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Prospective Teachers' Perceptions of Using Information and Communication Technologies in Biology Education: Insights from Some Colleges of Teacher Education in Ethiopia

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ABSTRACT

The use of information and communication technologies (ICTs) for teaching and learning is widely acknowledged. However, there is limited research focusing on prospective teachers' (PTs) perceptions regarding its usage within specific subject areas, notably biology. This study is intended to explore PTs perceptions of using ICT in biology. Mixed-method approaches were used. Questionnaires and semi-structured interviews were used to collect data. The study subjects, 142 PTs, were selected using purposeful and stratified random sampling techniques. The result shows PTs had a positive perception of ICTs, with significant differences based on gender and ICT experience ($p < 0.05$). As a result, those with less ICT experience, along with females, tend to have a lower perception of ICT use, emphasizing the need for targeted support to bridge these gaps and empower them in ICT integration. The correlation analysis showed ICT usage is positively linked to PTs' perceived usefulness of ICT ($r = 0.48$) and their perceived ICT abilities ($r = 0.62$). Regression analysis revealed that 40.8% of PTs' ICT usage in biology is predicted by these factors, indicating a strong relationship. The study offers valuable insights for teacher education programs, emphasizing the need to enhance PTs' ICT skills and self-efficacy, which is critical for advancing educational goals in developing nations such as Ethiopia.

KEY WORDS: Biology; information and communication technologies integration; perception; personal characteristics; prospective teachers'

INTRODUCTION

The rapid development of science and cutting-edge technologies in the era of globalization has raised pressure on universities, businesses, governments, and students, and they are turning to ICT to provide modern solutions to modern challenges (Abaidoo and Arkorful, 2014). Integrating ICT into teaching and learning processes within educational institutions empowers both educators and learners. Furthermore, ICT is essential to the education sector because it helps pupils get ready to live in a culture that values information. It also acts as a catalyst for improvements in teaching methods, student outcomes, and educational quality (Alemu, 2015). As a result, there is a growing need for educational institutions to use ICTs to equip students with the knowledge and skills they require for their success in the digital age (Lawrence and Tar, 2018). In this situation, higher education is critical for strengthening lifetime learning processes and mirroring learning settings.

Although reports indicate that digital technology equipment and facilities have greatly increased in the education sectors of most African countries, they underutilize their ICT resources, and most teachers do not include ICT in their classes as required (Salam et al., 2018; Sutter and Kihara, 2019). The state of ICTs availability and access in Ethiopia's higher education institutions today is noteworthy. In fact, ICT is profoundly transforming every area of the country on a daily basis. It is fairly typical to see teachers using ICT these days for a variety of purposes. It follows that further research is necessary to address the other important problems raised by the fact that teachers and PTs are not utilizing ICTs in teaching and learning at the required level. Given their indisputable importance in the utilization of ICTs in any educational setting, their perceptions become a crucial factor to take into account.

According to research, teachers' perceptions about their own ICT competencies can have a substantial impact on their willingness and capacity to use technology effectively for teaching and learning, as well as predict their future performance (Rubach and Lazarides, 2021). Similarly, students' perception of the advantage of ICT in education and their confidence in using ICTs play a vital role in their motivation to use ICT (Hammond et al., 2009). Likewise, Halim and Sulaiman (2020) showed that students' perceptions of multimedia e-learning help to increase their performance and their ICTS usage.

Within the framework of teacher education programs in Ethiopia, there is a recognized need for PTs to possess

21st century competencies, including digital literacy and the ability to integrate indigenous knowledge and skills into education, aligning with work, life, and production demands. However, inherent ICT-related challenges persist within these programs, potentially contributing to inadequate ICT integration in lower-grade education (MOE, 2022). Despite positive advancements in curriculum and ICT infrastructure, both teacher educators' and PTs' ICT utilization in educational settings is still limited at the colleges of teacher education, according to those comprised in this study. Investigating ICT integration in biology education is critical for optimal use of technology and meeting the new curriculum objectives, which emphasize science and ICT as learning tools for developing creative and problem-solving skills in aspiring teachers.

Research on the use of ICT in Ethiopian education has been intense in secondary schools and universities, with little attention paid to colleges' educational perspectives and PTs. Furthermore, these studies concentrate on non-biological fields that contain complex and abstract notions. Since teacher education has faced an urgent need to boost the new teachers' capacity to implement new teaching methods and use ICT for the teaching-learning process, a more thorough study is needed to analyze prospective teachers' perceptions and their ICT utilization.

Given the foregoing background, this study is aimed at exploring PTs' perceptions of their own ICT abilities and perceived usefulness of ICT in relation to how they use ICT in their learning of Biology since no research has addressed the actual barriers associated with using ICT at the selected colleges of teacher education in Ethiopia in response to Ethiopia's renewed emphasis on ICT to enhance science education. Furthermore, considering the study's primary focus was on the PTs, assumptions were made about how their own personal characteristics (gender and ICT experience) would affect how they perceived use of ICT, based on the continuing literature debate on the subject (Buabeng-Andoh, 2020; Kobak and Ruya 2012; Wondemetegegn, 2017).

