

**THE MEDIATING ROLE OF SELF-EFFICACY ON THE ICT SKILLS OF  
TEACHERS AND STUDENT ENGAGEMENT IN MATHEMATICS**

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## Abstract

The study examined the critical mediating role of self-efficacy in the relationship between the ICT skills of teachers and student engagement in mathematics among senior high school students in Davao City. A calculated sample size of 323 was determined using Slovin's Formula, based on a confidence level of 95 percent. Employing a descriptive-correlational approach alongside path analysis for mediation, the research rigorously analyzed data through means, Pearson correlation coefficients, and path analysis techniques. The instruments were measured on a five-point Likert scale, achieving an impressive internal consistency with a Cronbach's alpha of 0.98. The results indicated a high level of self-efficacy, strong ICT skills among teachers, and high student engagement. Additionally, a strong positive correlation among these variables was found. Moreover, it was determined that self-efficacy partially mediates the relationship between teachers' ICT skills and student engagement. Specifically, an increase of one unit in teachers' ICT skills resulted in a corresponding increase of 0.76 units in student engagement when self-efficacy was considered. These findings demand attention for their practical implications on educational policies and academic instruction, particularly regarding effective teaching strategies. Therefore, cultivating self-efficacy in teaching is essential for the personal and professional development of educators, significantly enhances student academic performance, reduces the risk of school dropout, and creates an optimal environment for comprehensive personal and institutional development.

**Keywords:** *education, mediation, self-efficacy, ict skills of teachers, student engagement, correlation, path analysis, Philippines.*

**SDG Indicator: #4** (*Quality Education*)







## INTRODUCTION

Student engagement is a major factor influencing student learning (Joshi et al., 2022) and academic achievement (Sen, 2022). In teaching mathematics, student engagement is significantly influenced by instructional support (Alrajeh & Shindel, 2020), innovative pedagogies (Cevikbas & Kaiser, 2022; Aguhayon et al., 2023), and technological adaptations (Attard & Holmes, 2020) which strengthens mathematics learning in a social environment. However, studies recorded a decline in mathematical performance, particularly concerning European self-efficacy (Ryan et al., 2022) and a global issue (Chand et al., 2021). In the Philippines, PISA 2018 and 2022 results indicated the same trend of decline in mathematics, reading, and science (PISA 2022: Factsheets PHILIPPINES, 2023). Additionally, student engagement was significantly affected due to the closures of schools during the pandemic lockdowns (Wu & Teets, 2021), and the post-pandemic transition to online learning hurt students' learning (Wester et al., 2021), especially in mathematics (M. Pineda et al., 2023). This poses a need to revisit ways to improve student engagement and enhance academic achievement.

Student engagement has three dimensions (Santi et al., 2022; Jansen et al., 2023) that will be highlighted in this study: cognitive, emotional, and behavioral engagement. Cognitive engagement is perceiving and evaluating the course content as relevant and important (Sesmiyanti, 2018) by using ICT in collaborative engagements (Buchanan & Lacey, 2019) and individual activities. Emotional engagement is the attitude toward the feeling of being comfortable in participating in discussions (Joshi et al., 2022) that can develop self-efficacy (Tang & Hew, 2022) and less dissatisfaction (Quintero et al., 2022)

in mathematics classes. Lastly, Behavioral engagement is the involvement of the students in learning tasks and activities (Buchanan & Lacey, 2019). Maamin, Maat, and Iksan (2021) suggest that these components [cognitive, affective, and behavioral engagement] have a significant relationship with mathematics achievement.

The use of ICT in mathematics education has positively impacted the teaching and learning process and its integration into lessons improves not only effectiveness and confidence in teaching Mathematics but also student engagement and knowledge retention (Goldhaber, Khuan, & Allysa, 2021), motivation, and achievement in the subject (Agyamen, et. al, 2023). Moreover, its incorporation into teaching methods boosts student engagement and academic performance (Hanaysha, Shriedeh, & In'airat, 2023; Ali, Yasmeen, & Munawar, 2023). Teachers' digital literacy and ability to integrate ICT into the curriculum impact student learning (Shabnam & Mahat, 2022). ICT application in classroom learning increases student engagement by providing opportunities for student-teacher interaction. Llorente and Tado (2024) found a significant relationship between technology integration and student engagement and the use of authentic materials (e.g., ICT), which encourages teamwork and motivation among students (Balol, 2023). Thus, the teacher's role in the integration of ICT and their skills in utilizing ICT in the classroom is important.

