborate, inquire and solve problem in order to develop a deeper understanding and motivation in science (Miller et al., 2019). Additionally, a study conducted by Wicaksono et al. (2024), demonstrated that using a Project-Based Learning model combined with sasambo local wisdom resulted in a statistically significant improvement in students' scientific attitudes. They concluded that contextualized and culturally relevant projects may enhance curiosity, open-mindedness, perseverance and environmental sensitivity. However, the extent to which positive attitudes toward science are influenced by instructional strategy alone versus the extent to which students' ability to access, evaluate and utilize digital information influences their ability to participate in modern science learning is unknown. Hwang et al. (2022) indicated that the relationship between digital literacy competence and attitude readiness toward technology-integrated learning is significant. They concluded that digitally literate learners may be better equipped to successfully complete science-related learning tasks due to increased confidence and receptivity. These findings form the foundation for this study and aim to investigate whether Project-Based Learning and digital literacy are predictors of students' attitude toward science (Ospankulova et al., 2025). The study of the relationship between project-based learning (PBL) and attitudes toward science is well supported by the literature, suggesting a positive relationship overall. Therefore, a study of Project Based Learning and its relationships to attitudes toward science in the senior high school setting could provide additional insight into the ways that this relationship develops and manifests in different learning environments.

Attitudes toward science have been shown to be strongly influenced by digital literacy. The acquisition of digital literacy enables learners to acquire, interpret and apply scientific knowledge in digital learning environments. Learners who develop higher levels of digital literacy are more likely to hold positive attitudes toward science than those with lower levels of digital literacy. This is due to the fact that those with greater digital literacy will be more competent in using online technologies, simulations and digital resources to assist in the comprehension of complex scientific concepts. Studies published within recent years have demonstrated that digital literacy aids learners in both cognitive engagement and academic self-efficacy, two important indicators of a learner's potential to hold positive attitudes toward science (Galve & Labio, 2023; Alegado, 2025). In addition, digitally literate students are typically better at evaluating scientific information critically, communicating ideas through digital tools and participating in collaborative inquiry, factors that increase their interest and motivation to learn about science (Delima et al., 2023). Additionally, research demonstrates that digital learning environments contribute to increased student engagement and preparedness in science education, ultimately resulting in more favorable attitudes toward learning when students possess adequate digital competence (Macario et al., 2026). Conversely, students with limited digital literacy will find difficulty in processing information related to technology, which may result in decreased confidence and diminished interest in science-related learning activities. Ultimately, digital literacy contributes substantially to forming positive attitudes toward science by creating an environment where learning is more interactive, accessible, and pertinent to current technology-based education systems.

Digital literacy has a strong and positive correlation with Senior High School students' attitudes toward science, as it helps learners gain the ability to access, interpret and critically analyze scientific information using digital formats. As such, students with a stronger sense of digital literacy are often more interested and confident in pursuing science-related learning opportunities because they can independently engage with simulations, virtual labs, online journal articles and other multimedia resources that make complex scientific concepts easier to comprehend and visually appealing. More recently, researchers have emphasized that digital literacy provides learners with enhanced cognitive engagement as well as improved self-efficacy in learning science -- two major contributors to a positive attitude toward the subject (Nguyen & Habók, 2022; Falloon, 2023).

Moreover, By giving learners the skills required for accessing, evaluating, creating and communicating information using digital tools, digital literacy can enhance their ability to successfully interact within a technology-based learning environment (Avinç & Doğan, 2024). Digital self-efficacy may also be able to support learner's social, cognitive, behavioral, collaborative and emotional participation in on-line learning environments (Getenet et al., 2024). Although it is possible that digitally literate learners will have an increased perception of relevance and applicability of science to every day life and therefore have increased motivation for learning science, this assertion needs to be supported by research that has assessed both motivation and attitudes toward science. Similar findings were reported by Pepito and Acledan (2022), whose research showed that STEM students with higher levels of digital literacy performed better in online learning environments as their digital competencies allowed them to successfully locate information, utilize various digital applications, and complete technology-based learning assignments. The authors found that together with self-directed learning, digital literacy was a significant predictor of online learning success. They concluded that digital literacy forms a fundamental base for learners' active involvement and performance in educational settings that incorporate technology. Further, digital literacy develops critical thinking capabilities and information analysis skills, allowing learners to identify reliable scientific sources from unreliable ones (UNESCO, 2023).

Therefore, students with limited digital literacy may experience difficulties accessing digital learning tools, which may detract from their engagement and enthusiasm for science-related learning. Overall, digital literacy acts as a powerful enabling agent for forming positive attitudes toward science by creating a learning environment that is more interactive, more accessible and more inquiry-oriented within today's Senior High School education system. Digital Literacy and Project-Based Learning (PBL) both positively affect different aspects of science education, but one key aspect is missing: what happens when the two are together? There was little-to-no prior research on how Digital Literacy acts as a mediator or moderator of PBL's effect on attitudes toward science in high school STEM students. Some studies have found that digital literacy can aid in collaborative learning, critical thinking, and participatory inquiry-based activities (Cairo, et, al., 2018), yet the link from digital literacy to attitude outcomes through PBL has never been fully studied. Moreover, Digital Literacy and PBL may also be used as tools to bridge gaps created by unequal access to technology and digitally-skilled workers that inhibit the full realization of the positive impacts of PBL for science attitudes in many countries such as the Philippines and other developing countries (Bahri et al., 2023; Nuraeni et al., 2022). As such, if we do not understand how digital literacy influences students' affective response to science via PBL, then educators and policy makers will not have empirically-based information to help guide them in creating equitable, accessible and effective means to engage students, create lifelong interest in science, and produce long-term achievements in science education.Thus, this study is urgent and timely since it seeks to address this void in the body of knowledge regarding how PBL and Digital Literacy jointly impact the attitudes toward science in high school STEM students. The findings of this study should provide valuable insights for those working in contexts with restricted digital infrastructures.

The primary objective of this quantitative study, First, to determine the extent to which Project-Based Learning among senior high school STEM students. Second, Determine the extent of Digital Literacy among senior high school STEM students. Third, Assess the level of Attitude Towards Science among senior high school STEM students. Fourth, To determine relationships among Project-Based Learning, Digital Literacy, and attitudes toward science among Senior High School STEM Students. Fifth, determine whether Project-Based Learning and Digital Literacy significantly predict senior high school STEM students' Attitude Towards Science.

