Assessing Students' Engagement with Technology Tools in Biology Learning among General Science Undergraduate Students

Morales, Shyla Joy M.

School of Graduate Studies, Saint Mary's University, Philippines

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ABSTRACT

This study examined the engagement of General Science undergraduate students with technology tools in learning Biology at Nueva Vizcaya State University Bambang Campus. It aimed to determine the students' level of engagement and identify whether gender, preferred learning style, and monthly household income were associated with or could predict their engagement with technology tools. A quantitative descriptive-correlational research design was used, involving 63 General Science undergraduate students. Data were collected through a structured questionnaire and analyzed using appropriate statistical tools. The findings showed that the students had a high level of engagement with technology tools in learning Biology, with an overall mean score of 2.93 (SD = 0.54). The results also showed no significant difference in engagement according to gender or preferred learning style. Similarly, monthly household income was not significantly related to students' engagement. Furthermore, multiple regression analysis showed that gender, preferred learning style, and monthly household income did not significantly predict overall engagement. Although these variables collectively explained 12.1% of the variation in students' engagement, the overall regression model was not statistically significant. Overall, the findings indicate that students generally demonstrated high engagement with technology tools in Biology learning regardless of their gender, preferred learning style, or monthly household income. The findings also suggest that other factors not included in the present study may contribute to students' engagement with technology tools in Biology learning.

Keywords: Technology Tools; Student Engagement; Biology Learning; Learning Styles; Household Income

INTRODUCTION

Technology has become an increasingly important part of higher education, changing how students access information, participate in learning activities, and interact with academic content. Digital platforms, multimedia resources, simulations, virtual laboratories, and other technology-based tools can provide additional ways for students to explore concepts and participate in learning. However, the educational value of technology does not depend on its availability alone. Evidence from the UNESCO Global Education Monitoring Report emphasizes that the effects of technology vary according to factors such as access, instructional quality, teacher preparedness, and the context in which technology is used (UNESCO, 2023). Similarly, a recent OECD review found that digital technologies can support learning and engagement, but their benefits depend largely on appropriate pedagogical implementation rather than technology access by itself (Forsström et al., 2025).

Student engagement is an important consideration in technology-supported learning. In higher education, engagement is understood as a multidimensional construct involving students' behavioral participation, emotional involvement, cognitive investment, and interaction with the learning environment (Heilporn et al., 2024). Technology may provide opportunities for students to interact with content, collaborate with peers, receive feedback, and take greater responsibility for their learning. A systematic review of educational technology in higher education likewise found that technology can support different forms of student engagement, although its effects depend on the type of technology, learning activity, and instructional context (Khan et al., 2024).

These possibilities are particularly relevant to Biology, where students encounter concepts and processes that may be difficult to observe directly. Simulations, multimedia materials, virtual laboratories, and other interactive resources can provide opportunities to visualize biological structures and processes and to conduct activities that may be difficult to perform in conventional laboratory settings. Reviews of virtual laboratories in Biology education have reported their use for abstract topics such as cell and molecular biology, genetics, microbiology, and biotechnology (Byukusenge et al., 2022). Virtual laboratory simulations have also been examined as alternatives or complements to physical laboratory experiences, particularly when access to equipment, time, or other resources is limited (Choate et al., 2021; Mercado & Picardal, 2023).

Recent research also suggests that technology-supported learning can promote active participation when digital tools are integrated with appropriate learning approaches. For example, collaborative digital storytelling has been investigated as a technology-supported strategy for Biology education, demonstrating the potential of digital activities to support students' academic and skill development (Bilici & Yilmaz, 2024). Recent reviews of virtual and interactive technologies similarly indicate that technology can contribute to engagement and learning when students are given meaningful opportunities to interact with content rather than simply receive information.

At the same time, technology integration presents challenges. Differences in access to devices and reliable internet connectivity can affect students' opportunities to participate in technology-supported learning. The UNESCO (2023) report emphasizes that digital access and equity remain important concerns, while the OECD (2025) notes that digitalization can produce different outcomes depending on students' circumstances and the quality of implementation. These concerns are particularly relevant in higher education settings where students may come from different socioeconomic backgrounds and therefore have different levels of access to digital resources.

Student characteristics may also shape their experiences with technology-supported learning. Gender, learning preferences, digital competence, motivation, and socioeconomic circumstances have been examined in relation to students' participation and experiences with educational technologies. However, these factors should not automatically be assumed to determine engagement. Rather, they provide useful dimensions for examining whether students experience technology-supported learning differently. This is important because research increasingly emphasizes that effective technology integration involves the interaction of learner characteristics, instructional design, access, and teacher support rather than the technology itself (UNESCO, 2023; Forsström et al., 2025)

The issue of learning preferences also requires careful consideration. Students may report preferences for particular ways of receiving or interacting with information, but such preferences should not be interpreted as fixed characteristics that necessarily determine how well students learn. Instead, technology can provide multiple representations and modes of interaction, allowing students to encounter Biology concepts through combinations of visual, auditory, textual, and interactive resources. This makes technology particularly useful for providing varied learning experiences while avoiding the assumption that instruction must be matched to a single learning-style category.

