

Exploring the Significance of Classroom Technology Integration on the Digital Competency of STEM Teachers and Student Engagement

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Abstract:- The study aimed to explore the importance of classroom technology integration to teachers' digital competency and student engagement. This study also assessed the significant relationship among these variables. There were 25 teacher-participants who were purposely selected in the Batanes National Science High School, Basco, Batanes. Furthermore, the study used adopted survey questionnaires from previous studies (Siripan & Noirid, 2022; Handlesman et al., 2005; Nasir et al., 2020; Abrami et al., retrieved 2023). The survey questionnaire consisted of 35 items for teachers' digital competency, 23 items for student engagement, and 61 items for classroom technology integration. The participants displayed a notable level of consensus and consistent confidence in their proficiency with various tools and media. However, it also perceived a lower level of digital competency in implementing comprehensive digital solutions, introducing a noteworthy discrepancy in participants' confidence between specific tools/media and broader digital strategies. There was a significant relationship between student engagement and the perceived importance of technology integration, revealing teachers' acknowledgment of a meaningful connection. Conversely, the absence of a statistically significant relationship between teachers' digital competence and the importance of technology integration suggests limited influence of digital skills proficiency on their overall assessment of its significance in instructional practices.

Keywords:- Digital Competency, Student Engagement, Class Technology Integration, Descriptive-Correlational Research Design, Batanes, Philippines.

I. INTRODUCTION

It has been observed through the years that the integration of emerging technologies in K-12 education has become an important aspect of teaching – learning process due to the fast-paced evolution of technology and its impact on modern-day society. In the Philippines, the Department of Education has launched different initiatives to incorporate technology in the curriculum to assess the impact of this integration on knowledge and skills acquisition of our high school learners. The research aims to identify the extent of the emerging impact of technologies used, the outcomes of technology integration,

and the factors that influence their effectiveness. among the motivation, self-concept, and academic performance of the basic education students. Results showed that self-concept and academic performance were significantly correlated.

II. RESEARCH QUESTIONS

➤ Research Questions

This study is important in helping educators and policy makers make informed decisions on how to effectively integrate technology in K-12 education, more particularly the secondary level to improve student learning outcomes.

➤ Research questions:

- What is the impact of emerging technology integration on teachers digital competence and student engagement?

➤ Objectives:

- To identify the types of emerging technologies used by teachers to improve digital competence in the Philippines.
- To assess the impact of emerging technology integration on student engagement.
- To identify gaps in the current research on the impact of emerging technology integration on knowledge and skills acquisition of K-12 students in Batanes.
- To provide recommendations for effective integration of emerging technologies on teachers' digital competence and student engagement.

III. LITERATURE REVIEW

To identify relevant studies, a comprehensive search was conducted in electronic databases including Google Scholar, ERIC, and Education Source using the following keywords: "emerging technology integration", "K-12 education", "Philippines", "student learning outcomes", "knowledge acquisition", and "skills acquisition". The search was practically limited to studies published from 2010 to 2022. In addition to electronic databases, relevant studies were also identified through a manual search of the reference lists of selected articles. Scholars like Kahu and Nelson (2017) and Zhoc et al. (2019) affirmed the significant impact of student engagement on academic success, cognitive development, and overall educational quality. The study's emphasis on the importance of applied engagement resonated with the broader

consensus that active involvement in academic-oriented activities is a fundamental criterion for assessing learners' engagement, as highlighted by Zhoc et al. (2019).

SCALE	SCALE RANGE	VERBAL DESCRIPTION	VERBAL INTERPRETATION
5	4.21-5.00	Very characteristic (VC) of me	Highest level of student engagement
4	3.41-4.20	Characteristic (C) of me	High level of student engagement
3	2.61-3.40	Moderately characteristic (MC) of me	Moderate level of student engagement
2	1.81-2.60	Not really characteristic (NR) of me	Low level of student engagement
1	1.00-1.80	Not at all characteristic (NA) of me	Lowest level of student engagement

The literature stressed that the presence of digital technology alone did not guarantee improved academic performance; effective integration with pedagogy was crucial

(Bond et al., 2019). This study aligned with the study's discovery that the "applied engagement" indicator, representing active technology application in learning, had the highest mean. Bond et al. (2020) and Zhoc et al. (2019) underscored the growing emphasis on aligning learning technology with student engagement for improved teaching methods and superior results, reinforcing the study's relevance.