As well as having global relevance, this study contributes to a greater comprehension of how digital literacy and Project Based Learning (PBL) interact to influence attitudes toward science. In spite of increasing recognition of the individual merits of each methodology, this topic continues to be relatively unexplored. By analyzing Digital Literacy as a predictor variable within PBL contexts, this research addresses a critical deficit in the body of literature concerning science education. Specifically, it offers empirical data demonstrating how technology skills foster positive science attitudes, which are vital factors related to continued engagement, motivation, and achievement in STEM fields worldwide (Beers, 2021; Hindun et al., 2024). These findings can assist curriculum developers, teachers and policymakers to develop curricula and educational methods that utilize digital tools and active learning techniques that enable students to meet the evolving requirements of the scientific environment and digital economy. Thus, these findings contribute to the international educational conversation.

Furthermore, this study has substantial social importance for institutions and communities experiencing inequality in access to digital competencies and technologies. Additionally, this study promotes fair science education and empowers students from disadvantaged regions to overcome barriers that prevent their participation in STEM by illustrating how integrating Digital Literacy into PBL can improve science attitudes (Nuraeni et al., 2022). K-12 schools, science instructors, and teacher training programs benefit directly as they can apply the research findings to better teach methodologies and encourage student engagement. Additionally, this study provides educational technology companies with useful suggestions for creating materials that support inquiry-based learning groups.

# METHODOLOGY

## Research Design

This study utilized a quantitative, non-experimental, correlational research design to investigate how project-based learning is related to digital literacy and students' views on science. Since this study looked for the relationship among the variables without changing the learning environment of the participants, the correlational design was most appropriate. Additionally, since the objective of this study was to explain if differences in the amount of project-based learning and differences in students' digital literacy are associated with the attitude towards science by the same group of students; therefore, this study was classified as an explanatory research. This study relied on survey research to collect quantifiable responses from the participant's so that the researcher may look at the trends and relationships among the variables. Also, this study used a cross-sectional design which means that the data were collected from all of the participants at one point in time instead of collecting data over multiple periods.

## Research Respondents

The respondents in this research study consisted of high school senior students in the Science, Technology, Engineering, and Mathematics (STEM) programs of several public and private educational institutions in Koronadal City, South Cotabato. The educational institutions included Koronadal National Comprehensive High School, Notre Dame of Marbel University – Integrated Basic Education Department, and Green Valley College Foundation Incorporated — Integrated Basic Education Department.

The STEM students were chosen as participants because of their involvement with project-based learning, technology supported instruction, collaborative projects and scientific inquiry. These elements make them ideal participants to investigate the relationship among project-based learning, digital literacy and attitudes toward science. A total of 511 students participated in the study from 1,044 STEM students. To determine the required sample size, a researcher used the Raosoft Sample Size Calculator. Researchers also sampled from different schools and STEM sections to represent both the public and private education systems.

In the research study, researchers employed the method of quota sampling to obtain sufficient numbers of participants from the selected schools. Once researchers identified the schools and STEM sections, researchers randomly selected students from those sections. In order for the respondents to qualify in this study, students had to be current students in a STEM program, agree to participate in the study and sign either an informed

consent document or assent form. Prior parental or guardian consent was necessary for any student under the age of 18 years; however, researchers then obtained assent from students after receiving such consent from parents/guardians.Students qualified to participate in this study if they were registered in a STEM program; completed accurate questionnaires; provided written consent/assent forms. If students did not meet the eligibility criteria for participation, they would not be able to continue participating. Students could withdraw from the study at any time without suffering consequences. Data collected from students who withdrew from the study would not be used in subsequent analyses.

**Research Instrument**

A research-based survey questionnaire was utilized in this study to gather quantitative data on three key areas that are central to this investigation: project-based learning; digital literacy; and student attitudes towards science. The survey had three parts, each section included adapted forms related to the objectives of the study and the intended recipients. The Project-Based Learning Questionnaire assessed student experiences relative to being an active participant, collaborating on meaningful project activities, applying learned knowledge, and having positive attitudes such as motivation, engagement and academic performance. Respondents answered questions based upon a five point Likert Scale, which ranged from 1-Strongly Disagree to 5-Strongly Agree. A higher mean score would indicate greater evidence of project-based learning.

The Digital Literacy Survey Questionnaire is an adaptation of Baterna et al.'s (2020) tool. This assessment evaluates students' abilities to access, evaluate, organize, analyze, create and disseminate information utilizing digital technology. Questions were assessed on a five-point scale, ranging from "Not at all" to "Very great extent." While the original tool has been found reliable with a Cronbach's Alpha of .904, it is recommended that any adaptations be subject to expert review/validation, piloted testing and reliability analyses.

The Attitudes Toward Science Inventory is an abbreviated form of the mATSI:2 developed by Tai et al. (2022). Student perceptions regarding the value they place on science; their level of enjoyment; how engaged they are; and how anxious or fearful they feel about science were assessed. Items scoring positively were evaluated as presented; negatively scored items were reversed. Students who received higher scores had a more positive attitude toward science. Since many items were deleted from the mATSI:2; any modifications to this tool should also include content validity reviews; pilot testing and internal consistency analyses.

The adapted survey questionnaire underwent a validation process prior to conducting the study. Four (4) expert panelists from the relevant discipline reviewed and assessed the survey questionnaire to validate content, relevance, clarity and suitability for use by the target respondents.

**Data Gathering Procedure**

Before this study is conducted the researcher made sure that a formal letter, with an attached copy of the research proposal and the adapted survey questionnaire, was sent prior to collecting the data to each of the schools' administrative bodies. This allowed them to understand clearly the reasons for the study; its purpose, objectives, methods and ethical implications as well as any potential contributions to education.