Despite the growing body of research on educational technology, questions remain about how students engage with technology specifically in Biology learning within particular institutional and socioeconomic contexts. Much of the existing literature examines technology-supported learning broadly, specific technologies such as virtual laboratories, or particular instructional interventions. There is comparatively less research examining the overall engagement of General Science undergraduate students with technology tools in Biology while simultaneously considering learner characteristics such as gender, preferred learning style, and monthly household income. This gap is especially relevant in Philippine higher education, where access to digital resources and patterns of technology use may differ across students and institutions. The UNESCO Southeast Asia regional report likewise highlights the importance of examining technology in relation to the diverse educational and socioeconomic contexts of countries in the region, including the Philippines.

In response to this gap, the present study examines the level of engagement with technology tools in learning Biology among General Science undergraduate students at Nueva Vizcaya State University–Bambang Campus. Specifically, it determines students' overall level of engagement, examines whether engagement differs according to gender and preferred learning style, determines whether engagement is related to monthly household income, and identifies which profile variables significantly influence engagement. By examining these factors within a specific Philippine higher education context, the study seeks to provide evidence that can help inform the appropriate and context-sensitive integration of technology in Biology instruction.

Statement of the Problem

This study aimed to assess students' engagement with technology tools in learning Biology and determine whether gender, preferred learning style, and monthly household income were associated with or significantly predicted their level of engagement among General Science undergraduate students enrolled in the academic year (A.Y) 2025-2026 at Nueva Vizcaya State University.

Specifically, this study seeks to answer the following questions:

1. What is the level of engagement of General Science undergraduate students with technology tools in learning Biology?
2. Is there a significant difference in students' engagement with technology tools when grouped according to gender?
3. Is there a significant difference in students' engagement with technology tools when grouped according to preferred learning style?
4. Is there a significant relationship between monthly household income and students' engagement with technology tools?
5. Which among gender, preferred learning style, and monthly household income significantly predict students' engagement with technology tools in learning Biology?

THEORETICAL FRAMEWORK

This study is anchored on five complementary perspectives: Engagement Theory (Kearsley & Shneiderman, 1998), the Technology Acceptance Model (TAM) (Davis, 1989), Self-Determination Theory (SDT) (Deci & Ryan, 1985; Ryan & Deci, 2020), Constructivist Learning Theory (Vygotsky, 1978), and Cognitive Load Theory (CLT) (Sweller, 1988; Chen et al., 2023). Together, these perspectives provide a multidimensional basis for understanding how students engage with technology in Biology learning by considering active participation, technology acceptance, motivation, knowledge construction, and cognitive processing. Recent research on technology-enhanced learning likewise emphasizes that the effectiveness of educational technology depends on the interaction among technology, pedagogy, learner characteristics, and instructional design rather than on technology alone (Choi-Lundberg et al., 2023; Giannakos et al., 2023).

Engagement Theory provides the primary foundation for understanding students' active involvement in technology-supported learning. Kearsley and Shneiderman (1998) proposed that meaningful learning is promoted when students participate in collaborative, project-oriented, and authentic activities supported by technology. In Biology, technology can facilitate such engagement through simulations, virtual laboratories, interactive activities, and collaborative digital tasks. These tools can provide opportunities for students to explore biological processes, investigate scientific problems, and interact with learning materials. Thus, Engagement Theory helps explain how meaningful interaction with technology may encourage students to participate actively and sustain their involvement in Biology learning.

The Technology Acceptance Model provides a complementary explanation of students' willingness to use technology. Davis (1989) identified perceived usefulness and perceived ease of use as central factors influencing technology acceptance. A systematic review by Granić and Marangunić (2019) further demonstrated the continued application of TAM in educational settings. In the present study, TAM suggests that students may be more willing to engage with technology tools when they perceive them as useful for understanding Biology and easy to operate. Conversely, technology that is difficult to use or perceived as having little relevance to learning may discourage continued participation. TAM therefore helps explain the role of students' perceptions in their engagement with technology-supported learning.

Self-Determination Theory adds a motivational dimension to the framework. Deci and Ryan (1985) and Ryan and Deci (2020) explain that motivation and engagement are supported when learning environments satisfy the basic psychological needs for autonomy, competence, and relatedness. Technology-supported Biology activities may provide autonomy by allowing students to explore materials independently, competence by providing opportunities to successfully complete interactive tasks, and relatedness through digital collaboration and communication. Recent research continues to demonstrate the relevance of these psychological needs to students' motivation and engagement (Zheng et al., 2025). SDT therefore helps explain why students may remain actively involved when technology-supported learning provides meaningful choices, appropriate challenges, opportunities for success, and social interaction.