IV. RESEARCH METHODOLOGY

The researcher will adopt a quantitative research approach, specifically employing the descriptive-correlational research design. This research type will be geared towards providing a detailed account of variables and the inherent relationships among them, utilizing surveys and observations to systematically characterize a phenomenon, situation, or population through comprehensive description. According to Bhandari (2020), quantitative research involved the collection and analysis of data organized to facilitate statistical analysis, enabling the acquisition of measurable data by establishing connections between variables.

Furthermore, the descriptive-correlational design is instrumental in accurately and systematically describing a population, circumstance, or phenomenon, addressing questions related to what, where, when, and how, though not delving into the realm of why questions (McCombes, 2019). This method allows for the study of one or more variables within a broad spectrum of research approaches. This method will be used to describe the frequency of the participants and the descriptive data of all the underlying variables of teachers' digital competence, student engagement, and technology integration. Cherry (2023) outlines a correlational study as a research design wherein researchers explore the relationship

between two or more variables. In addition, Predictive correlational research, on the other hand, aims to identify and understand relationships between variables with the specific goal of making predictions about future outcomes (Johnson & Williams, 2018). This seeks to determine the extent to which one variable can be used to forecast another. So, this study employs correlational design to find out if there is a link between the level of teacher' digital competence and student engagement and their level of importance of technology integration in the classroom.

➤ *Participants*

This study will be conducted in Batanes National Science High School in Batanes where the researcher is currently affiliated. There will be twenty-five (25) selected teachers in the school which is proportionally allocated among Junior High School STEM Teachers. The participants are purposely selected based on the inclusion criteria set by the researcher. These inclusion criteria include teachers who have at least three years teaching experiences, currently teaching and handling Junior High School STEM students, and have acquired appropriate seminar, trainings, and workshops on classroom technology integration. Moreover, the study will be conducted within the academic year 2023-2024.

➤ *Instruments of the Study*

The study will utilize an adopted survey questionnaire from various studies (Siripan & Noirid, 2022; Handlesman et al., 2005; Nasir et al., 2020; Abrami et al., retrieve 2023). This survey questionnaire is composed of four parts. In part one, it encompasses the key elements, such as the informed consent, a confidentiality statement, and a demographic profile capturing details like name, age, gender, years of teaching experience, and the type of equipment available for use. Primarily, this aimed to discern and document the distribution of participants, thereby creating a comprehensive profile. The second part includes items on the teachers' digital competence. It consists of 35 items for four indicators; nine (9) items for the digital cognitive component, eight (8) items in terms of digital use of tools and media, nine (9) items for digital solutions or the problem-solving elements, and nine (9) items digital adaptation and transformation (Siripan & Noirid, 2022).

This part was measured based on the scaling parameters below: This part will be measured based on the scaling parameters below:

Scale	Scale range	Description	Interpretation
5	4.21-5.00	Strongly agree	Highest level of digital competency
4	3.41-4.20	Agree	High level of digital competency
3	2.61-3.40	Neither agree or disagree	Medium level of digital competency

2	1.81-2.60	Disagree	Low level of digital competency
1	1.00-1.80	Strongly disagree	Lowest level of digital competency

SCALE AND INTERPRETATION FOR USES OF TECHNOLOGY			
SCALE	SCALE RANGE	VERBAL DESCRIPTION	VERBAL INTERPRETATION
5	4.21-5.00	Strongly agree	Highly important
4	3.41-4.20	Agree	Important
3	2.61-3.40	Neither agree or disagree	Moderately important
2	1.81-2.60	Disagree	Somewhat important
1	1.00-1.80	Strongly disagree	Not important at all

The third part comprises statements concerning the student engagement, focusing on four elements: applied engagement, goal-oriented engagement, self-disciplined engagement, and interactive engagement. There are four (4) items for applied engagement, seven (7) items for goal-oriented engagement, six (6) items for self-disciplined engagement, and six (6) items for interactive engagement (Handlesman et al., 2005; Nasir et al., 2020). This section utilizes specific scaling parameters for its analysis and interpretation. Finally, the last part involves statements on technology integration in relation to its uses and process of integration. There will be a total of 61 items where 33 of which are items for the use of technology in the classroom while 28 of the items are intended for the process of integration (Abrami et al., retrieved 2023). This section uses the scale parameters below:

SCALE AND INTERPRETATION FOR PROCESS OF INTEGRATION			
SCALE	SCALE RANGE	VERBAL DESCRIPTION	VERBAL INTERPRETATION
5	4.21-5.00	Always	Highly important
4	3.41-4.20	Often	Important
3	2.61-3.40	Sometimes	Moderately important
2	1.81-2.60	Once in a while	Somewhat important
1	1.00-1.80	Never	Not important at all

➤ *Procedure*

The researcher seeks approval from the school principal of Batanes National Science High School. Following the approval, the researcher will identify the participants of the

study and obtain the necessary consent from them. It is also requested that every respondent sign an informed consent form as part of the usual ethical procedure. Then, the distribution of the survey questionnaire will commence after. Subsequently, all the data gathered will undergo data analysis and interpretation. The researcher will use various statistical analysis and method to obtain the desired results based on the objectives of the study.