Based on the feedback from the panel, the revised survey questionnaire were piloted tested on fifty (50) Notre Dame of Marbel University (NDMU) students. These pilot test subjects were not part of the actual sample group in order to avoid tainting the ultimate data set. The pilot test was conducted to evaluate clarity of items, identify any potential problems associated with administering the survey, and to verify the reliability of the survey instruments. Following the pilot testing, the internal consistency of the instruments was determined using Cronbach's alpha reliability analysis. Cronbach's alpha was employed to measure the extent to which the items within each scale were consistent in measuring the intended constructs. The obtained Cronbach's alpha coefficients indicated the reliability of the instruments, confirming their suitability for use in the actual data collection. An appropriate reliability testing procedure was applied to measure the internal consistency among the items included within the survey. Any needed adjustments to improve the survey instruments were made after receiving the reliability testing results prior to making a final administration of the survey instruments.

Once institutional approvals and compliance with ethical research requirements had been obtained, arrangements were made with school administrators, designated teachers and other personnel involved with data collection to coordinate schedules and logistics for conducting data collection. The researcher then identified the eligible participants consistent with the inclusion criteria defined in this study and coordinated the distribution of the surveys to the participants at a mutually agreeable time with respect to the participating schools.

Prior to allowing respondents to complete the surveys, the researcher explained to them the purpose, methodological design and possible value added aspects of this research project. Respondents were also advised about their rights as they related to their voluntary participation in this study including maintaining confidentiality of their responses and withdrawing from participation in this study at any point without any consequences. With regard to minors, both parental/guardian consent and student assent were first received prior to any involvement of these minors in this study. The researcher only utilized data from participants who provided voluntary consent for participation and completed all requisite procedural steps for consent.

During scheduled class periods, the validated survey instruments were distributed under supervision by assigned teachers/school personnel. As such, respondents received clear directions relative to responding to survey items in order to accurately reflect their opinions. Upon completing the surveys, the researcher collected all completed surveys and conducted preliminary data validation/organization/categorization/coding/recording activities. Surveys that contained incomplete questions/inadequately completed surveys/forms or those submitted by participants who withdrew from the study were removed from consideration when compiling the final data set.

Data collection occurred from January 1 through March 31, 2026. Following completion of data collection, all responses were systemically organized and prepared for subsequent statistical analyses. The researcher maintained the anonymity/confidentiality of all study participants throughout this study. No personal identifying information was reported as part of the results of this study. All data collected was used exclusively for educational/research purposes. All data collected was appropriately protected against unauthorized access. Data management, retention and disposal practices were implemented consistent with institutional research policies and applicable ethical guidelines concerning safeguarding of research-related information.

### Data Analysis Procedure

The data that were collected were checked for accuracy, assigned codes, put into a table format, and analyzed by applying both descriptive and inferential statistic measures. Averages (mean) and the dispersion of averages (standard deviation) were applied to measure the average amount of project based learning, digital literacy, and positive or negative feelings about science. Descriptive values (mean scores) for each variable were identified using a five level descriptive scale developed from this study.

Pearson's r were used to analyze the relationship between project based learning, digital literacy, and positive or negative feelings about science in terms of direction, strength, and statistical significance; preferably with an alpha of .05. Prior to performing the analysis several assumptions need to be met including: linearity, approximately normally distributed data, data measured on an interval scale, and no outlier(s) exist that could have a significant influence on the results of the analysis.A multiple linear regression may also be performed to identify if project based learning and digital literacy are predictors of positive or negative feelings about science. While the analysis will provide information regarding associations and the predictive contribution of variables being studied it will not provide evidence of causality.

## RESULTS AND DISCUSSION

### Level of Project-Based Learning Among Senior High School STEM Students

The descriptive results concerning students' experiences with Project-Based Learning (PBL) will be discussed. Table 1 shows the Level of Project-Based Learning Among Senior High School STEM Students. As shown in the table, students' levels of engagement in PBL are measured in three ways: learning, motivation and performance. Therefore, the table displays students' perceptions towards whether they believe projects helped

them develop their understanding of content; encouraged their participation; developed their ability to work collaboratively; developed their practical skills.

**Table 1 The Level of Project-Based Learning among Senior High School STEM Students**

| Indicators | Mean | SD | Descriptive Equivalent |
|---|---|---|---|
| Learning | 3.99 | 0.63 | High |
| Motivation | 4.04 | 0.64 | High |
| Performance | 4.05 | 0.62 | High |
| **Overall** | **4.02** | **0.55** | **High** |

The Table 1 show that senior high school STEM students have consistently high levels of experience using Project-Based Learning (PBL) across all three measures. On average, the students scored a total mean of 4.02 (SD = .55). Of the three aspects of PBL measured, Performance (mean of 4.05) and Motivation (mean of 4.04) were very close to each other and both scored slightly above the Learning measure (mean of 3.99) – meaning that although students believe they are improving their output and being more motivated as well as working harder on projects; they believe their conceptual knowledge development is moving forward at a slower rate than either their production or motivation. This was supported by low SD scores that indicated that students had very similar views about the effectiveness of PBL, implying it was implemented fairly consistently. The results suggest that PBL has created a supportive learning environment that develops student's abilities to produce quality work; as well as sustaining their interest in and active participation in learning activities. The fact that Performance and Motivation emerged as most significant in this context implies that the experiential and collaborative components of PBL help facilitate students in applying what they know as well as remaining interested in doing so.

These results support the theoretical literature related to PBL. Specifically, these results support Constructivist Learning Theory, because students learned from actively constructing their own knowledge via engaging in real-world like experiences (Darling-Hammond et al., 2020); and support Self-Determination Theory, because students experienced greater autonomy, collaboration and competence when engaging in PBL, resulting in increased student motivation (Ryan & Deci, 2020). Empirical evidence supports the current research supporting the notion that PBL produces better academic performance and student motivation. A study conducted by Chen and Yang (2021), showed that students who used PBL outperformed those who did not engage in PBL by having a significantly greater engagement with course materials and achieving academically. Likewise, a study by Kokotsaki et al. (2021), reported that not only did PBL enhance the students' cognitive capabilities, but also fostered their cooperative and problem solving capabilities. That said, the slight decrease in the Learning component does indicate that some structural guidance may be necessary in order for PBL to achieve its full potential; specifically regarding developing students conceptual understanding. This is in line with the findings of Zhan et al. (2022), that suggested the role of teacher facilitation in PBL is critical to maximize conceptual understanding. Overall, the study provides strong empirical evidence to support current literature supporting PBL as an effective and comprehensive method of instruction.