The specific research questions that this study intended to address were as follows:

1. What perceptions of the ICT-related variables (perceived usefulness and perceived abilities) do Biology PTs hold about using ICT in their learning?
2. Is there a statistically significant difference in perceptions of ICT use among PTs based on gender and ICT experience?
3. Is there a statistically significant correlation between Biology PTs' ICT use and their ICT perceptions?
4. To what extent do PTs' perceived usefulness of ICT and perceived ICT abilities predict their ICT usage in Biology?

LITERATURE REVIEW

ICT Usage in Teaching and Learning

The use of information and communication technologies (ICT) in teaching and learning has revolutionized education by offering a vast array of tools for information creation, sharing, storage, and communication (Yadav and Mehta, 2014). As educational institutions face diverse challenges, ICT emerges as a powerful solution, driving its widespread adoption in the sector (Wiseman et al., 2018). The integration of technology into curricula, aiming to enhance the teaching and learning experience, has evolved alongside advancements in hardware, software, and increased access to computers in schools (Juma, 2018). Globally, there is growing enthusiasm for incorporating ICT into education, although the opportunities and limitations vary across different contexts.

Higher education seeks to equip an increasing number of students with the skills and knowledge needed for lifelong learning, ensuring they are prepared for the demands of a networked economy. Graduates are expected to excel in creative and critical thinking, adapt to the fast-changing communications landscape, and apply advanced cognitive abilities (Vogel and Klassen, 2001). In countries such as Ethiopia, there are high expectations for the effective use of ICT in education. While ICT has the potential to significantly enhance teaching and learning in universities, its implementation often falls short in improving instructional strategies (Ergado, 2019).

Perceptions on ICT Use

Perception, as defined by Coles and Scior (2012), is the process by which individuals interpret and organize sensory information to understand their environment. This process is shaped by the perceiver's attitude, which can be either positive or negative. Teachers with a positive attitude toward technology are more likely to embrace changes in the field and integrate it into their teaching. In the context of this research, PTs' perceptions can be understood as the collective attitudes, behaviors, beliefs, and views that they hold regarding the use of ICT in education.

Numerous studies have explored the relationship between teachers' perceptions of ICT's usefulness and its integration into instruction, yielding mixed results. Gebremedhin and Fenta (2015) found a strong correlation between teachers' positive perceptions of ICT's potential to enhance course quality and their increased productivity when using it. However, Tusiime et al. (2020) identified teachers' negative attitudes as a key barrier to adopting ICT in classrooms. Similarly, Muia (2021) reported that many teachers view ICT integration as time-consuming and less suitable for examination-focused teaching. Overall, teachers' attitudes toward ICT use in the classroom were found to be only moderately positive.

Theoretical Frameworks

We applied a combination of the Diffusion of Innovation Theory (DOI; Rogers, 1983) and the Technology Acceptance Model (TAM; Davis, 1989) for this study. Diffusion is defined as "the process by which an innovation is communicated through certain channels over time among the members of a social system," with the goal of innovation diffusion theory being to explain how the public adopts new innovations

(Rogers, 1983). According to him, an innovation's perceived features influence its adoption. Among the five innovative traits identified, "compatibility" – the degree to which the innovation is perceived as consistent with past practices or experiences and the current values and needs of potential adopters – predicts how quickly innovations will be adopted. This theory is relevant to this study as it suggests that ICTs utilization in education is influenced by the specific conditions faced by teachers and students. Moreover, it was thought to explain how PTs perceive using ICT differently in their learning processes.

The perceived usefulness (PU) and perceived ease of use (PEOU) of technology are the two primary components of the TAM. PEOU, according to Davis (1989), refers to the specific components that might encourage individuals to make use of a discovery. While PU is the degree to which an individual feels that utilizing a system will enhance his or her job performance, studies have confirmed that these factors influence individuals' behavioral intentions and their actual utilization of a technology's (Al-Nuaimi and Al-Emran, 2021; Teo et al., 2019). Thus, we attempted in this study to ascertain whether the anticipated factors, including PTs' personal characteristics, had an impact on PTs' ICT perceptions by integrating the two aspects of the TAM with the DOI framework.

MATERIALS AND METHODS

Research Design

A mixed research approach with concurrent embedded design was used for this study for its suitability to examine perceptions (Creswell, 2014). Using this design, the study aimed to assess PTs' perceptions (perceived ICT usefulness and abilities), the correlation between their ICT perceptions and ICT usage, and investigate significant variations among the respondents in their ICT perceptions based on gender and prior ICT experience.