➤ *Ethical Considerations*

The researcher ensures that the study survey and interview will be carried out in accordance with high standards to safeguard the participants' interests, rights, welfare, and dignity throughout the course of the research. They have full confidence that they will not come to any mental or physical damage because there is no chance of such happening. Participants are not pressured or misled in any way in order to take part in the research, which had the only purpose of filling a knowledge void in the educational area for the benefit of education as the overarching goal of the investigation.

V. RESULTS AND DISCUSSION

Based on the gathered responses, the frequency distribution of the respondents in terms of age, gender, years of teaching experience, and type of equipment available for use was shown in Table 1.

The study revealed that most of the participants were 20-30 years old, with 9 (36.0%). Meanwhile, the age group of 31-40 had the lowest frequency, with f=4 (16.0%). The age distribution suggested a predominantly youthful cohort, which might have had implications for the study's generalizability, as younger individuals could have possessed different technological experiences and preferences compared to their older counterparts. In terms of gender, most of the participants were female, with f=18 (72.0%). This gender skew prompted considerations about how gender dynamics might have influenced attitudes and engagement with technology in the classroom.

Table 1 Demographic Profile of the Participants

Profile	Frequency	Percent
Age		
20-30	9	36.0
31-40	4	16.0
41-50	6	24.0
Above 50	6	24.0
Gender		
Male	7	28.0
Female	18	72.0
Years of Teaching		
3-6	8	32.0
7-9	4	16.0
More than 10	13	52.0

Type of equipment		
Laptop	8	32.0
Tablet	3	12.0
Smartphone	5	20.0
Desktop	2	8.0
Smartphones and laptop	7	28.0

Likewise, most of the participants, with a frequency of 13 (52.0%), had more than 10 years of teaching experience. This suggested that a significant portion of the study's participants brought extensive classroom experience to the exploration of technology integration and digital competency. On the other hand, most of the participants used their laptop in teaching (f=8, 32.0%). Some of them had both smartphones and a laptop (f=7, 28.0%). Meanwhile, two (8.0%) of them made use of their desktops.

➤ *Level of digital competence*

Table 2 presented the four (4) indicators that measured the level of digital competence as perceived by the school teachers. These included digital cognitive competence, digital use of tools and media, digital solutions, and digital transformation and adaptation.

Table 2 Level of Digital Competence

Indicators	Mean	Std. Deviation	Interpretation
Digital Cognitive Competent	4.27	.53	Highest level
Digital Use of Tools and Media	4.40	.53	Highest level
Digital Solutions	4.18	.59	High level
Digital Transformation and Adaptation	4.24	.58	Highest level

Among the four indicators, the findings showed that the highest mean of 4.40 (SD=0.53) was associated with the "digital use of tools and media." This indicated that the participants perceived themselves to have the highest level of digital competency in utilizing various tools and media in their teaching practices. The relatively low standard deviation (SD) suggested a certain degree of consensus among the participants regarding their proficiency in this aspect, indicating a consistent perception of high competence.

On the contrary, despite the participants acknowledging the importance of digital solutions, the indicator related to "digital solutions" had the lowest mean of 4.18 (SD=0.59). This was an intriguing finding as it suggested a perceived lower level of digital competency in implementing comprehensive digital solutions. The discrepancy between the high mean for the digital use of tools and media and the lower mean for digital solutions may have indicated that while teachers felt confident using specific tools and media, they might have been less assured in deploying broader digital solutions or strategies. This could have been attributed to factors such as the complexity of integrating comprehensive

digital solutions into teaching practices or perhaps a need for further professional development in this specific aspect. Based on the findings, aligned with existing literature on digital competence for teachers, scholars such as Duran (2019) and Castañeda et al. (2018) emphasized that digital competence involves a holistic set of knowledge, skills, and attitudes essential for effective ICT use in education. This encompassed didactic and technological knowledge for integrating digital technologies into educational practices. The results aligned with this literature by showing a consistent perception of high competence among participants in utilizing specific tools and media. The emphasis on didactic and technological knowledge corresponded to the higher mean observed for the "digital use of tools and media." Teachers may have felt more proficient in employing specific tools, reflecting their competence in integrating these technologies into their teaching practices.