**Level of Digital Literacy among Senior High School STEM Students**

The descriptive finding reports on the level of Digital Literacy among senior high school STEM students as an important skill to enable them to utilize technology-supported science learning. Table 2 describes the various dimensions of Digital Literacy among senior high school STEM students including accessing and evaluating information, utilizing and managing information, analyzing media, creating media products, effectively applying technology, and interacting through technology. The table represents students' ability to utilize digital tools, assess and manage information, communicate effectively using technology, and generate digital content related to science learning and academic responsibilities. Additionally, the indicators illustrate how students utilize digital competences to access scientific information and collaborate with peers in educational contexts.

**Table 2 Level of Digital Literacy among Senior High School STEM Students**

| Indicators | Mean | SD | Descriptive Equivalent |
|---|---|---|---|
| Accessing and Evaluating Information | 3.98 | 0.62 | High |
| Utilization and Management of Information | 3.89 | 0.69 | High |
| Media Analysis | 4.16 | 0.63 | High |
| Creation of Media Products | 3.85 | 0.72 | High |
| Effective Application of Technology | 4.23 | 0.65 | Very High |
| Interaction through Technology | 4.21 | 0.66 | Very High |
| **Overall** | **4.05** | **0.66** | **High** |

The table 2 shows that STEM Seniors have a high average score in terms of Digital Literacy (average x = 4.05, standard deviation s = .66). This suggests they are competent in all areas assessed by this test. They scored the highest in the area of Technology Application (average x = 4.23) and in Interacting Through Technology (average x = 4.21); both were rated very high, indicating that students can utilize digital tools and communicate through technology. Lower, but still high scores were recorded in Media Product Creation (average x = 3.85) and Utilization and Management of Information (average x = 3.89), indicating students may require additional training or experience in creating content digitally and organizing information electronically. In summary, this data indicates that although students have an excellent capacity to apply and interact with technology, there is a need for them to develop an increased ability to create and manage digital materials.

The findings from this study support many current theory and research related to Digital Literacy. As previously mentioned, the Digital Competence Framework emphasizes that digital competence is multi-dimensional. Thus, it encompasses not just technical skills, but also critical thinking, communication and content creation (Vuorikari et, al., 2022). Research studies (Siddiq et al., 2021; van Laar et al., 2020) have found that while students tend to perform better in applying and communicating via technology, they have difficulty with creating content and managing information critically. Very high scores in utilizing technology and interacting through technology confirmed that students adapt well to digital environments; however, lower scores in media creation and information management suggested that students would benefit from more directed practice in higher-order digital skills. Moreover, this study provides further support to the body of research that developing digital literacy will require an equal balance of developing technical skill levels and developing advanced cognitive skills.

This study's findings also supported the growing amount of literature regarding digital interaction being a primary element of digital literacy. The European Commission stated that digital communication needs to be functional, aware of the target audience and ethically correct (Vuorikari et, al., 2022). Other studies found similar results when students used digital tools for communication purposes, but required instruction on adapting their message based on various types of audiences, and combining information appropriately (Siddiq et al., 2021; van Laar et al., 2020). Overall, these results indicated that STEM students had strong capabilities in communicating through technology, while showing the importance of continued focus on developing more complex communication skills and integrating information in order to become fully literate in the digital world.

**Level of Attitude towards Science among Senior High School STEM Students**

The last set of descriptive statistics presented the students' attitudes toward science as students' perceptions, confidence, interests, and motivations toward learning about science. Table 3 shows the degree of attitude toward science of senior high school STEM students across five dimensions including Perceptions of the Teacher, Anxiety Toward Science, Value of Science to Society, Self-Confidence in Science, and Desire to Do Science. Table 3 illustrates how students feel about science, how confident they are in their own abilities to learn science, how interested they are in learning science, and how motivated they are to pursue their educational goals related

to science. Additionally, each dimension offers insight into what influences students' participation and commitment to learning about science.

**Table 3 Level of Attitude towards Science among Senior High School STEM Students**

| Indicators | Mean | SD | Descriptive Equivalent |
|---|---|---|---|
| Perception of the Teacher | 4.12 | 0.68 | High |
| Anxiety toward Science | 3.25 | 0.96 | Moderate |
| Value of Science to Society | 4.23 | 0.69 | Very High |
| Self-confidence in Science | 3.43 | 0.68 | High |
| Desire to do Science. | 3.72 | 0.80 | High |
| **Overall** | **3.75** | **0.52** | **High** |

In evaluating student attitudes toward science from an educational perspective, the data suggests that the average senior high school STEM student has a very favorable view of science ($\bar{x}$ = 3.75; SD = 0.52) which translates to having a good understanding and appreciation for the science discipline and/or being engaged in the process of learning science. Of all the aspects evaluated, students have the most positive perception of the value of science to society ($\bar{x}$ = 4.23; "Very High") as they clearly understand how important it is to understand scientific principles and theories relative to everyday life. Students also report relatively low levels of anxiety ($\bar{x}$ = 3.25; "Moderate") when performing tasks that require them to apply scientific concepts and methods. Collectively, this data implies that students appear to be enthusiastic about studying science, believe in themselves as learners, and see science as applicable to society. However, there does seem to be evidence of moderate levels of anxiety associated with science learning; if addressed through appropriate instructional strategies (e.g., hands-on projects) may ultimately increase the enthusiasm for and confidence in science education for students.

The results support both theory and research supporting the notion that attitudes toward science are positively correlated with motivation and engagement in science education. Tai et al. (2018) noted that when students perceive science as valuable and relevant to society, they will be more interested and persistent in pursuing careers in science, technology, engineering and mathematics (STEM). Osborne et al. (2021) supported this idea by noting that students who possess high degrees of confidence in their ability to perform well in a science class as well as those who express a strong desire to learn new things tend to do well academically and remain involved in science education longer than students who lack confidence and/or interest in learning. Conversely, moderate anxiety in response to science-related tasks was found to negatively impact a student's likelihood to participate and succeed in science classes. Together, these results suggest that developing interventions designed to minimize science anxiety via supportive instruction and opportunities for students to explore science using hands-on approaches would likely result in stronger attitudes toward science education and enhanced long-term commitment to exploring science.