The success of learning Mathematics is influenced by the level of teacher experience (Siregar et al., 2022), teacher effectiveness (Johnson, 2019), and teacher self-efficacy (Alibakhshi et al., 2020). As teachers feel comfortable using ICT in teaching (Dogan, Dogan, & Celik, 2020) and felt ease in accessing digital technology (J. Garzon & J. Garzon, 2023), technology

integration increases which can stimulate student engagement in the learning process (Joshi, 2019; Afari et al., 2023). Research implies that when teachers are adept at employing different instructional strategies, they are better equipped to integrate technology effectively into their teaching methods (Morales et al., 2023). Consequently, Dellomos et al. (2023) suggested that a higher level of self-efficacy indicates a high level of teacher adjustment in pedagogy. Research states that teachers' self-efficacy influences their ICT integration in the classroom (Peng et al., 2023; Nagy & Dringó-Horváth, 2024).

However, there are obstacles to ICT integration, such as the lack of confidence and frustration (Ayuba & Muhammad, 2020; Winter et al., 2021; Sen, 2022), stress and anxiety (Dogan, Dogan, & Celik, 2020), age (Murithi & Yoo, 2021), gender (Alrajeh & Shindel, 2020), and skills and technical support (Joshi, 2019) which affects the teachers' instructional behaviors and strategies (Alibakhshi et al., 2020) and develop Amotivation (Gustiani, 2020), the reduced motivation or self-efficacy in teaching the subject (Motongo, 2022). Additionally, the use of word processors alone does not necessarily correlate with the methods of teaching used by the teachers (Guerrero, 2022). It should be transformative to evolve knowledge by using teaching methods and ICT as a tool in the process.

UNESCO's study in 2023 stated that the Philippines and some SEAMEO countries need assistance to speed up the ICT integration in education but are already making progress (*Integrating ICT for Teaching and Learning in Selected SEAMEO Countries*, 2023). An intervention should be made to fill the lacks and inadequacies of ICT adoption in education (Tomaro, 2018). Teachers



should be capacitated to revamp students' competence and engagement (Siregar et al., 2022) in the teaching and learning process.

Teachers' ICT self-efficacy in their teaching practice is associated with their use of ICT (Clipa, Delibas, & Măță, 2023). Paetsch, Franz, and Wolter (2023) suggest that the higher teachers' technology integration self-efficacy, the more they use ICT in their teaching. Self-efficacious teachers frequently use computers and educational technology in their classes (Alibakhshi et al., 2020), which correlates to high student engagement levels (Bergdahl, Nouri, & Fors, 2019). Moreover, ICT tools enhance students' understanding of mathematical concepts and improve their engagement and motivation in mathematics classes (Shé et al., 2023). On the contrary, Arhin et al. (2022) suggested that no significant relationship exists between self-efficacy and teachers' attitudes toward integrating ICT in teaching and learning.

Research shows that ICT integration in Mathematics education has a positive impact on the teaching-learning process (Das, 2019), teaching methods (Alibakhshi et al., 2020), understanding of basic concepts (Dhakal, 2018), self-learning capacity (Lopez, Hartman, & Apaolaza, 2019), student's academic performance, self-efficacy, learning attitude, motivation (Lee, Hwang, & Chen, 2022), and student engagement (Maamin et al., 2022). Kundu, Bej, and Dey (2021) and Baroudi and Shaya (2022) stated that the teacher's self-efficacy positively correlated with students' classroom engagement. Moreover, research suggests that teacher self-efficacy positively predicts students' mathematics interests (Hettinger, Lazarides, & Schiefele, 2023), which connects the students to the lesson and helps them understand it better.