Sampling Techniques

The study was undertaken at three colleges of teacher education situated in two regional states Ethiopia: Arba Minch and Dilla (South Ethiopia Regional State), and Hosanna (Central Ethiopia Regional State), selected purposefully because of the assumption that the researcher's familiarity with the institutions could help the collection of accurate and in-depth data that gives a better picture of PTs in Biology education. Hence, 142 PTs of Biology who joined since 2022/2023 academic year based on the new teacher education curriculum of Ethiopia were chosen as the participants of this study using stratified random sampling techniques. The study also includes insights from six PTs (three females and three males) chosen based on their achievement across three colleges, providing valuable perspectives for the research. The demographic data shows a significant gender disparity, with 61% of participants being male and 49% female. Age distribution reveals that 48% are aged 18–21 and 52% are 22–25 years old. The participants have substantial prior ICT experience: 35% over 10 years and 32% with 6–10 years. Nevertheless, 33% of them are discovered to have fewer years of experience (1–5), which is still far lower than what is typically expected of students pursuing higher education nowadays.

Instrumentation

Semi-structured interviews and a questionnaire comprising two sections were used for the data collection. The first section of a questionnaire focused on demographic information. The second section consisted of five-point Likert scale questions to solicit information on PTs' perceptions of ICT and their ICT usage and was pilot-tested to ensure its reliability and validity.

Reliability of the Instrument

Internal consistency reliability, which is frequently expressed in terms of Cronbach's alpha, was calculated twice: once during the pilot project and again after the final data was gathered for the instrument. A Cronbach's alpha of 0.70.8 is adequate (Taber, 2018). Hence, the tests revealed internal consistency; the reliability coefficient alpha of all constructs (PTs' Perceived ICT Usefulness (PICTU), Perceived ICT Abilities (PICA), and Extent of ICT Use (EICTU)) is greater than 0.7 (Table 1), and it confirms the survey instrument is reliable.

Pilot Test

The survey was pilot tested on 18 biology PTs at Hawassa College of Teacher Education, which resulted in the rewording and elimination of some items from the survey. Once the face validity and content of the instruments were assessed, the exploratory factor analysis (EFA) statistical method was used to support the construct validity for its suitability to examine the construct validity of an instrument (Yu and Richardson, 2015). Thus, to reveal the factor structure, an EFA was conducted for each of the scales of the instrument that the investigators designed with the extraction technique of principal component analysis (PCA). Hence, the EFA of all the scales confirmed the factorial validity.

Data Gathering Procedures

A questionnaire was administered after obtaining approval from Hawassa University and based on permission granted by the respective sampled colleges. Following this, all subjects provided unambiguous verbal consent. The investigators provided participants with orientation regarding the nature and purpose of the instruments to ensure they felt comfortable. Subsequently, the researchers physically collected the completed questionnaires from each respondent. Afterward, we conducted six in-depth interviews, using a blend of general and specific questions to gather comprehensive insights. Each

Table 1: Internal consistency reliability for scale items

Variables	No of items	Cronbach's alpha (pilot study)	Cronbach's alpha (final study)
1. PICTU	7	0.85	0.82
2. PICTA	8	0.86	0.81
3. EICTU	7	0.83	0.86

session began with a general interview to collect background information about the participants. This was followed by targeted questions specifically exploring how they perceive the usefulness of and their own abilities regarding the use of ICTs and how their perceptions influence their actual use of ICT in their learning.

Here are a few samples of questions we asked: Would you like to share your experience with the use of ICT in your learning? Can you describe specific ways in which you believe ICT enhances your learning in Biology? What features of ICT do you find most beneficial? How confident do you feel in your ability to use various ICT tools for your Biology studies? Can you provide examples of situations where you felt either confident or challenged in using ICT? In what ways do you think your perceptions of ICT's usefulness and your own abilities influence your actual use of ICT in your learning processes?

Data Analysis

The data collected were used to establish the instrument's psychometric properties (factor structure, internal consistency reliability, and discriminant validity [PCA]) first. To examine PTs' ICT usage and their ICT perception sub-scales, descriptive statistics such as frequencies (F), percentages (%), means (M), and standard deviations (SD) were computed. One-way analysis of variance (ANOVA) was used with SPSS version 24 software to assess statistically significant differences in PTs' perceptions of ICT based on prior ICT use experience. An independent sample t-test was conducted to compare the average scores of male and female PTs regarding their perceptions of ICT usage. To analyze correlations between variables, Pearson product moment correlation was used. Moreover, to determine the extent of differences, effect sizes were calculated using eta squared ($\eta 2$).

Multiple linear regression analyses were also conducted to determine the explanatory power of the independent variables. Before the actual data analysis, the key assumptions on which multiple regression models rely were assessed. The scatter plot of residuals confirmed the linearity of the relationship between the dependent variable (EICTU) and the independent variables (PICTU and PICTA). The assessment of residual distribution using the Durbin-Watson statistic yielded a value close to 2, affirming the assumption of residual independence. In addition, the Shapiro–Wilk test for unstandardized residuals produced a statistic of 0.984 (df = 142, p = 0.108), consistent with the results for standardized residuals (S-W = 0.984, df = 142, p = 0.108), indicating normality in the distribution. This finding was further reinforced by the characteristic pattern observed in the P-P plot.