**Relationships among Project-Based Learning, Digital Literacy, and Attitudes Toward Science**

This section reports the statistical analysis of whether Project-Based Learning correlates with students' Attitudes Toward Science and Digital Literacy correlate with students' attitude toward science of senior high school STEM students. More specifically, it examines the degree to which Project-Based Learning is associated with senior high school STEM students' attitudes toward science and how Digital Literacy correlates with their attitude toward science. Tables 4 and 5 show the statistical analyses of correlations between Project-Based Learning with attitude toward science and Digital Literacy with attitude toward science of senior high school STEM students. Table 4 assesses the association between the three areas of Project-Based Learning (learning, motivation, and performance) and the six dimensions of attitude toward science (perception, self-confidence, interest, motivation, enjoyment, and general attitudes). In addition Table 5 identifies the association between Digital Literacy and the six dimensions of attitude toward science, including communication skills, learning experiences, use of technology/digital tools, engagement with content, collaborative work, and effective information exchange.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VII July 2026

These tables collectively offer insight into how project-based learning experiences and digital Literacy foster positive attitudes, motivation, and active involvement in science education.

**Table 4 Significance of the Relationship between Project-Based Learning and Attitude towards Science among Senior High School STEM Students**

| | Attitude towards Science | | | | | |
|---|---|---|---|---|---|---|
| **Project-Based Learning** | Perception of the Teacher | Anxiety toward Science | Value of Science to Society | Self-confidence in Science | Desire to do Science | **Overall** |
| Learning | .410** | .200** | .375** | .360** | .429** | **.509**** |
| Motivation | .412** | .180** | .331** | .268** | .320** | **.432**** |
| Performance | .391** | .202** | .382** | .273** | .357** | **.461**** |
| **Overall** | **.467**** | **.223**** | **.417**** | **.346**** | **.424**** | **.538**** |

These results indicate a strong association between the degree to which students engage in Project-Based Learning (PBL), and their confidence, motivation, and enthusiasm for science. All aspects of PBL — learning, motivation, and performance — correlate strongly with each indicator of attitude. Specifically, the most consistent association was found between total PBL and perception of the teacher. Thus, it can be inferred that when students experience relevant, meaningful projects they do not only gain greater understanding of science topics but also develop a positive disposition toward science due to perceiving their instructors as supportive and interactive.

In addition, these results demonstrate that the incorporation of PBL into instructional practices offers additional academic benefits beyond those related to content. In addition to promoting self-assurance through hands-on, interactive, collaborative experiences in authentic contexts, PBL promotes intrinsic motivation toward learning science, and helps foster a favorable predisposition toward acquiring new knowledge. As such, these results provide empirical support for research suggesting that experiential, student-centered learning strategies promote both cognitive and emotional growth in Science, Technology, Engineering and Mathematics (STEM) education (Osborne et al., 2019; Tai et al., 2020). Similarly, empirical studies have supported the idea that project-based, collaborative learning activities lead to increased involvement in science learning, improved attitudes toward science learning and enhanced achievement in science.

**Table 5 Significance of the Relationship between Digital Literacy and Attitude towards Science among Senior High School STEM Students**

| | Attitude towards Science | | | | | |
|---|---|---|---|---|---|---|
| **Digital Literacy** | Perception of the Teacher | Anxiety toward Science | Value of Science to Society | Self-confidence in Science | Desire to do Science | **Overall** |
| Accessing and Evaluating Information | .382** | .062.165 | .453** | .336** | .521** | **.493**** |
| Utilization and Management of Information | .328** | .175** | .442** | .365** | .507** | **.521**** |
| Media Analysis | .349** | .088*.047 | .514** | .264** | .407** | **.456**** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Creation of Media Products | .354** | .274** | .397** | .417** | .459** | **.551**** |
| Effective Application of Technology | .307** | -.006.901 | .514** | .174** | .373** | **.376**** |
| Interaction through Technology | .296** | .002.969 | .523** | .190** | .385** | **.386**** |
| **Overall** | **.398**** | **.123**.005** | **.560**** | **.348**** | **.525**** | **.553**** |

A positive relationship is demonstrated by the data in Table 5 between digital literacy and students' general attitudes toward science in relation to senior high school STEM students. An r = 0.553 value was identified at a p = 0.000 level. The positive correlation demonstrates a strong statistical relationship between students with high levels of digital literacy and having an increased number of positive perceptions, an increase in self-confidence, and an increased motivation for studying science. Each area of digital literacy—accessing/evaluating information, utilizing/managing information, analyzing media, creating media products, effectively applying technology, and interacting through technology—also has a significant relationship with students' attitudes toward science. Some areas of digital literacy—such as interacting through technology and effectively applying technology—are less associated or do not demonstrate a significant relationship with various indicators of attitude toward science—i.e., anxiety toward science —which may indicate that digital literacy does not equally impact each of the various dimensions of attitude toward science.

This implies that developing students' digital literacy could be a valuable method to improve students' attitudes toward science in terms of valuing science, viewing teachers positively, and increasing self-confidence. The strong associations found between digital literacy and overall attitude indicate that digital literacy enhances student's active participation and engagement in STEM learning by allowing students to utilize digital tools for evaluating, managing and creating scientific information. The results are consistent with previous theoretical and empirical literature stating that the development of digital Literacy promotes cognitive and affective learning outcomes because digitally competent students have improved ability to access, process, and convey scientific information which increases motivation and confidence in science (van Laar et al., 2020; Siddiq et al., 2021). In summary, this research shows that developing students' digital literacy will provide a critical component for improving both engagement and positive attitudes toward STEM education.

**Influence of Project-Based Learning and Digital Literacy on Attitudes Toward Science Among Senior High School STEM Students**

The Table 6 presents the significance of the influence of Project-Based Learning and Digital Literacy on attitude toward science among senior high school STEM students using regression analysis. The table determines whether the two independent variables significantly predict students' attitudes toward science and identifies the extent of their contribution to the overall model. It also provides insights into how learning experiences and digital competencies collectively shape students' perceptions, confidence, and engagement in science education.