A high sense of self-efficacy facilitates constructs that include decision-making (Garcia & Velasquez, 2020), student engagement (Seneviratne, 2019), and student academic achievement (Hayat et al., 2020). In the academic context, self-efficacy refers to the subject's perception of his or her ability to learn and carry out a given task (Supervia, Bordas, and Robres, 2022). Additionally, math self-efficacy affects the student's academic behavior, which reflects on the student's academic performance (Arens, Frenzel, and Goetz, 2022). Consequently, a change in student engagement was significantly associated with teacher self-efficacy (Emiru & Gedefaw, 2024). This suggests the strong relationship between self-efficacy and the constructs of student engagement in various aspects of their academic life.

Ample research has studied the influence of the ICT Skills of Teachers on Student engagement (Johnson, 2019; Aidoo et al., 2022; Jewnandan, 2022; Bergdahl, Nouri, & Fors, 2019; Hanaysha, Shriedeh, & In'airat, 2023; Shabnam & Mahat, 2022; Goldhaber, Khuan, & Allysa, 2021; Llorente & Tado, 2024), Teacher ICT skills on Self-efficacy (Martínez-Borreguero et al., 2022; Herch, 2020; Motongo, 2022; J. Garzon & J. Garzon, 2023; Morales et al., 2023; Peng et al., 2023; Nagy & Dringó-Horváth, 2024), self-efficacy on student engagement (Santi, et al., 2022; Joshi, et al., 2022; Kundu, Bej, & Dey, 2021; Baroudi & Shaya, 2022; Emiru & Gedefaw, 2024), and the mediating role of self-efficacy on other variables and constructs but not on its mediating role to these variables (ICT skills of teachers and Student Engagement). Thus, this study is necessary to broaden understanding of the different variables involved in self-efficacy, ICT skills of teachers, and student engagement to develop

teaching strategies to improve quality education and learning processes and contribute to the existing literature on the variables of this study.

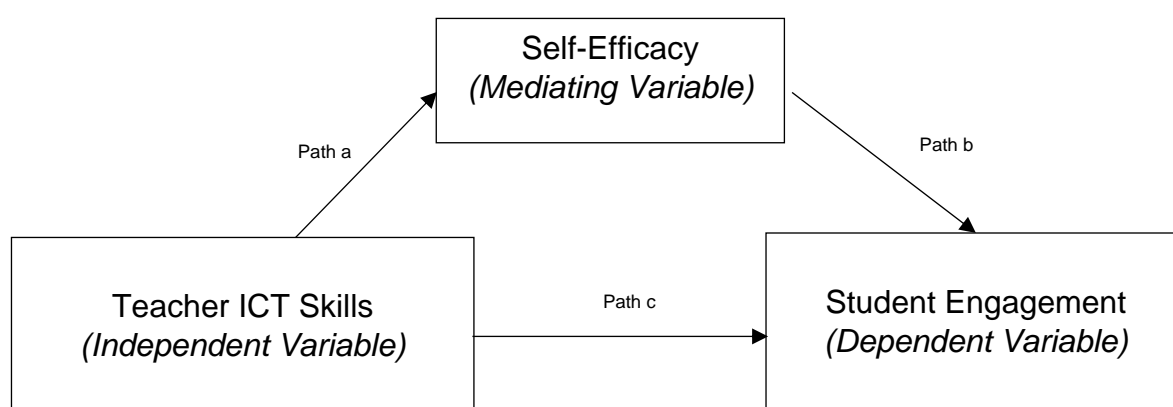
In this context and given the absence of studies that directly relate the variables under consideration, the main aim of this study is to ascertain the mediating role of self-efficacy on the relationship between the ICT skills of teachers and student engagement in the context of Mathematics students. The study's two hypotheses are that the ICT skills of teachers and Self-efficacy are interrelated to student engagement and that Self-efficacy plays a mediating role in the relationship between teacher ICT skills and student engagement.

These are the specific objectives of the study: (1) to know the level of teachers' ICT Skills in teaching Mathematics in terms of the teacher's input of ICT integration into pedagogy, the implementations of ICT-integrated pedagogy, and the students' output of ICT-integrated pedagogy; (2) to determine the level of student engagement in a mathematics class in terms of Cognitive engagement, Emotional engagement, and Behavioral engagement; (3) to measure the level of students' self-efficacy; (4) to ascertain the relationship between and among the variables; and (5) to establish the mediating role of self-efficacy on the relationship between ICT skills of teachers and student engagement in Mathematics.