Constructivist Learning Theory further supports this hybrid framework by viewing learning as an active process in which learners construct knowledge through experience and interaction with their environment (Vygotsky, 1978). Technology can facilitate this process by allowing students to explore information, manipulate variables, visualize biological processes, and connect new concepts with prior knowledge. Digital Biology resources may also provide students with different ways of interacting with content, such as visual representations, audio materials, and interactive activities. However, this study does not assume that students learn better when instruction is matched to a particular learning style, as evidence remains insufficient to support the learning-styles matching hypothesis (Pashler et al., 2008). Instead, Visual, Auditory, and Kinesthetic classifications are treated as respondent characteristics and are examined to determine whether students' engagement with technology tools differs among these groups.Cognitive Load Theory provides another important perspective by explaining how the design and complexity of technology-supported learning materials can influence students' learning experiences. Sweller (1988) proposed that working memory has limited capacity, making the management of cognitive demands important for effective learning. More recent developments of the theory continue to emphasize the effects of task complexity and the number and interaction of information elements that learners must process (Chen et al., 2023). This is particularly relevant to Biology, where students often encounter complex structures, processes, and relationships. Appropriately designed multimedia, simulations, and interactive materials can help students focus on relevant information, whereas poorly organized or excessively complex digital materials may impose unnecessary cognitive demands (Mayer, 2024; Mutlu-Bayraktar et al., 2019).

Taken together, these theories provide a comprehensive but focused explanation of technology-supported Biology engagement. Engagement Theory emphasizes active participation, TAM explains technology acceptance, SDT addresses motivation, Constructivist Learning Theory explains active knowledge construction, and Cognitive Load Theory considers the cognitive demands of technology-supported learning. These perspectives collectively support the view that students' engagement with technology may vary according to how technology is perceived, designed, implemented, and experienced by learners.

Within this framework, gender, preferred learning style, and monthly household income are treated as profile variables that may be associated with differences in students' engagement with technology tools. Gender and preferred learning style are examined to determine whether students demonstrate different levels of engagement across groups, while monthly household income is examined in relation to engagement. The framework therefore provides a theoretical basis for investigating the level of engagement with technology tools in Biology and determining whether engagement varies according to the selected student characteristics.

CONCEPTUAL FRAMEWORK

This study conceptualizes student engagement with technology tools in Biology as a multidimensional outcome that may be associated with learner characteristics, access to technology, and the learning environment. Engagement includes behavioral participation, emotional involvement, and cognitive investment in learning activities (Fredricks et al., 2004; Bond et al., 2020; Bergdahl et al., 2024). Educational technology can support these dimensions of engagement, although its educational value may vary depending on the type of technology, learning context, and quality of instructional integration (Godsk & Møller, 2025; Forsström et al., 2025).

The framework considers gender, preferred learning style, and monthly household income as profile variables to be examined in relation to students' engagement. Gender is treated as a grouping variable, allowing the study to determine whether male and female students differ in their reported engagement rather than assuming that gender determines engagement. This approach recognizes that students' experiences with technology may vary across individual and contextual characteristics (Bond et al., 2020; Balalle, 2024).

Preferred learning style is treated as a profile variable in the present study. Digital Biology resources may provide different ways of interacting with content, including visual representations, audio materials, animations, simulations, and interactive activities. However, this study does not assume that students learn better when instruction is matched to a particular learning style, as evidence remains insufficient to support the learning-styles matching hypothesis (Pashler et al., 2008). Therefore, Visual, Auditory, and Kinesthetic classifications are examined empirically to determine whether students' engagement with technology tools differs among these groups.

Monthly household income represents the socioeconomic dimension of the framework and is examined in relation to students' engagement with technology tools. Differences in income may be associated with differences in access to devices, internet connectivity, and other digital learning resources. However, this study does not assume that household income determines students' engagement. Instead, the relationship between monthly household income and engagement is examined statistically (OECD, 2025; Forsström et al., 2025).

At the center of the framework is the level of engagement with technology tools in Biology, which serves as the main outcome variable. Technology is not assumed to automatically increase engagement; rather, digital tools may support behavioral, affective, and cognitive engagement when they promote active learning, interaction, communication, and meaningful participation (Godsk & Møller, 2025; Bond et al., 2020).

The framework therefore views engagement as a characteristic of students' interaction with their technology-supported learning environment. Students' engagement may vary according to their personal characteristics, access to resources, digital experiences, and the design of learning activities (Bergdahl et al., 2024; Forsström et al., 2025). The three profile variables are consequently examined in relation to engagement rather than assumed to cause or determine it.