Multicollinearity was assessed using correlation analysis to evaluate the strength of the relationships between the independent variables. When the independent variables are significantly correlated (r = .9 or higher), multicollinearity emerges, indicating that the regression model is statistically unstable in terms of prediction (Pallant, 2020). The correlation in this study between the two independent variables (PICTU and PICTA) was r = .569, which is not a cause for concern. The tolerance and VIF values for the two variables were found to be 0.677 and 1.478, respectively. The results indicated no multicollinearity issues among the independent variables, as tolerance values exceeded 0.01 and VIF values remained below 10, both falling within acceptable limits (Tabachnick & Fidell, 2001).

Thematic analysis of the interview data was used to explore PTs' perceptions of ICT. To ensure confidentiality, each participant was assigned an anonymous code. The codes used were PT1-PT2 for prospective teachers. Following Braun and Clarke's (2012) six-step process, the analysis involved immersing in the data, generating initial codes, identifying and reviewing themes, and naming them, culminating in a comprehensive report. Although various qualitative data analysis software's are available, the textual data was manually coded using Microsoft Word's "comments" feature for a meticulous and hands-on approach. Verbatim transcriptions of the text data from the individual interviews were made, and a preliminary examination provided an overview. Codes were then determined based on research questions, leading to the creation of predefined core topics and subthemes.

To streamline the coding process, subthemes and code categories were distinguished using color-coding. Following the development of case descriptions, a cross-case thematic analysis was done to present the findings comprehensively. During this process, the authors reviewed the generated codes, identified areas of likeness, and combined them. Finally, the data are narrated, forming the basis for discussions, conclusions, and recommendations.

RESULTS

EFA Results of PTs' PICTU, PICTA, and EICTU Scales

The factorability of the seven PICTU items was examined. All the items correlated with at least one of the items on the scale, suggesting reasonable factorability. Then, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy is examined and found to be 0.758, which is above the recommended value of 0.5, and Bartlett's test of sphericity yielded significant correlations between items (χ^2 (21) = 94.562, p = 0.000). Given these overall indicators, EFA was conducted with all seven items.

Two sub-dimensions or factor structures, with Eigen values of 4.10 and 1.33 were identified for seven items on the PICTU scale. These two factors explained 77.7% of the total variance. Five items were loaded into one factor, and the remaining two were loaded into another. The factor load was determined to be the lowest (0.66). It was therefore determined whether the items contributed considerably to the factor, as factor loads of 0.40 or above are considered desirable (Field, 2009). Of the overall variance, the first factor accounted for 58.6% and the second for 19.07%. Overall, the factorial validity of the scale was validated by EFA.

The factorability of the eight PICTA items was confirmed, with a KMO value of 0.83 and significant BTS (χ^2 [28] = 53.772, p = 0.000), meeting factor analysis assumptions. The communalities were all above 0.5, with a minimum and maximum value of 0.50 and 0.83, respectively. The overall indicators revealed that the values were sufficiently large for factor analysis. The EFA revealed that the PICTA scale of PTs was composed of two factors with Eigen values of 4.21 and 1.08, which accounted for 66.3% of the total variance. Four items were loaded into one factor, while the rest were loaded into another. The first component accounted 52.7% of the overall variation, while the second contributed 13.5%. Thus, the EFA of PICTA validated the scale's factorial validity.

Similarly, the seven EICTU items showed reasonable factorability, with a KMO of 0.84 and significant BTS (χ^2 [21] =49.441, p = 0.000). Communalities exceeded 0.5, and EFA revealed two factors with Eigenvalues of 3.88 and 1.22, explaining 55.5% and 17.4% of the variance, respectively. All factor loadings were above 0.65, confirming the EICTU scale's factorial validity.

PTs' Perceptions of Using ICT in Biology

PTs' perceptions are of their perceived ICT usefulness and perceived ability in this study. Hence, we used a questionnaire with 15 items (five-point Likert-type questions). The results are presented in the tables below (Tables 2 and 3). The overall results of the sub-scale (PICTU) had a mean score of 3.61/ SD = 1.11. This indicated that respondents appeared to have a strong perception of the usefulness of ICT in learning. When this was analyzed in detail, it was discovered that the majority of the respondents scores ranged between agrees and strongly agrees. Especially with the statements on the usefulness of ICT as it enables them to understand biology concepts better, increases their interest in learning, and makes learning easy, accounting for 76, 74, and 73.2%, respectively. However, as compared to the other groups, fewer participants agreed (56, 54, and 46.5%) on the statements "ICT helps to engage in practical learning," "Saves time in learning," and "It makes me effective in learning," respectively.

Conversely, though, a relatively significant portion of respondents disagree that ICT makes them more effective in their learning (M = 3.20, SD = 1.16). Similarly, notable percentages of both "strongly disagree" and "disagree" responses were received for the "ICT saves time in my learning" item (M = 3.34, SD = 1.27). Compared with other items, respondents agreed less with ICT in enhancing teacher and student interaction (M = 3.57, SD = 1.15).