**Table 6 Significance of the Influence of Project-Based Learning and Digital Literacy on Attitude towards Science among Senior High School STEM Students**

| **Attitude towards Science** | | | | |
|---|---|---|---|---|
| (Variables) | B | β | t | Sig. |
| Constant | 1.204 | | 8.048 | .000 |
| Project-Based Learning | .300 | .317 | 7.043 | .000 |
| Digital Literacy | .330 | .355 | 7.883 | .000 |
| R | .606 | | | |
| $R^2$ | .367 | | | |

| | | | | |
|---|---|---|---|---|
| ΔR | .365 | | | |
| F | 147.393 | | | |
| ρ | .000 | | | |

The data in Table 6 demonstrate that both project based learning (PBL) and digital literacy have a highly significant positive association with STEM students' attitudes toward science. According to the model fit, the beta coefficients for PBL and digital literacy are $\beta = .317$, $p < .001$ and $\beta = .355$, $p < .001$ respectively, illustrating that both variables provide an excellent prediction of student attitudes. The full model accounted for approximately 37 percent of the variance in students' attitude toward science ($F = 147.39$, $R2 = .367$, $p < .001$), demonstrating that including both PBL and digital literacy in a science program will result in a large improvement in how students perceive themselves as being prepared to take on future STEM challenges.

The equations from the models were:

Attitude toward Science = 1.204 + .30 (project based learning) + .33 (digital literacy)

Therefore, for each unit increase in PBL, there was a corresponding unit increase of .3 in students' attitudes toward science. Similarly, for each unit increase in digital literacy, students' attitudes increased by .33 units. It is evident from this data that while both PBL and digital literacy positively affect students' attitudes toward science independently, digital literacy had a larger predictive effect. Therefore, combining hands-on and collaborative forms of teaching with the development of students' digital Literacy may serve as effective ways to promote not only students' acquisition of scientific knowledge but also a more positive disposition toward science.

The results of this study clearly illustrate that both Project-Based Learning (PBL) and digital literacy significantly influence STEM students' attitudes toward science. Additionally, since PBL is associated with positive predictive effects, it can be inferred that when students are provided with opportunities to complete meaningful projects and work collaboratively with their peers using scientific concepts to solve problems within the context of the world around them, they are more likely to develop a greater interest and appreciation for science. These results support recent studies that demonstrate that PBL creates learner-centered classrooms where students actively create their own knowledge about science and consequently, understand science better (Muskania et al., 2023 Hindun et al., 2024); therefore, they view science learning more favorably. Furthermore, the slight additional predictive contribution of digital literacy indicates the increasing importance of students' ability to utilize technology effectively in modern science education. Research conducted over the past few years illustrates that having adequate levels of digital literacy enables students to find pertinent information, evaluate the quality of digital sources, and feel more confident participating in technology-assisted educational settings; thus, ultimately contributing to improved participation and learning experiences (Getenet et al., 2024).

Collectively, these findings demonstrate that merely exposing students to scientific content is insufficient for creating a positive attitude toward science; rather, it is essential to create educational environments that include authentic experiences via PBL, coupled with students' digital competencies to investigate, express, and formulate scientific knowledge in today's technologically driven culture. In addition to the empirical evidence collected during this investigation, the results presented above also concur with theoretical frameworks and research studies that support the notion that technology proficiency and engaging instructional strategies can complement one another to produce enhanced STEM education outcomes. While PBL fosters engagement, motivation and experiential understanding, digital literacy provides students with the technical skills required to locate, evaluate, and disseminate scientific information electronically (Siddiq et al., 2021 Tai et al., 2020).

Ultimately, the results obtained during this investigation illustrate the combined effects of pedagogical and technological approaches used in educational programs; henceforth indicating that a comprehensive curriculum incorporating elements of both PBL and digital literacy can effectively enhance STEM students' attitudes and preparation for the challenges associated with future STEM endeavors.

# CONCLUSION

The study's descriptive findings confirm that, at this time, many senior high school STEM students are exhibiting high levels of engagement with project based learning (PBL) and exhibit good levels of digital literacy and good attitudes towards science. This includes a high rating of all aspects of PBL, indicating that students are engaged in meaningful and collaborative learning. Students' ratings of their digital literacy skills were also generally good; however, students exhibited exceptionally high ratings regarding their ability to effectively apply technology and interact with technology to facilitate their learning. Additionally, students demonstrated an overall high level of attitude towards science, with a high recognition of the importance of science to society. However, the fact that students reported moderate anxiety regarding science related tasks suggests that some students continue to feel anxious about engaging with science-related concepts.

In addition to the descriptive findings, the inferential findings of this study clearly demonstrate that both PBL and digital literacy have statistically significant relationships and predictive influences on students' attitudes towards science. The correlation data indicate that there is a strong positive relationship between students' PBL experiences and their attitudes toward science. Likewise, the correlation data indicates that there is a strong positive relationship between students' digital literacy abilities and their attitudes toward science. As a result, both of the null hypotheses tested in this study are rejected. Further regression analysis supports the fact that both PBL and digital literacy have significant predictive relationships with attitude toward science. Digital literacy had a slightly greater impact than PBL. Together, they account for approximately 37 percent of the total variance in students' attitudes toward science. The findings from this study support a partial additive effect of PBL and digital literacy. Both independent variables appear to be contributing to students' attitudes toward science independently, but do not completely mediate each other's impacts. Path analysis indicated that both independent variables positively influenced attitude toward science, which indicates that both independent variables operate along separate paths.

The findings of this study support the theoretical frameworks upon which it was built. Constructivist learning theory appears to be well represented in the findings. PBL is consistent with constructivist learning theory because it engages students in activities that promote active participation, experiential learning and student centeredness which are thought to lead to improved cognitive and affective (motivation/self confidence) outcomes. The digital Literacy theory developed by Van Aalst et al. (2006) is also evident in the finding that students' abilities to use technology in a competent manner contributed significantly to their learning experiences and positive attitudes toward science. Overall, the findings support the idea that incorporating hands-on experiential learning methods into STEM curricula that incorporate strong digital literacy competencies may help develop better attitudes toward science in students.

# ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude for those who helped me through this experience that brought me to this success of my thesis. I am deeply thankful to Dr. Michelle Y. Acledan for her constant support, patient guidance, very useful recommendations, and inspiration and encouragement at each phase of my thesis process.

In addition, I am extremely grateful to my mother, Rubenita Gillesania, for her loving generosity and sacrifice financially and emotionally that made it possible for me to reach my goals in life. I am grateful to my two sisters, Gerlyn Gletch Pastera and Queenie Rose Balquin, for being so supportive and encouraging as they continue to be with me through many phases of my education. Moreover, I appreciate the consistent encouragement and from my close friends, Elizer C. Calibayan, Keneth John O. Candido, and Frances Marie L. Galo, especially during those difficult times. Furthermore, I also dedicate this work to my School Year 2025–2026 Grade 6 students of St. Benedict, my advisory class, for their cooperation, kindness, and inspiration throughout my teaching journey. Finally, I give thanks to God Most High for His divine leading, wisdom, power, and blessing which allowed me to successfully accomplish each step along the way as I completed this dissertation.

# REFERENCES

1. Abramo, G., & D'Angelo, C. A. (2023). The relationship between the number of authors of a publication, its citations and the impact factor of the publishing journal: Evidence from Italy. Heliyon, 9(7), e23116. https://doi.org/10.1016/j.heliyon.2023.e23116
2. Alegado, R. T. (2025). Assessing the digital literacy and design skills needs of parish youth and senior high school students in Cabanatuan City. International Journal of Innovative Research and Scientific Studies, 8(7), 488–493. https://doi.org/10.53894/ijirss.v8i7.10481
3. Avinç, E., & Doğan, F. (2024). Digital literacy scale: Validity and reliability study with the Rasch model. Education and Information Technologies, 29, 22895–22941. https://doi.org/10.1007/s10639-024-12662-7
4. Bahri, S., Nurhadi, A., & Amri, S. (2023). Digital readiness and inequality: Impacts on science learning in rural Indonesian schools. International Journal of Instruction, 16(2), 335–350.
5. Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Prentice Hall.
6. Baterna, H. B., Mina, T. D. G., & Rogayan, D. V., Jr. (2020). Digital literacy of STEM senior high school students: Basis for enhancement program. International Journal of Technology in Education, 3(2), 105–117. https://doi.org/10.46328/ijte.v3i2.28
7. Beers, S. Z. (2021). Digital literacy and project-based learning: Preparing students for the 21st century. Journal of Educational Technology Systems, 49(2), 245–261.https://doi.org/10.1177/0047239521999170
8. Candia, L. A., & Lay, Y. F. (2025). Attitudes toward science as mediators between perceptions of classroom environment, family involvement, self-efficacy, and science achievement. Problems of Education in the 21st Century, 83(1), 30–47. https://doi.org/10.33225/pec/25.83.30
9. Cermik, H., & Fenli-Aktan, A. (2020). Primary and secondary school students' attitudes toward science. International Journal of Educational Methodology, 6(2), 355–365. https://doi.org/10.12973/ijem.6.2.355
10. Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. Educational Research Review, 26, 71–81. https://doi.org/10.1016/j.edurev.2018.11.001
11. Coiro, J., & Hobbs, R. (2016). Digital literacy as collaborative, transdisciplinary, and applied. American Educational Research Association Annual Meeting.
12. Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. Applied Developmental Science, 24(2), 97–140. https://doi.org/10.1080/10888691.2018.1537791
13. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340. https://doi.org/10.2307/249008
14. Delima, D. A., Mamaril, R. J., Javier, D. R. C., Dela Peña, M. O., Soriano, R. F., & Ladjammah, K. S. J. (2022). Awareness of senior high school students on digital literacy skills: A qualitative study. Sinaya: A Philippine Journal for Senior High School Teachers and Students, 1(3), 22–48. https://doi.org/10.59588/3027-9283.1048
15. Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. Educational Technology Research and Development, 68(5), 2449–2472. https://doi.org/10.1007/s11423-020-09767-4
16. Galve, J. M., & Labio, R. (2023). Information and communications technology skills and digital literacy of senior high school students. Psychology and Education: A Multidisciplinary Journal, 8(5), 556–566. https://doi.org/10.5281/zenodo.7879476
17. Getenet, S., Cantle, R., Redmond, P., & Albion, P. (2024). Students' digital technology attitude, literacy and self-efficacy and their effect on online learning engagement. International Journal of Educational Technology in Higher Education, 21, Article 3. https://doi.org/10.1186/s41239-023-00437-y

18. Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on attitude–behavior relationships: A natural experiment with curbside recycling. Environment and Behavior, 27(5), 699–718. https://doi.org/10.1177/0013916595275005
19. Hindun, I., Nurwidodo, Wahyuni, S., & Fauziah, N. (2024). Effectiveness of project-based learning in improving science literacy and collaborative skills of Muhammadiyah middle school students. JPBI (Jurnal Pendidikan Biologi Indonesia), 10(1), 58–69. https://doi.org/10.22219/jpbi.v10i1.31628
20. Hudha, M. N., Fajriyah, M. I., Rosyidah, F. U. N., & Ayu, H. D. (2023). Project-based learning in improving scientific literacy: Systematic literature review. Psychology, Evaluation, and Technology in Educational Research, 5(2), 93–105. https://doi.org/10.33292/petier.v5i2.157
21. Hwang, G.-J., Chu, H.-C., Lin, Y.-S., & Tsai, C.-C. (2022). Effects of an augmented reality-based educational game on students' learning achievements and motivation in a science course. Educational Technology & Society, 25(1), 1–15. https://files.eric.ed.gov/fulltext/EJ1376861.pdf
22. Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733
23. Kortam, N., Basheer, A., Hofstein, A., & Hugerat, M. (2018). How project-based learning promotes 7th grade students' motivation and attitudes towards studying biology. Action Research and Innovation in Science Education, 1(2), 9–17. https://doi.org/10.51724/arise.10
24. Kurt, G., & Akoglu, K. (2023). Project-based learning in science education: A comprehensive literature review. Interdisciplinary Journal of Environmental and Science Education, 19(3), e2311. https://doi.org/10.29333/ijese/13677
25. 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. Frontiers in Psychology, 12, Article 784068. https://doi.org/10.3389/fpsyg.2021.784068
26. Macario, R. P. B., Tabian, J. R., & Paguigan, J. (2026). Impact of digital learning platforms on senior high school students' engagement in the Philippines. International Journal for Multidisciplinary Research, 8(1). https://doi.org/10.36948/ijfmr.2026.v08i01.67161
27. Miller, E. C., & Krajcik, J. S. (2019). Promoting deep learning through project-based learning: A design problem. Disciplinary and Interdisciplinary Science Education Research, 1, Article 7.https://doi.org/10.1186/s43031-019-0009-6
28. Muskania, R. T., Maksum, A., & Astra, I. M. (2023). STEM-PjBL learning incorporates local knowledge to improve science literacy. Cypriot Journal of Educational Sciences, 18(2), 522–532. https://doi.org/10.18844/cjes.v18i2.8791
29. Ngereja, B., Hussein, B., & Andersen, B. (2020). Does project-based learning (PBL) promote student learning? A performance evaluation. Education Sciences, 10(11), Article 330. https://doi.org/10.3390/educsci10110330
30. Nguyen, L. A. T., & Habók, A. (2022). Digital literacy of EFL students: An empirical study in Vietnamese universities. Libri, 72(1), 53–66. https://doi.org/10.1515/libri-2020-0165
31. Nuraeni, N., Binhayeekhonoh, A., Ramadhani, J., Holisah, N., & Gusnadi, N. (2022). Access to digital learning and science engagement. International Journal of Instruction, 15(4), 637–654.
32. OECD. (2023). PISA 2022 results (Volume I): The state of learning and equity in education. OECD Publishing. https://doi.org/10.1787/53f23881-en
33. Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. International Journal of Science Education, 25(9), 1049–1079. https://doi.org/10.1080/0950069032000032199
34. Ospankulova, E., Maxutov, S., Lathrop, R., Anuarova, L., & Balta, N. (2025). Science students' attitudes, learning, critical thinking and engagement in project-based learning. Cogent Education, 12(1), Article 2445358. https://doi.org/10.1080/2331186X.2024.2445358
35. Pepito, M. J. T., & Acledan, M. Y. (2022). Influence of digital literacy and self-directed learning in the online learning success of STEM college students. International Journal of Humanities, Social Sciences and Education, 9(1), 88–100. https://doi.org/10.20431/2349-0381.0901007

36. Piaget, J. (1954). The construction of reality in the child. Basic Books. https://www.routledge.com/The-Construction-Of-Reality-In-The-Child/Piaget/p/book/9780415210003
37. Potvin, P., & Hasni, A. (2021). Interest and attitudes toward science: A systematic review. Studies in Science Education, 57(2), 181–221.
38. Rahman, N., Liswijaya, Hendratmoko, A. F., Nagy, E. K., & Mashwani, H. U. (2025). Effectiveness of a project based learning model integrated with Sasambo local wisdom to enhance students' scientific attitudes. JIPI (Jurnal IPA dan Pembelajaran IPA), 9(1), 78–89. https://doi.org/10.24815/jipi.v9i1.42626
39. Ryan, R. M., & Deci, E. L. (2020). Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. Contemporary Educational Psychology, 61, 101860. https://doi.org/10.1016/j.cedpsych.2020.101860
40. Salmi, H., & Thuneberg, H. (2018). The role of self-determination in informal and formal science learning contexts. Learning Environments Research, 22(3), 43–63. https://doi.org/10.1007/s10984-018-9266-0
41. Schukajlow, S., Blomberg, J., Schoenherr, J., & Leopold, C. (2021). The role of strategy-based motivation in mathematical problem solving: The case of learner-generated drawings. Learning and Instruction, 80, 101561. https://doi.org/10.1016/j.learninstruc.2021.101561
42. Siddiq, F., Hatlevik, O. E., Olsen, R. V., Throndsen, I., & Scherer, R. (2016). Taking a future perspective by learning from the past – A systematic review of assessment instruments that aim to measure primary and secondary school students' ICT literacy. Educational Research Review, 19, 58–84. https://doi.org/10.1016/j.edurev.2016.05.002
43. Tai, R. H., Ryoo, J. H., Skeeles-Worley, A., Dabney, K. P., Almarode, J. T., & Maltese, A. V. (2022). * (Re-)Designing a measure of student's attitudes toward science: A longitudinal psychometric approach.* International Journal of STEM Education, 9, Article 12. https://doi.org/10.1186/s40594-022-00332-4
44. UNESCO Institute for Statistics. (2018). A global framework of reference on digital literacy skills for indicator 4.4.2. UNESCO Institute for Statistics.
45. https://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf
46. van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2019). Determinants of 21st-century digital skills: A large-scale survey among working professionals. Computers in Human Behavior, 100, 93–104. https://doi.org/10.1016/j.chb.2019.06.017
47. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens: With new examples of knowledge, skills and attitudes (EUR 31006 EN). Publications Office of the European Union. https://doi.org/10.2760/115376
48. Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.). Harvard University Press.
49. Wicaksono, A., Suyatno, & Rahmawati, F. (2024). The effectiveness of problem-based learning integrated with local wisdom in enhancing students' scientific literacy: A systematic literature review. Heliyon. https://doi.org/10.1016/j.heliyon.2024.e406364158
50. Muskania, R. T., Maksum, A., & Astra, I. M. (2023). STEM-PjBL learning incorporates local knowledge to improve science literacy. Cypriot Journal of Educational Sciences, 18(2), 1–15. https://doi.org/10.18844/cjes.v18i2.8791
51. Zhan, Z., Shen, W., & Lin, W. (2022). Effect of product-based pedagogy on students' project management skills, learning achievement, creativity, and innovative thinking in a high-school artificial intelligence course. Frontiers in Psychology, 13, 849842. ttps://doi.org/10.3389/fpsyg.2022.849842
52. Zhan, Z., Shen, W., Xu, Z., Niu, S., & You, G. (2022). A bibliometric analysis of the global landscape on STEM education (2004–2021): Towards global distribution, subject integration, and research trends. Asia Pacific Journal of Innovation and Entrepreneurship, 16(2), 171–203. https://doi.org/10.1108/APJIE-08-2022-0090