Accordingly, gender and preferred learning style are examined through group comparisons, monthly household income is examined in relation to engagement, and the three profile variables are considered as potential predictors of engagement. This structure directly corresponds to the study's research questions and statistical procedures. Overall, the framework provides a basis for determining whether engagement with technology-supported Biology learning differs across learner profiles and socioeconomic conditions and whether these variables significantly predict engagement among General Science undergraduate students at Nueva Vizcaya State University.

METHOD

Research Design

This study used a quantitative descriptive-correlational research design to examine how General Science undergraduate students at Nueva Vizcaya State University engage with technology tools in learning Biology and to determine how engagement varies according to gender, preferred learning styles and monthly household income. The descriptive aspect of the design will measure the level of student engagement with available technology tools while the correlational aspect will test whether significant differences exist among groups and whether a relationship is present between confidence in learning Biology and household income. Since the full population of General Science students is accessible, the design supports comprehensive data collection through

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a structured questionnaire administered via Google Forms and allows for objective analysis through statistical techniques that identify differences, associations and predictive influences among the variables.

Research Environment

This study was conducted at the Nueva Vizcaya State University Bambang Campus, a public higher education institution that offers the Bachelor of Secondary Education major in General Science and serves as the primary setting for the respondents of this research. The campus provides an academic environment where face-to-face instruction is gradually enhanced with digital resources such as online modules, multimedia presentations and basic virtual laboratory materials used in science courses, including Biology. As a campus attended by students from varied socioeconomic backgrounds within the province, the Bambang Campus presents natural differences in access to personal devices and internet connectivity, making it an appropriate setting for examining patterns of engagement with technology tools. Its classrooms and specialized laboratories are equipped with essential technological facilities, although the extent of their use depends on course requirements and instructor practices, which creates realistic conditions for assessing how General Science students interact with technology in learning Biology.

Research Respondents

The respondents of this study were all 63 enrolled General Science undergraduate students of the Nueva Vizcaya State University Bambang Campus, representing the entire population to ensure comprehensive and accurate data. These students are currently taking Biology-related courses where technology tools are utilized to support instruction, making them suitable participants for examining their level of engagement with digital resources. The population includes learners of varied sexes, preferred learning styles and monthly household incomes, allowing the study to analyze how these characteristics influence engagement in technology-supported Biology learning. All 63 students were invited to participate through a structured online questionnaire administered via Google Forms to ensure consistency in data collection.

Research Instrument

The research instrument for this study is a structured questionnaire adapted from Abanikannda (2018) as published in the African Research Journal of Education and Social Sciences, 5(3). The questionnaire was originally designed for assessing the effect of technology tools on students' interest in science and was modified to suit the context of General Science undergraduate students at Nueva Vizcaya State University Bambang Campus. The adapted instrument was divided into two sections. Section A collects demographic data, including gender, preferred learning styles and monthly household income, while Section B contains statements related to students' engagement with technology tools in learning Biology. Part B was further organized into three parts: Part 1 examines the usage of technology tools, Part 2 measures interest and engagement when using technology tools, and Part 3 identifies challenges faced during technology-mediated learning. The questionnaire uses a four-point Likert scale ranging from 1 (Strongly Disagree) to 4 (Strongly Agree), with negative statements reverse-coded to ensure accurate scoring. The draft instrument was reviewed by experts in tests and measurement as well as specialists in technology tool implementation, who confirmed the face and content validity of the questionnaire. Reliability was established using the test-retest method and analyzed with the Pearson Product Moment Correlation, yielding a coefficient of 0.762, indicating high internal and external consistency. This reliability value demonstrates that the instrument is valid and suitable for measuring the intended constructs in the present study.

Data Gathering Procedure

Data for this study were collected using a structured online questionnaire administered to all 63 General Science undergraduate students of Nueva Vizcaya State University Bambang Campus. Prior to distribution, permission was sought from the university administration and instructors to ensure proper coordination and adherence to ethical standards. The Google Form used as the instrument will include four key sections: a Letter to Respondents explaining the purpose of the study and emphasizing voluntary participation, a Checked Agreement where

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respondents indicate informed consent, a Profile of Respondents section capturing demographic data including gender, preferred learning styles and monthly household income, and a section containing 15 questions measuring students' engagement with technology tools in learning Biology. Respondents were instructed to answer all items honestly and were allowed to complete the form at their convenience to minimize disruption to their academic schedule. Upon submission, the responses will be reviewed for completeness, coded appropriately, and prepared for statistical analysis to address the research questions and test the hypotheses of the study.

Treatment of Data

The data collected from the 63 General Science undergraduate students were analyzed using IBM SPSS Statistics to address the research questions and test the stated hypotheses. Descriptive statistics, including frequency counts, percentages, mean scores, and range, will be used to determine the level of engagement with technology tools in learning Biology.