Similarly, PTs were asked to answer eight items about their confidence in their capacity to use various ICT tools in their educational practices. As shown in Table 3, the overall mean of PTs' PICTA scale was 3.30 (SD = 1.12). This shows that they perceive that they can use the ICT tools mentioned. On the scale's individual items, we see that the mean scores range from 2.80 to 3.70. The highest item mean (M = 3.70), with

Table 2: Descriptive statistics of PTs' PICTU (n=142)

Items	%						
	SD	D	U	A	SA	M	SD
ICT enables students to understand Biology better.	6.3	7	10.6	54.2	21.8	3.76	1.06
ICT makes learning easy.	2.8	11.3	12.7	38	35.2	3.92	1.08
ICT increases my interest in learning.	2.8	7.7	15.5	43	31	3.92	1.01
ICT helps to engage in practical learning.	2.8	15.5	24.6	39.4	17.6	3.54	1.04
ICT saves time in teaching and learning.	14	9.9	21.1	38	16.9	3.34	1.27
ICT makes me more effective in my learning.	10	16.2	26.8	35.2	11.3	3.20	1.16
ICT enhances teacher and student interaction.	7	11.3	20.4	40.1	21.1	3.57	1.15
Grand mean						3.61	1.11

SD: Strongly disagree, D: Disagree, U: Undecided, A: Agree, SA: Strongly agree

Table 3: Descriptive statistics of PTs' PICTA (n=142)

Items	%						
	SD	D	U	A	SA	M	SD
I feel confident in my ICT ability for my learning using;							
Ms. Word to do my assignment	5.6	9.2	20.4	50	14.8	3.59	1.03
Spreadsheet processor (such as Excel)	8.5	16.2	32.4	36.6	6.3	3.16	1.04
Microsoft PowerPoint for presentations	11.3	19	28.2	33.1	8.4	3.08	1.14
Data base processor (access program)	13.4	30.3	27.5	21.1	7.7	2.80	1.15
Subject-specific software	14.1	20.4	21.8	33.8	9.9	3.05	1.22
Search engines (Internet)	4.2	16.2	16.9	40.1	21.8	3.60	1.12
Android apps (dictionaries, etc.)	7	14.8	21.8	38.7	17.6	3.45	1.15
		12.7	14.1	40.8	26.8	3.70	1.16
Grand mean	5.6					3.30	1.12

67.6% of participants agreeing with the statement, "I feel confident in my ability to use social media platforms," Most participants (61.9%) agreed on their ability to use search engines (M = 3.60). The third-highest item got a mean score of 3.59, indicating that respondents highly agreed with feeling competent when using Ms. Word (SD = 1.03), which shows that there is less variability than in the other items.

The next highest item means was 3.45, indicating that around 56% of the participating PTs agreed that they felt comfortable utilizing Android apps. In contrast, only 43.7% of them reported feeling proficient with subject-specific software, and 28.8% reported feeling confident using database processors. Thus, four items had mean scores that were lower than the grand mean, indicating that respondents rated them lower than the average. Overall, PTs' assessments of ICT perceptions ranged between 2.8 and 3.92. This demonstrates moderate to strong agreement among them, according to Hue and Jalil's (2013) mean group determination to rate the extent of agreement.

PTs' Perceptions of the Use of ICT Based on Gender

An independent samples t-test was conducted to examine differences in perceptions of ICT usage between male and female prospective PTs. The results (Table 4) indicated that male PTs had a mean perception score of 3.37 (SD = 0.69), compared to a mean score of 3.11 (SD = 0.71) for female PTs. This suggests that male prospective teachers generally have a more favorable perception of ICT usage than their female counterparts. The t-test yielded a t-value of (140) = 2.21, $p < 0.05$, indicating that the difference in perceptions is statistically significant and unlikely to be due to random chance. The effect size, calculated using eta squared, was 0.37, which falls within the range of small to moderate effect sizes. This suggests that while the difference is statistically significant, its practical significance is limited. An effect size of 0.37 implies that the difference in perceptions is noticeable but may not be substantial enough to have major implications for educational practices or policies.

PTs' Perceptions of ICT Based on Experience in ICT Use

Participants were categorized into three groups based on how long they had used ICT. Then a one-way ANOVA was performed to investigate the impact of PTs' prior experience on their perceptions of ICT use. The result revealed a statistically significant difference in perceptions among the three groups of PTs ($F(2, 141) = 9.28$, $p < 0.05$). This indicates that at least one group differed significantly from the others in terms of how they perceive the role of ICT in their learning. While the difference is statistically significant, it was not substantially large, as the effect size calculated using eta squared was 0.11, suggesting a small to moderate effect.