This research is anchored in the theory of Connectivism and the Engagement Theory, which will explain the relationship between engagement and teaching methods, including technology-based teaching and learning methods. Connectivism Learning is based on incorporating technology to engage students (Jewnandan, 2022), and using ICT in teaching can enhance the students' engagement Bhattarai (2020). This research is also anchored on

Self-Efficacy, as cited by Supervia et al. (2022) in their study, stating that self-efficacy can enhance personal motivation and interaction as it is the capacity to execute behaviors necessary to produce specific performance attainments. This is an important variable as it will dictate the teachers' level of Student engagement and ICT skills.

This research suggests the conceptual model illustrated in Figure 1.



This framework suggests the interrelationship of the variables in question in this study. It is proposed that the Teacher's ICT skills as the independent variable directly influence (path c) the student engagement, the dependent variable, given the input and output of ICT-integrated pedagogy as indicated by Bhattarai (2022). Path c explains the level of direct relationship between the independent variable and the dependent variable. However, if there is an intervention of Self-efficacy, the mediating variable, in teaching using ICT (path a), student engagement will be increased (path b). Moreover, path a suggests the relationship of the independent variable to the mediating variable and how, in turn, it affects the dependent variable as it moves to path b, which explains the relationship of the mediating variable to the dependent variable. These paths will ascertain the mediating role of self-efficacy on the ICT skills of teachers and student engagement in Mathematics.

As the UN Sustainable Development Goal No. 4 aims for Quality education and lifelong learning opportunities for all, this research proves the importance of upskilling teachers to ensure a full and productive life for all individuals and provide quality education. This also suggests that in embracing digital transformations, teachers can integrate ICT to enhance the teaching and learning process (Merillo & Domingo, 2019; Garg, 2021) to realize sustainable development. Thus, the results of this research will notify policy-making bodies and educational institutions such as the Department of Education to enhance and upskill teaching methods. The relationships among these variables can yield further information that can inform policies and decisions about the planning, implementation, evaluation, and funding of professional development and curriculum implementation that affects the system and reform of the process. This study will benefit the teachers by reforming and modifying the teaching strategy, especially in using ICT, that they apply and know the effects of self-efficacy on student engagement. They will have a basis for how they will improve during their career profession. This can also impact how the administration will approach the growing need to enhance the ICT capability of teachers for a better quality of education. Stakeholders, such as parents and the community, can also benefit by promoting adaptive behaviors and ensuring an optimal climate for adequate personal and school development.

## **METHOD**

This section presents the methods used in conducting the research with a thorough discussion on the following: research respondents, materials and instruments, and the research design employed in this study.

### *Research Respondents*

The target population was taken from 3 schools selected by proximity, namely Saint Peter's College of Toril, Davao Central College, and Brokenshire College of Toril, with a total of 1690, of which the distribution is 750, 500, and 440, respectively. The required sample size, as calculated using Slovin's Formula based on a confidence level of 95% and a margin of error of 5%, is 323. The sample comprised 323 students, the accumulated percentage per school being 47.9%, 24.2%, and 27.9%, respectively. Of these, the total gathered responses are 325, with 99.4 % indicating Yes and 0.06% stating No in answering the questionnaire. Among the respondents who clicked Yes, 42% were Grade 11 and 58% were Grade 12 Students. Moreover, 47.2% were STEM Students, 11.3% were ABM Students, 41.1% were HUMSS Students, and 0.3% were GAS Students. Additionally, 29.8% are 16-year-olds, 36.2% are 17-year-olds, and 34% are 18-year-old Students.

The respondents were Senior High School students at the schools indicated above, of any ethnicity, who can use ICT (e.g., cell phones or computers) and are knowledgeable in using Google Forms, with or without learning challenges or difficulties, and are enrolled in an Academic Track (STEM, HUMSS, GAS, and ABM) for the Second Semester of the SY 2023-2024 in the schools of Cluster Four and Five schools (Toril District) of the Division of Davao City. The researcher applied a stratified random sampling technique and used Slovin's Formula (Munir, Rita, & Hanif, 2021), which allowed the researcher to sample the population with the desired degree of accuracy in acquiring the target population and sample this study.