Table 1. Qualitative Description for the Level of Engagement of Undergraduate Students in Learning Biology

Mean Range	Interpretation
1.00 – 1.49	Very Low Engagement
1.50 – 2.49	Low Engagement
2.50 – 3.49	High Engagement
3.50 – 4.00	Very High Engagement

To examine differences in engagement based on gender and preferred learning styles, the independent samples t-test and one-way ANOVA were employed, respectively. The relationship between students' engagement with technology tools in Biology and monthly household income was analyzed using Spearman's rank-order correlation coefficient (Spearman's rho). Furthermore, multiple regression analysis was conducted to identify which of the profile variables, including gender, preferred learning styles, and monthly household income, significantly predict the level of engagement with technology tools. A significance level of 0.05 was set for all statistical tests. Negative statements in the questionnaire will be reverse-coded prior to analysis to ensure consistency in interpretation, and all data were checked for completeness and accuracy before performing statistical procedures.

RESULTS AND DISCUSSION

This section presents the findings on General Science students' engagement with technology tools in learning Biology, organized by research problems. Section 1 reports the frequency count and percent distribution of the level of engagement of undergraduate students on technology tools. Section 2 examines differences based on gender (independent samples t-test) and learning styles (one-way ANOVA with post hoc tests). Section 3 analyzes the relationship between engagement and household income using Pearson correlation, and Section 4 analyzes the relationship between engagement and monthly household income using Spearman's rho, while Section 5 identifies the profile variables that significantly predict engagement through multiple regression analysis.

Section 1. Level of Engagement with Technology Tools in Biology

Table 2 shows the overall mean, standard deviation and interpretation based on table 1 that will indicate the level of engagement of the General Science students in using technology tools in Biology.

Table 2. Overall Level of Engagement with Technology Tools in Biology

Level of Engagement	Frequency	Percent
Very Low Engagement	0	0
Low Engagement	7	11.7

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High Engagement	52	86.7
Very High Engagement	1	1.7
Total	63	100

Mean: 2.9312 Standard Deviation: .54450

Table 2 presents the level of engagement of General Science students in the use of technology tools during Biology instruction. The results show that the majority of the respondents were classified as having High Engagement, with 52 students, while 7 students were classified as having Low Engagement. Only 1 student was classified as having Very High Engagement, and none were classified as having Very Low Engagement. Overall, the distribution indicates that most of the respondents demonstrated a high level of engagement in technology-supported Biology instruction.

The obtained mean of 2.93, with a standard deviation of 0.54, falls within the established mean range of 2.50–3.49, which corresponds to High Engagement. The standard deviation indicates relatively limited variation in the respondents' engagement ratings, suggesting that their responses were generally clustered around the mean.

These findings indicate that students generally reported a high level of engagement when technology tools were incorporated into Biology instruction. The predominance of students under the High Engagement category suggests that technology-supported learning activities were associated with active participation and sustained involvement in Biology learning. The findings further highlight the potential of appropriately integrated technology tools to support student engagement during Biology instruction.

Section 2. Engagement with Technology Tools According to Gender

To determine the level of engagement of General Science students in the use of technology tools in Biology according to gender, the respondents were classified into different engagement levels based on their computed engagement scores. The distribution of respondents across the engagement categories is presented in Table 3.1, showing the frequency and percentage of male and female students within each level of engagement.

Table 3. Level of Engagement with Technology Tools in Biology According to Gender

		Level of Engagement				
		Very Low Engagement	Low Engagement	High Engagement	Very High Engagement	Total
Gender	Male	0	6	19	0	25
	Female	0	2	35	1	38
Total		0	8	54	1	63

Table 3 presents the distribution of General Science students according to their level of engagement with technology tools in Biology when grouped according to gender. Among the 25 male respondents, 19 (76.0%) were classified as having high engagement, while 6 (24.0%) were classified as having low engagement. None of the male respondents were classified as having very low or very high engagement. Among the 38 female respondents, 35 (92.1%) demonstrated high engagement, 2 (5.3%) demonstrated low engagement, and 1 (2.6%) demonstrated very high engagement. No female respondent was classified as having very low engagement.

The results indicate that the majority of both male and female students demonstrated high engagement in the use of technology tools during Biology instruction. A larger proportion of female students (92.1%) than male students (76.0%) fell under the high-engagement category. Conversely, a greater proportion of male students (24.0%) than female students (5.3%) were classified as having low engagement. Overall, the distribution suggests that both groups generally demonstrated a high level of engagement with technology-supported Biology instruction.

Section 2.1 Mean and Standard Deviation of Engagement According to Gender

To further describe the engagement of General Science students in the use of technology tools in Biology, the mean and standard deviation of their engagement scores were computed according to gender. The mean indicates the average engagement score of each group, while the standard deviation describes the extent of variation in their responses. The results are presented in Table 4.