Subsequent to scrutinizing the ANOVA test, a post hoc examination of the F-test was conducted to pinpoint the groups between which the differences seemed significant. Hence, significantly different results ($p < 0.05$) were observed in the years of experience with ICT use among PTs with 1–5 years of experience (M = 2.93, SD = 0.655), both of those with (6–10) years (M = 3.38), and over 10 years (M = 3.49, SD = 0.698) (Table 5). These findings suggest that PTs with less experience tend to have a less favorable ICT perception in their biology learning process.

Relationship between PTs' Perceptions (PICTU and PICTA) and their ICT Usage

The correlation analysis findings (Table 6) indicate robust positive associations between PTs' ICT usage and their perceived usefulness of ICT ($r = 0.480$, $p < 0.01$), as well as their perceived ability to use ICT ($r = 0.628$, $p < 0.01$). These results suggest that PTs perceive ICT to be more beneficial in their learning. This may tend to be employed more extensively in their educational practices.

Contribution of Independent Variables in Using of ICT in Biology Learning

After establishing the relationship between the dependent and independent variables, a linear multiple regression analysis was undertaken to determine the predictive power of independent

Table 4: PT' ICT perceptions based on gender

Scale	Sex	N	Mean	SD	df	t	Sig. (2-tailed)	Effect size value
Perceptions	Male	86	3.37	0.69	140	2.21	0.029	0.37
	Female	56	3.11	0.71				

Table 5: *Post hoc* test on perception scale based on PTs' ICT experience

(I) Experience	(J) Experience	Mean difference	Std. error	Sig	95% confidence interval	
					Lower bound	Upper bound
1–5	6–10	−0.4550681*	0.139564	0.004	−0.78570	−0.12442
	>10	−0.5595807*	0.137388	0.000	−0.88506	−0.234095
6–10	1–5	0.4550681*	0.139564	0.004	0.12442	0.785709
	>10	−0.1045126	0.138148	0.730	−0.43179	0.222774
>10	1–5	0.5595807*	0.137388	0.000	0.23409	0.885066
	6–10	0.1045126	0.138148	0.730	−0.22277	0.431799

*Mean difference is significant at the 0.05 level.

variables in influencing how much ICT is used in educational practices among prospective teachers (Table 7).

The analysis yielded R square and adjusted R square values of 0.416 and 0.408, respectively. The adjusted R square suggests that the combined variables explain 48.8 percent of the variance in ICT usage among prospective teachers, confirming the model's significance ($F2, 141 = 49.6$; $p < 0.05$). PICTU's coefficient of standardized regression (β) is 0.181, while PICTA's ($\beta = 0.525$, $p = 0.001$) strongly predicts the ICT usage of PTs. This suggests that both variables play a role in explaining variations in ICT usage among PTs. Notably, PICTA demonstrated a higher unique contribution to explaining ICT usage.

Results from Interview

The interviews revealed rich qualitative insights that reinforced the survey findings, shedding light on how biology PTs perceive both the PICTU and PICTAs in using them. These were shown to significantly shape their actual use of ICT. Hence, the interview transcripts were organized into three major themes in this study: perceived usefulness, self-assessment of abilities, and impacts of PTs' perceptions on their ICT utilization. These themes provide a framework for understanding the participants' perspectives, which are explored in detail narratively as follows (PT refers to participants):

PTs' perceived usefulness of ICTs

An overwhelming majority (over 83%) of interviewees acknowledge the significant value of ICT in enhancing their educational outcomes. Participants emphasized that ICT provides a vast array of information through the internet. This accessibility allows them to deepen their understanding of complex biological concepts and processes. Participants also reported that tools such as simulations and interactive diagrams significantly enhance their comprehension of intricate topics, such as photosynthesis. For instance, one participant noted: *ICT provides a wealth of information via the internet. The current rise in social media is influencing education. ICT tools like simulations and interactive diagrams help me visualize complex processes like photosynthesis that I have difficulty understanding in class. So, it makes learning easy and interesting for me." (PT5)*

Participants expressed appreciation for the variety of instructional materials that ICT offers. The flexibility to explore different strategies and resources tailored to their individual learning needs was highlighted. One participant further explained: *"ICT enables us to explore different instructional materials and strategies to fulfill our needs. For example, visual and simulation tools provide realistic approaches to how experiments should be conducted…Overall, it has a favorable impact on learning and is of great interest to me." (PT3)*

Although most interviewees recognize the benefits of ICT, some participants express a sense of being overwhelmed and a preference for traditional learning approaches, reflecting a notable divide in attitudes toward its effectiveness. One participant articulated this sentiment, stating:

"The sheer volume of information online feels overwhelming, making me hesitant to engage with digital tools. I find traditional methods, such as reading modules and teacher handouts, to be more straightforward and manageable for me." (PT1)

Self-assessment of abilities

The response provided by participants highlights varying levels of confidence in utilizing ICT tools for biology studies, emphasizing a blend of strengths in basic tools and challenges with more specialized applications. Most participants demonstrate a solid foundation in essential ICT tools commonly used for academic purposes, such as document creation, presentation preparation, and basic online research. However, they also recognize the need to improve their proficiency in more advanced tools to further enhance their skills.