Sports, Arts, and TVL Strand students were excluded since they are more into practical and livelihood performances, allowing them to utilize more of the technology available and not the teachers as they present the lesson. Consequently, the participating school only offered an academic track suitable for the inclusion criteria. Students with physical disabilities who find it hard to answer the questionnaire may wish not to participate.

### *Materials and Instrument*

Three questionnaires were adapted from published research by different authors who studied the variables that will be used in this research. It was modified to suit the respondents' level and subjected to the experts' validation. Comments and suggestions for editing the questionnaire were followed, and the Validators rated the questionnaire as Very Good with an average score of 4.6. The finalized questionnaire underwent pilot testing on 30 respondents from the participating schools and revealed an overall Cronbach's alpha of 0.98, indicating excellent internal consistency.

The first part of the questionnaire measured the Teacher's ICT Skills is from Bhattarai (2020) and consisted of 10 questions for the first indicator (the input of ICT integrated pedagogy where item no. 7, with the word "University" will be replaced with "School" to suit the respondents; 14 questions for the second indicator (the implementation of ICT integrated pedagogy), and eight questions for the third indicator (the output of ICT integrated pedagogy) with a total of 32 questions. The term "Integrated Pedagogy" will include the words "Classroom Teaching" enclosed in parenthesis so the respondents will better understand the term. This questionnaire has a Cronbach's  $\alpha = 0.98$  with a level of significance set at 5%.

The second part of the questionnaire that measured student engagement in mathematics was a 57-item questionnaire developed by Kong et al. (2003) and was modified by Maamin et al. (2022) in their study. This questionnaire was divided into three parts: the cognitive engagement part, which consists of nine questions (Cronbach's  $\alpha = 0.806$ ; level of significance at 5%), behavioral engagement, which consists of six questions (Cronbach's  $\alpha = 0.864$ ; level of significance at 5%), and affective engagement which consists of six questions (Cronbach's  $\alpha = 0.864$ ; level of significance at 5%), a total of 21 questions for the student engagement questionnaire.

The third part of the questionnaire that measured the mediating role of self-efficacy is the Teacher Self-efficacy Scale (TSES) developed by Tschannen-Moran and Hoy (2001) and adopted by Shahzad and Naureen (2017) and was reviewed by Hussain and Khan (2022). This standardized instrument gauges teacher self-efficacy because it is a standardized instrument and has been used in Teacher self-efficacy research. The 24 questions in the questionnaire are divided into three sub-scales: classroom management (8 questions), instructional strategies (8 questions), and student engagement (8 questions) to measure teacher self-efficacy. The instrument was converted into a 5-point Likert scale with an overall internal reliability of  $\alpha = 0.94$ .

Participants' responses on all the variables are measured based on a five-point Likert-type scale ranging from strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The instrument contained details of the respondents' identity in terms of Name (optional), Gender, Grade Level, SHS Strand/Track, and the ICT and AF consent was ticked and uploaded on the same Google Form link.



In evaluating the scores for the teachers' ICT skills, self-efficacy, and student engagement in mathematics, the following scales were employed:

Range of Means	Descriptive level	Interpretation
4.20 - 5.00	Very High	This measure on teachers' ICT skills, self-efficacy, and student engagement in mathematics is always observed.
3.40 - 4.19	High	This measure on teachers' ICT skills, self-efficacy, and student engagement in mathematics is often observed.
2.60 - 3.39	Moderate	This measure on teachers' ICT skills, self-efficacy, and student engagement in mathematics is sometimes observed.
1.80 - 2.59	Low	This measure on teachers' ICT skills, self-efficacy, and student engagement in mathematics is seldom observed.
1.00 - 1.79	Very Low	This measure on teachers' ICT skills, self-efficacy, and student engagement in mathematics is never observed.