On the other hand, the lower mean for "digital solutions" in the study suggested that teachers may have perceived a lower level of competence when it came to implementing comprehensive digital solutions. This discrepancy aligned with the literature's emphasis on the holistic nature of digital competence, which includes broader skills, attitudes, and knowledge required to support student learning in a digital world. The challenges highlighted in the literature, such as those noted by Trust and Whalen (2020), regarding teachers' difficulties in adapting to online teaching strategies, especially during events like the pandemic, may have contributed to this perceived lower competence in deploying broader digital solutions. Moreover, the literature also accentuated the importance of models and frameworks to guide digital competence in teachers. The "European Framework for Digital Competence of Teachers: DigCompEdu" and the "Information and Communication Technology Standards for Teachers" by ISTE, as mentioned by Caena & Redecker (2019) and Lu et al. (2021), provided guidelines for the digital competencies' teachers should possess. The study results, highlighting a perceived lower competence in broader digital solutions, may have pointed to the challenges in aligning teacher competence with these comprehensive frameworks.

➤ *Level of student engagement*

In Table 3, the level of student engagement in terms of applied engagement, goal-oriented, self-disciplined engagement, and interactive engagement was measured and indicated.

Table 3. Level of Student Engagement

Indicators	Mean	Std. Deviation	Interpretation
Applied Engagement	4.04	.69	High level
Goal-oriented	3.76	.64	High level
Self-disciplined Engagement	3.99	1.73	High level
Interactive Engagement	3.95	.70	High level

Notably, the indicator "applied engagement" stood out with the highest mean of 4.04 (SD=0.69), reflecting a consensus among teachers that students exhibited a high level of engagement when actively applying technology in their

learning experiences. The relatively low standard deviation suggested that teachers generally agreed on the effectiveness of applied engagement strategies, indicating a consistent perception of high student involvement in these activities. Conversely, the indicator "goal-oriented" had the lowest mean of 3.76 (SD=0.64). Despite this lower mean, it is crucial to note that the standard deviation remained relatively low, signifying a degree of agreement among teachers regarding the level of student engagement in goal-oriented activities related to technology integration. Even though the mean was slightly lower, the results still suggested a generally high level of perceived student engagement in tasks with specific goals linked to technology use.

➤ *Level of importance of technology integration*

Table 4 presented the results on the importance of technology integration in terms of its uses and processes.

Table 4 Level of importance of technology integration

Indicators	Mean	Std. Deviation	Interpretation
Uses of technology integration	3.84	.44	Important
Process of technology integration	3.55	.55	Important

The findings indicated that teachers, overall, viewed technology integration, encompassing both its uses and processes, as crucial in the educational setting. Specifically, the mean for the importance of the uses of technology integration was notably high at 3.84 (SD=0.44). This suggested a strong consensus among teachers that incorporating technology into various aspects of instruction, such as interactive lessons, multimedia presentations, and collaborative activities, held significant importance. The low standard deviation indicated a high level of agreement among teachers regarding the significance of the use of technology in the classroom, reflecting a shared perception of its positive impact on teaching and learning. On the other hand, the processes of technology integration were considered important with a mean of 3.55 (SD=0.55). While slightly lower than the mean for the uses of technology integration, the result still suggested a general agreement among teachers on the importance of the processes involved in integrating technology into instructional practices. The standard deviation, though higher than that for the uses, still indicated a reasonable level of consensus among teachers regarding the significance of the processes. Hence, the results highlighted that teacher recognized the importance of technology integration in the classroom, both in terms of its uses and the associated processes. The emphasis on the uses of technology suggested a strong belief in the positive impact of incorporating technological tools and resources directly into teaching practices. Simultaneously, the acknowledgment of the importance of the processes involved highlighted the recognition that effective implementation and integration strategies were crucial for maximizing the benefits of technology in education.