One participant (PT5) stated, *"I feel pretty confident using various ICT tools for my biology studies, especially with basic*

Table 6: Pearson's product moment correlation between variables and ICT usage

Variables	Extent of ICT use	Perceived usefulness of ICT	Perceived ability of ICT
Extent of ICT use			
Pearson correlation	1		
Sig. (2-tailed)			
N	142		
Perceived usefulness of ICT			
Pearson correlation	0.480**	1	
Sig. (2-tailed)	0.000		
N	142	142	
Perceived ability of ICT			
Pearson correlation	0.628**	0.569**	1
Sig. (2-tailed)	0.000	0.000	
N	142	142	142

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

Table 7: Multiple regression analysis predicting ICT usage from PTs' PICTU and PICTA

Model	Dependent variables	Independent variables	R square	Adj. R square	Unstandardized coefficients		Standardized coefficient	T value	Sig.
					B	SE	Beta		
1	Extent of ICT use	PICTU	0.416	0.408	0.244	0.106	0.181	2.30	0.023
		PICTA		0.793	0.646	0.097	0.525	6.66	0.000

applications like MS Word, search engines, and Microsoft PowerPoint. However, I also acknowledge that I have room to improve when it comes to more complex software, like data analysis programs."

Similarly, another participant (PT2) shared, *"I often struggle with advanced tools like data analysis programs, subject-specific software, online databases, and research tools, and I feel lost without guidance."* This response underscores significant challenges faced by some learners when engaging with specialized software and research-oriented ICT tools.

Impact of PTs' perceptions on ICT use

Participants highlighted how PICTU and PICTA influence their EICTU in their learning processes of biology and how these perceptions affect their engagement with the material.

PT3 noted, "I see ICT as vital for understanding biology, which motivates me to explore resources like search engines and educational platforms. My confidence in using tools like MS Word and PowerPoint allows me to express my ideas clearly, enhancing my participation in discussions.... Simulations helped me visualize complex topics like cellular respiration. Overall, my positive outlook on ICT encourages me to use these tools actively, enriching my learning experience."

"Personally, I'm not very experienced with ICT. I often feel that ICT tools are too complex, which discourages me from using them. My limited confidence in advanced software makes me hesitant to explore new resources. As a result, I might miss out on valuable information and opportunities for deeper engagement with the material." (PT6)

DISCUSSION

Despite the increasing emphasis on ICT integration in Ethiopian teacher education colleges, significant limitations persist (MOE, 2022). This study delves into the perceptions of biology PTs (their PICTU and PICTA) in using ICTs. It also examines how these perceptions influence their actual engagement with ICT in their learning. Moreover, the study investigates how individual characteristics shape their perceptions toward incorporating ICT into their educational experiences.

The result of this study indicated that PTs generally hold a strong positive perception of ICT's usefulness in learning. A positive perception of ICT's usefulness among PTs carries significant implications for their professional growth and the future of education. It encourages them to integrate ICT tools into their teaching, driving classroom innovation and fostering dynamic, engaging learning environments. As technology becomes central to education, PTs who value its potential are better prepared to adapt and thrive in the evolving landscape. This mindset not only enhances their teaching skills but also promotes lifelong learning and adaptability. Davis's (1989) Technology Acceptance Model reinforces this, highlighting perceived usefulness as a key factor in technology adoption. Halim and Sulaiman (2020) similarly found that students widely acknowledge the potential of digital tools to enhance learning outcomes, reinforcing this perspective. Other previous studies also highlighted the role of positive perception of ICT on one's ICT usage in education (Buabeng-Andoh, 2020; Francisca and Samsudin 2018; Kobak and Taskin 2012).

The findings of this study reveal that while the majority of PTs hold a positive view of ICT's role in enhancing biology learning, there remain notable gaps in their skills. Many still require support, even in foundational ICT areas, to fully develop their capabilities in specific domains, implying the gap between their perception of ICT and their actual proficiency. This discrepancy has been noted in other studies as well. Tondeur et al. (2018) revealed that while preservice teachers expressed positive outlooks towards ICT, many lacked the necessary skills to implement it effectively in classrooms.

The independent sample t-test results indicate the mean scores of male and female PTs were statistically significant. Although females did not have negative perceptions, they had lower expectations for ICT. A complex interplay of contexts in Ethiopian teacher education colleges may contribute to this. Many female PTs in Ethiopia, particularly from rural areas, face limited access to modern technologies, leading to lower familiarity and confidence with ICT. A lack of personal devices such as smartphones further hampers their engagement and reinforces the perception that technology is less accessible or relevant in their education. These challenges are compounded by inadequate ICT resources and access within teacher education colleges, where limited exposure to quality training often lowers females' self-efficacy and perceptions of ICT's importance. Such systemic barriers create a significant disparity in ICT expectations compared to their male counterparts.