Additionally, to measure the correlation between and among the variables in this study, the following scales were employed:

Ranges of r	Interpretation
0.00	No correlation, no relationship
0.01 to 0.20	Very low correlation, almost negligible relationship
0.21 to 0.40	Slight correlation, definite but small relationship

0.41 to 0.70	Moderate correlation, substantial relationship
0.71 to 0.90	High correlation, marked relationship
0.91 to 0.99	Very high correlation, very dependable relationship
1.00	Perfect correlation, perfect relationship

### *Design and Procedure*

The mediating role of self-efficacy in the relationship between teacher ICT skills and student engagement in Mathematics was investigated using a descriptive-correlational approach and mediation analysis. This study emphasized the path analysis results based on the independent variable's direct influence on the dependent variable and the influence involving the intervening variable as a mediator. Mean was used to identify the scores of the levels of each variable, and Pearson  $r$  correlation was used to establish the relationship between and among the variables. Path analysis was used to measure the direct effect of the independent variable on the dependent variable (Siregar et al., 2022). Mediation was carried out using the Bootstrapping method (10,000 runs) using SPSS. For all the operations, a  $p \leq 0.05$  alpha level will be used with a confidence level of 95%. The applicability to a small sample and its independence on the assumption of normality is the most important quality of this test. This test method randomly selects cases with replacements to create new samples from existing data. It guarantees that the probability of any case being included in the sample remains the same. The collected samples are then treated as a population reservoir, as per the findings of Sidhu and Balla (2021).

Upon the approval of the school administration, an Informed Consent Form (ICF) and Assent Form (AF) for the respondents below 18 years old was given to the Research Coordinator of the participating schools. The ICF and AF were also indicated in the Google Form questionnaire. Approval on answering the questionnaire was indicated on the link and participation is purely voluntary and upon the respondents' discretion. The respondents did not waive any legal claims, rights, or remedies for their participation, and no unfavorable consequences or harm was done due to their participation or non-participation in the data-gathering procedure. The data was collected using a Google Form Questionnaire sent through e-mails or group chats by the respective school research facilitator and was carried out from February 2024 to March 2024.

The researcher ensured compliance with research guidelines and the Data Privacy Act of 2012. The study was conducted ethically, with unbiased data and proper literature citations, and with a plagiarism checker result of less than 15%. Permission was obtained from the UM Ethics and Review Committee with UMERC Protocol No. UMERC-2023-457 given last November 13, 2023, and data will be securely stored in a Google Drive and disposed of after 5 years. Participant anonymity will be maintained, and research publication adheres to UM Research Guidelines.

## **RESULTS AND DISCUSSION**

This section presents the results and analysis of a study on the mediating role of self-efficacy on the ICT skills of teachers and students' engagement in mathematics. It covers the level of teachers' ICT skills in mathematics, student engagement, students' self-efficacy, the significance of various relationships, and the mediating role of self-efficacy on the relationship

between the ICT skills of teachers and student engagement in mathematics through mediation using path analysis.

### Teachers' ICT Skills in Teaching Mathematics

The level of teachers' ICT skills in teaching Mathematics is presented in Table 1, and the items and indicators are interpreted and analyzed. Based on the data, it is evident that the indicator with the highest mean score of 4.09, which signifies a high level of perception, is the Implementation of ICT-integrated pedagogy. On the other hand, the Output of ICT-integrated pedagogy has the lowest mean score of 4.05, although it is also at a high descriptive level.

**Table 1**  
*Level of teachers' ICT Skills*

<b>INDICATORS</b>	<b>SD</b>	<b>Mean</b>	<b>Descriptive Level</b>
<b>Perception of students towards...</b>			
The input of ICT-integrated pedagogy	0.633	4.088	High
Implementations of ICT-integrated pedagogy	0.616	4.092	High
Output of ICT-integrated pedagogy	0.713	4.046	High
<b>Overall</b>	<b>0.591</b>	<b>4.082</b>	<b>High</b>

The overall level of teachers' ICT Skills in teaching Mathematics has a mean score of 4.082, which indicates a high descriptive level, and a standard deviation of 0.59, meaning there is a moderate difference in the indicator means. This suggests that students' perception of the teachers' ICT skills is evident in learning Mathematics.