Table 4. Mean and Standard Deviation of Engagement According to Gender

Gender	N	Mean	SD
Male	25	2.76	0.34
Female	38	2.89	0.33
Total	63		

Table 4 shows the mean and standard deviation of students' engagement scores according to gender. Male students obtained a mean engagement score of 2.76 (SD = 0.34), while female students obtained a slightly higher mean score of 2.89 (SD = 0.33). Based on the established mean interpretation scale, both mean scores fall within the range corresponding to High Engagement. This indicates that both male and female students generally reported high engagement in the use of technology tools during Biology instruction.

The standard deviations of 0.34 for male students and 0.33 for female students indicate relatively limited variability in the engagement scores within each group. This suggests that the responses of students within each gender were generally clustered around their respective mean scores.

Section 2.2. Test of Difference in Engagement According to Gender

To determine whether the observed difference in engagement between male and female students was statistically significant, an independent-samples t-test was conducted.

Table 5. Test of Difference in Engagement with Technology Tools in Biology According to Gender

Comparison	t	df	p-value	Decision
Male vs. Female	-1.555	61	.125	Not Significant

The independent-samples t-test revealed that the difference in engagement scores between male and female students was not statistically significant, $t(61) = -1.555$, $p = .125$. Since the obtained p-value is greater than the 0.05 level of significance, the null hypothesis is not rejected. Thus, there is no statistically significant difference in the engagement of General Science students in the use of technology tools in Biology when grouped according to gender.

Although female students obtained a slightly higher mean engagement score (M = 2.89) than male students (M = 2.76), the difference was not statistically significant. This suggests that male and female students demonstrated generally comparable levels of engagement in technology-supported Biology instruction. Therefore, gender did not significantly differentiate the students' reported engagement with technology tools in Biology.

Section 3. Engagement with Technology Tools in Biology According to Learning Styles

Students may differ in their preferred learning styles, which may influence how they respond to different instructional approaches and learning resources. In this study, respondents were classified according to their identified learning styles as Visual, Auditory, and Kinesthetic. Their engagement with technology tools in Biology was examined across these learning-style groups to determine the extent to which students reported engagement during technology-supported Biology instruction.

Section 3.1 Mean and Standard Deviation of Engagement According to Learning Style

To further describe the engagement of General Science students in the use of technology tools in Biology, the mean and standard deviation of their engagement scores were computed according to learning style. The mean represents the average engagement score of students within each learning-style group, while the standard deviation indicates the variability of their responses. The results are presented in Table 6.

Table 6. Mean and Standard Deviation of Engagement with Technology Tools in Biology According to Learning Style

Learning Styles	N	Mean	SD	Descriptive Rating
Visual	16	2.90	0.28	High Engagement
Auditory	22	2.73	0.38	High Engagement
Kinesthetic	25	2.89	0.32	High Engagement
Total	63			

Table 6 presents the engagement of General Science students in the use of technology tools in Biology according to their learning styles. The results show that Visual learners obtained a mean engagement score of 2.90 (SD = 0.28), followed closely by Kinesthetic learners with a mean of 2.89 (SD = 0.32). Meanwhile, Auditory learners obtained a mean score of 2.73 (SD = 0.38). Based on the established interpretation scale, all three learning-style groups fall within the range corresponding to High Engagement.

The results indicate that students across all three learning styles generally demonstrated a high level of engagement in the use of technology tools during Biology instruction. Visual learners obtained the highest mean engagement score, although the difference from the Kinesthetic group was minimal. Auditory learners obtained the lowest mean score among the three groups, but their score likewise remained within the High Engagement category.

The standard deviation values ranged from 0.28 to 0.38, indicating relatively limited variability in engagement scores within each learning-style group. The Visual group showed the smallest variation (SD = 0.28), suggesting that their engagement ratings were relatively consistent. The Auditory group had the largest variation (SD = 0.38), although the variability remained relatively small.

Overall, the findings suggest that students demonstrated high engagement with technology tools regardless of their identified learning style. Although Visual learners obtained the highest mean engagement score, followed closely by Kinesthetic learners, all three groups showed comparable descriptive levels of engagement. These results indicate that technology-supported Biology instruction was associated with high reported engagement across different learning-style groups.

Test of Difference in Engagement According to Learning Style

To determine whether the engagement of General Science students in the use of technology tools in Biology differed significantly according to learning style, a one-way analysis of variance (ANOVA) was conducted. Prior to the analysis, the homogeneity of variance assumption was examined using Levene's test.

Table 7. Test of Difference in Engagement with Technology Tools in Biology According to Learning Style

Source	df	F	p-value	Decision	Interpretation
Between Groups	2	1.759	.181	Fail to reject H_0	Not Significant
Within Groups	60				
Total	62				

Table 7 presents the results of the one-way ANOVA examining differences in students' engagement with technology tools in Biology across the three learning-style groups. The test of homogeneity of variances showed a Levene statistic of 0.079 with $p = .924$, indicating that the assumption of equal variances was satisfied. Thus, the standard one-way ANOVA was appropriate for comparing the three groups.