This study's findings confirm those of Kubiatko et al. (2012), who discovered that males perceive ICT in Biology more positively than females. Also, this finding is congruent with that of Siva Sankar (2015), who discovered that male PTs had a more positive perception of instructional technology than their counterparts. In contrast, a study by Wondemetegegn (2017) found no significant difference in perceptions regarding gender. Hence, this study result suggests that teacher education institutes should regularly assess females' performance with ICT use and implement suitable interventions to help them increase their abilities and confidence.

A one-way ANOVA analysis revealed a significant difference in PTs' perceptions of ICT use based on their prior experience. PTs with more extensive ICT experience tended to have a more positive outlook on its role in their learning. This is consistent with the Padmavathi (2016) study, which indicates a positive correlation between the computer experience of student–teachers' and their computer view. Similarly, Al-Busaidi (2012) discovered that long-term use of ICT impacts a student's impression of its usefulness. These findings underscore the more technology exposure a student gets; the easier it is for the student to apply it and its importance in building confidence

and competence. Likewise, Gialamas et al. (2013) discovered that the more students used the internet, the more positively they perceived it.

The finding from correlation analysis further confirms significant positive associations between PTs' EICTU, PICTU, and PICTA. This indicates that PTs are more inclined to incorporate ICT into their learning when they perceive it as more useful and become confident in ICT. This finding resonates with earlier research emphasizing the influence of students' positive perceptions toward technology on their use of ICT (Teo, 2008; Padmavathi, 2016). Similarly, Francisca and Samsudin (2018) uncovered a strong connection between biology preservice teachers' perceptions, their ICT usage, and confidence levels. Supporting this, Katakara et al. (2024) identified a significant positive relationship between student teachers' perceptions and their use of ICT tools.

The regression analysis demonstrated that both PICTU and PICTA had a significant role in explaining variations in ICT usage among PTs in biology. Notably, PICTA emerged as the stronger predictor, underscoring the pivotal role of PTs' confidence in their ICT skills in shaping their integration practices. This study finding is in line with prior research, which indicates that one's perceived ICT ability and attitude toward ICTs in education have a considerable influence on one's readiness to employ technology in future teaching practices (So et al., 2012). Likewise, perceived usefulness has been identified as a strong determinant of preservice teachers' intentions to adopt ICT, as observed by (Baydas and Goktas, 2017).

CONCLUSION

According to the findings of this study, PTs have an overall positive perception of the usefulness of ICT in biology education. Quantitative analyses reveal significant differences between perceptions of ICT use among PTs based on gender and ICT experience. Males and PTs with greater ICT experience tend to view the integration of ICT in biology education more favorably than their peers with less experience. The correlation analysis results confirm substantial positive relationships between PTs' EICTU, PICTU, and PICTA. In addition, regression analysis revealed that both PICTU and PICTA had a big effect on the different ways biology PTs used ICT, with PICTA being the better predictor.

Qualitative insights revealed that the majority of PTs recognized the transformative role of ICT in enriching their educational experiences. They emphasized its capacity to provide extensive access to online resources, fostering a deeper understanding of complex biological concepts and facilitating the exploration of diverse strategies and personalized learning resources tailored to individual needs. However, the responses also highlighted varying levels of confidence in using ICT tools, with strengths in basic applications but challenges in more specialized applications, leading to the underutilization of ICTs that could enhance learning. Furthermore, a positive outlook on ICT was shown to motivate active use of these tools, enriching the overall learning experience. Overall, the study's findings imply that PTs' perceptions are an important factor in determining ICT integration. This, in turn, is essential for achieving quality education goals, particularly in developing countries like Ethiopia.

In light of these conclusions, we recommend that teacher education colleges should place greater focus on the integration of ICT, working to bridge the gaps in PTs' skills. This is essential to ensure that future educators are not only confident in using technology but also equipped to harness it effectively in their teaching practices. Special attention should be given to female PTs and those from rural areas or with limited ICT exposure, addressing the gender and experience disparities. By providing targeted training and support, they can be empowered to integrate ICT seamlessly into their teaching, fostering an inclusive and technology-driven educational environment. Moreover, teacher education colleges should ensure access to ICT and resources, enabling PTs to gain valuable hands-on experience. In addition, they should implement a system for regular feedback from PTs regarding their ICT training experiences, facilitating ongoing enhancements in the integration process.

Study Limitations and Future Directions

This study was limited to biology education and PTs from three teacher education colleges in Ethiopia. The relatively small sample size may reduce the statistical power and generalizability of the findings, as participants were drawn from a specific demographic and geographic area. A larger, more diverse sample would provide more robust data and strengthen the validity of the conclusions. Therefore, future research should involve a broader range of colleges and PTs, not only in biology but across other fields, to gain a more comprehensive understanding of perception-related factors in ICT integration. In addition, while gender and prior ICT experience were considered in this study, other demographic factors should be explored in future research.

Ethical Statement

Authors declared that the study was approved by the official Research Ethics Review Committee (RERC) at Hawassa University, Ethiopia (RERC reference: CNCS-REC010/24).

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