The study's findings robustly aligned with the emphasized importance of integrating technology in

education, as outlined in the relevant literature and studies. Espinosa-Dublar's research conducted in 2023 illuminated the Philippines' committed endeavors to enhance its education system through technology. This was evident in the formulation of policies and the implementation of programs aimed at transforming education. The study, focusing on research publications from 2010 to 2022, reflected the contemporary setting and underscored the continuous effort to integrate technology into the Philippine educational system. Moreover, Ranosa (2020) emphasized the significant role of the Department of Education (DepEd) in promoting the integration of technology, specifically through the Enhanced Basic Education Act of 2013. This legislation explicitly highlighted the incorporation of technology into the educational program, with a specific emphasis on utilizing information and communication technology (ICT) to improve learning outcomes. The subsequent initiatives implemented by DepEd, such as the DepEd Computerization Program (DCP), showcased a systematic approach to providing public schools with ICT tools, software, and teacher training. The establishment of the National Teachers' Academy for ICT Integration (NTA) underscored the commitment to enhancing teachers' ICT skills through specialized training programs. These findings highlighted the continuous national endeavors and initiatives to include technology in the education system, aligning with the current study's findings that underscored the perceived importance of technology integration among teachers in the Philippines. The government's legal frameworks and programs established the broader context for the study's findings, providing a comprehensive background to the observed significance given to the integration of technology in the educational landscape.

➤ *A significant relationship between the teachers' digital competence and student engagement when compared to the importance of classroom integration technology*

Table 5 Significant relationship between the level of teachers' digital competence and student engagement when compared to the importance of technology integration

	Digital Competency		Student engagement	
	F	Sig.	F	Sig.
Importance of technology integration	.390	.054	.568	.003

In Table 5, the results revealed a significant relationship between student engagement and the importance of technology integration (p=.003). This suggested that teachers perceived a meaningful connection between the level of student engagement and the significance they attributed to integrating technology into their instructional practices.

However, a different picture emerged when considering the relationship between teachers' digital competence and the importance of technology integration. In this case, the results indicated no statistically significant relationship (p=.054). This suggested that, in the context of this study, teachers' digital proficiency may not have strongly influenced their

overall assessment of the importance of incorporating technology into instructional practices.

The study's findings aligned with the insights provided by related literature and studies. Abrigo, Ocdol, and Sadia's (2019) research reported a positive relationship between the implementation of the DepEd Computerization Program (DCP) and improved access to technology for both students and teachers. Their study also highlighted a correlation between the integration of technology and heightened student involvement and academic performance, reinforcing the study's observation of an association between technology use and increased student engagement.

However, a contrasting scenario emerged concerning the relationship between teachers' digital competence and the perceived importance of technology integration. The literature, particularly exemplified by Sun et al. (2018), noted a positive correlation between technology use and heightened engagement, providing additional support to the study's findings of increased student involvement in technology-integrated activities. Despite these positive connections, the related literature also underscored persistent challenges, as identified by Abrigo, Ocdol, and Sadia (2019), such as resource constraints, infrastructure deficiencies, insufficient teacher preparation, and disparities in educators' technical proficiency. These challenges needed to be addressed to fully realize the potential benefits of technology integration in education. Thus, while the study and literature affirmed the positive relationship between technology and student engagement, they also highlighted the need for addressing impediments to ensure effective technology use in educational settings.

VI. CONCLUSION

- The study's demographic analysis revealed a distinct profile of participants, primarily consisting of individuals aged 20-30 years, with a marked prevalence of females. Additionally, a substantial portion of participants had more than 10 years of teaching experience, suggesting a wealth of classroom expertise within the study's sample.
- The participants displayed a notable level of consensus and consistent confidence in their proficiency with various tools and media. However, it also perceived a lower level of digital competency in implementing comprehensive digital solutions, introducing a noteworthy discrepancy in participants' confidence between specific tools/media and broader digital strategies.
- The analysis of student engagement indicators in the study revealed a distinct contrast between "applied engagement" and "goal-oriented" activities. "Applied engagement" emerged signifying a consensus among teachers that students were actively engaged when applying technology in their learning experiences. Conversely, "goal-oriented" activities indicated agreement among teachers regarding student engagement in tasks with specific goals linked to technology use.
- The study's results underscored that teachers hold a strong collective belief in the importance of technology integration in education, covering both its uses and

processes. Notably, the importance of the use of technology integration indicates a robust consensus among teachers on the significance of incorporating technology into various instructional aspects. Additionally, the importance of the processes remained a general agreement among teachers on the crucial role of these processes in integrating technology into instructional practices.

- There's a significant relationship between student engagement and the perceived importance of technology integration, revealing teachers' acknowledgment of a meaningful connection. Conversely, the absence of a statistically significant relationship between teachers' digital competence and the importance of technology integration suggests limited influence of digital skills proficiency on their overall assessment of its significance in instructional practices.

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