The ANOVA results revealed that there was no statistically significant difference in engagement among Visual, Auditory, and Kinesthetic learners, $F(2, 60) = 1.759$, $p = .181$. Since the obtained p-value is greater than the 0.05 level of significance, the null hypothesis is not rejected. This indicates that the differences observed among the mean engagement scores of the three learning-style groups were not statistically significant.

Although Visual learners obtained the highest mean engagement score ($M = 2.90$, $SD = 0.28$), followed closely by Kinesthetic learners ($M = 2.89$, $SD = 0.32$) and Auditory learners ($M = 2.73$, $SD = 0.38$), these differences were not statistically significant. Therefore, the findings suggest that students' engagement with technology tools in Biology was generally comparable across the three learning styles.

Section 4. Engagement with Technology Tools According to Monthly Household Income

The engagement of General Science students in the use of technology tools in Biology was further examined according to their monthly household income. The respondents were grouped into four income categories: Poor (₱19,999 and below), Middle Class (₱20,000–₱79,999), Upper Middle Class (₱80,000–₱149,999), and Rich (₱150,000 and above). The mean and standard deviation of students' engagement scores were determined for each income category to describe their level of engagement with technology tools in Biology. The results are presented in Table 8.

Table 8. Mean and Standard Deviation of Engagement with Technology Tools in Biology According to Monthly Household Income.

Monthly Household Income	N	Mean	SD	Descriptive Rating
Poor (₱19,999 and below)	55	2.82	0.33	High Engagement
Middle Class (₱20,000-₱79,999)	7	2.98	0.36	High Engagement
Upper Middle Class (₱80,000-₱149,999)	1	--	--	--
Rich (₱150,000 and above)	0	--	--	--
Total	63			

Table 8 presents the level of engagement of General Science students in the use of technology tools in Biology according to their monthly household income. The results show that students classified under the Poor income category (₱19,999 and below) obtained a mean engagement score of 2.82 ($SD = 0.33$), while those in the Middle Class category (₱20,000–₱79,999) obtained a slightly higher mean of 2.98 ($SD = 0.36$). Both groups were classified as having High Engagement based on the established interpretation scale.

The majority of the respondents belonged to the Poor income category ($n = 55$), whereas only 7 respondents were classified under the Middle Class category. Only one respondent belonged to the Upper Middle Class category, and no respondent was classified under the Rich category. Because of the very small number of respondents in the Upper Middle Class category and the absence of respondents in the Rich category, meaningful comparisons involving these groups cannot be made.

The findings indicate that students from the two income groups with sufficient representation generally reported high engagement with technology tools in Biology. Although the Middle Class group obtained a slightly higher mean engagement score than the Poor group, the difference in descriptive means alone does not establish a statistically significant difference.

Section 4.1. Test of Relationship Between Engagement with Technology Tools and Monthly Household Income

To determine whether a significant relationship existed between students' engagement with technology tools in Biology and their monthly household income, a Spearman rank-order correlation analysis was conducted. Spearman's rho was used because monthly household income was measured using ordered income categories. The results of the correlation analysis are presented in Table 9.

Table 9. Spearman Rank-Order Correlation Between Engagement with Technology Tools in Biology and Monthly Household Income

Variable	Spearman's p	p-value	Decision	Interpretation
Engagement with Technology Tools x Monthly Household Income	0.142	0.268	Fail to reject H_0	Not Significant

N = 63; significance level = 0.05; two-tailed test.

Table 9 shows a weak positive relationship between students' engagement with technology tools in Biology and monthly household income ($\rho = 0.142$). This indicates a slight tendency for engagement scores to increase as the monthly household income category increases. However, the relationship was not statistically significant, as indicated by the p-value of 0.268, which is greater than the 0.05 level of significance.

Since the obtained p-value exceeds the established significance level, the null hypothesis is not rejected. Thus, there is no statistically significant relationship between monthly household income and students' engagement with technology tools in Biology. Although students from higher income categories showed a slight tendency toward higher engagement, the observed relationship was weak and insufficient to establish a meaningful association in the present sample.

The findings suggest that monthly household income alone may not be a significant factor associated with students' engagement with technology tools in Biology. The relatively high engagement observed across the represented income groups indicates that students may engage with technology-supported Biology learning regardless of their household income. However, interpretation should be made cautiously because the income groups were highly unevenly distributed, with most respondents belonging to the Poor income category and only one respondent belonging to the Upper Middle Class category.

Section 5. Profile Variables as Predictors of Engagement with Technology Tools in Biology

To determine whether the respondents' profile variables significantly predicted their engagement with technology tools in learning Biology, a multiple linear regression analysis was conducted. Overall engagement was treated as the dependent variable, while gender, preferred learning style, and monthly household income were entered as predictor variables. For preferred learning style, Visual learning style was used as the reference category, while Auditory and Kinesthetic learning styles were represented using dummy variables. The analysis was conducted at a 0.05 level of significance.

Table 10. Multiple Linear Regression Analysis of Profile Variables Predicting Engagement with Technology Tools in Biology

Variable	β	p	Interpretation
Gender	.187	.136	Not Significant
Auditory Learning	-.256	.104	Not Significant
Kinesthetic Learning Style	-.007	.966	Not Significant
Monthly Household Income	.172	.171	Not Significant

Model Summary: $R = .348$; $R^2 = .121$; Adjusted $R^2 = .060$; $F(4, 58) = 1.994$; $p = .107$; $N = 63$.

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The multiple linear regression analysis showed that gender, preferred learning style, and monthly household income did not significantly predict students' overall engagement with technology tools in learning Biology. The regression model yielded an R of .348 and an R^2 of .121, indicating that the predictor variables collectively explained 12.1% of the variance in overall engagement. However, the overall regression model was not statistically significant, $F(4, 58) = 1.994$, $p = .107$.

Since the obtained significance value of .107 is greater than the 0.05 level of significance, the null hypothesis was not rejected. This indicates that the combination of gender, preferred learning style, and monthly household income did not provide a statistically significant prediction of students' engagement with technology tools.

Among the individual predictors, gender did not significantly predict engagement ($\beta = .187$, $p = .136$). Although the positive coefficient suggests that female respondents had slightly higher predicted engagement than male respondents, the difference was not statistically significant.

Similarly, auditory learning style did not significantly predict engagement ($\beta = -.256$, $p = .104$). Compared with the Visual learning-style group, auditory learners had a slightly lower predicted engagement score; however, this difference was not statistically significant.

Kinesthetic learning style also did not significantly predict engagement ($\beta = -.007$, $p = .966$). The coefficient was almost zero, indicating virtually no difference in predicted engagement between kinesthetic and visual learners after controlling for gender and household income.

Lastly, monthly household income did not significantly predict engagement ($\beta = .172$, $p = .171$). Although the coefficient was positive, suggesting a tendency toward higher engagement across the coded income groups, the relationship was not statistically significant.

Overall, the findings indicate that gender, preferred learning style, and monthly household income were not significant predictors of students' engagement with technology tools in learning Biology. Thus, the results suggest that students' engagement may be influenced by other factors not included in the present regression model.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The study concludes that General Science undergraduate students demonstrated a high level of engagement with technology tools in learning Biology, with an overall mean engagement score of 2.93 (SD = 0.54). The findings further revealed that engagement did not significantly differ according to gender or preferred learning style, while monthly household income was not significantly related to students' engagement. Moreover, the multiple regression analysis showed that gender, preferred learning style, and monthly household income did not significantly predict overall engagement, $F(4, 58) = 1.994$, $p = .107$, with the predictors collectively explaining 12.1% of the variance in engagement ($R^2 = .121$). These findings indicate that students generally demonstrated high engagement with technology tools in Biology learning regardless of their gender, preferred learning style, or monthly household income, suggesting that other factors not examined in the study may contribute to their engagement.

Recommendations

Based on the findings of the study, Biology instructors are encouraged to continue integrating technology tools into Biology instruction through meaningful, interactive, and student-centered activities to sustain the high level of engagement demonstrated by the respondents. The university is likewise encouraged to strengthen access to reliable technological resources, internet connectivity, and appropriate digital learning platforms to support technology-enhanced instruction. Students should also be encouraged to develop digital literacy and responsible technology-use skills to maximize the benefits of technology in their academic learning. Since gender, preferred learning style, and monthly household income did not significantly predict engagement, future researchers are

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encouraged to examine other factors that may be associated with students' engagement, such as digital competence, motivation, technology self-efficacy, accessibility, instructional strategies, and teacher-related factors. Future studies may also involve larger and more diverse populations from different programs or institutions to provide broader evidence regarding students' engagement with technology tools in Biology learning.

Ethics declaration: The study adhered to ethical principles governing research involving human participants by ensuring that participation was voluntary and that respondents were properly informed about the purpose and nature of the study before completing the questionnaire. Informed consent was obtained from the participants, and they were informed of their right to decline participation or withdraw without penalty. The privacy and confidentiality of the respondents were maintained throughout the research process, with personal identifiers excluded from the collected data and the information used solely for academic and research purposes. Furthermore, the researchers maintained honesty, objectivity, and integrity in the collection, processing, analysis, and reporting of data by presenting the findings based on the actual results without fabrication, manipulation, or selective alteration.

Conflicts of Interest: The authors confirm that no conflicts of interest are associated with this study. No personal, institutional, or organizational affiliations were identified that could compromise the objectivity or influence the conduct and findings of the research.

Data Availability Statement: The data collected and analyzed in this study may be obtained from the corresponding author upon reasonable request, subject to applicable privacy and confidentiality requirements.

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