The results showed that the students often observe the level of teachers' ICT skills in delivering ICT-integrated pedagogy. This indicates that the teachers' digital literacy and ability to integrate ICT into the curriculum impact student learning (Shabnam & Mahat, 2022), which is why it has the highest score of means. Teachers' ICT Skills also boost student engagement, knowledge retention (Goldhaber, Khuan, & Allysa, 2021), motivation, achievement (Agyamen et. al, 2023), and academic performance (Hanaysha, Shriedeh, & In'airat, 2023; Ali, Yasmeeen, & Munawar, 2023). With this, teachers should capitalize on the integration of ICT and learn to be self-efficient in using ICT to enhance their teaching instruction.

### **Student Engagement in Learning Mathematics**

The level of student engagement in learning Mathematics is presented in Table 2, and the items and indicators are interpreted and analyzed. The data shows that behavioral engagement has the highest mean score of 4.21, with a descriptive level of high and a standard deviation of 0.736. On the other hand, cognitive engagement has the lowest mean score of 4.08, with a descriptive level of high. The overall mean level of student engagement in teaching mathematics is high, with a mean score of 4.14 and a standard deviation of 0.62, indicating a moderate difference in the means of the indicators.

**Table 2**

*Level of Student engagement in learning Mathematics*

<b>INDICATORS</b>	<b>SD</b>	<b>Mean</b>	<b>Descriptive Level</b>
Cognitive Engagement	0.650	4.083	High
Emotional Engagement	0.718	4.125	High
Behavioral Engagement	0.736	4.205	High
<b>Overall</b>	<b>0.621</b>	<b>4.138</b>	<b>High</b>

It shows the level of student engagement in teaching mathematics is also often observed by the students in a mathematics class. Research suggests that students are engaged when teachers use ICT (Joshi, 2019), and it influences student learning and achievement (Joshi et al., 2022). Since student engagement is significantly influenced by instructional support (Alrajeh & Shindel, 2020), innovative pedagogies (Cevikbas & Kaiser, 2022; Aguhayon et al., 2023), and technological adaptations (Attard & Holmes, 2020), teachers should be upskilled in utilizing ICT to enhance their students' engagement in the classroom which also strengthens mathematics learning in a social environment.

### **Students' Self-efficacy**

The level of students' self-efficacy in teaching Mathematics is presented in Table 3, and the items and indicators are interpreted and analyzed. It can be seen in the data that the indicator with the highest mean score of 4.26 with a descriptive level of very high is Instructional Strategies.

**Table 3**  
*Level of Students' Self-efficacy*

<b>INDICATORS</b>	<b>SD</b>	<b>Mean</b>	<b>Descriptive Level</b>
Classroom Management	0.677	4.197	High
Instructional Strategies	0.648	4.259	Very High
Class Engagement	0.685	4.193	High
<b>Overall</b>	<b>0.631</b>	<b>4.216</b>	<b>Very High</b>

Furthermore, the indicator with the lowest mean score of 4.19 with a descriptive level of high is Class engagement. The level of student self-efficacy in teaching mathematics has an overall mean score of 4.22 with a descriptive

level of high, and the standard deviation is 0.63, indicating a moderate difference in the means of the indicators. This measure indicates that student self-efficacy in learning mathematics is often observed. The result on the level of students' self-efficacy with teachers using ICT in their class indicated that the higher the technology integration, the more they use ICT in their teaching it is always observed (Paetsch, Franz, & Wolter, 2023). The more teachers use ICT, the more the students understand the mathematical concepts (Shé et al., 2023). When students are involved in the learning process (Joshi, 2019) it promotes teamwork and motivation (Balol, 2023), and can enhance their cognitive, behavioral, and affective engagement (Goldhaber, Khuan, & Allysa, 2021).

The findings demonstrate the pivotal role of teacher ICT skills, self-efficacy in using ICT technology, and student engagement in enhancing mathematics learning. These factors were prominently observed by the students in their classroom, significantly impacting their overall engagement and participation in class.

### **Significance of the Relationship between ICT Skills of Teachers and Student Engagement in Mathematics**

The data in Table 4 shows the correlation between ICT Skills of Teachers and Student Engagement in Mathematics. It can be seen from the results that there was a significant positive, strong relationship between the ICT Skills of Teachers and Student Engagement in Mathematics as reflected in the correlation coefficient of 0.757 and a probability value of 0.000 as tested at 0.5 level of significance. The indicators of student engagement, such as cognitive engagement and behavior engagement, are strongly correlated and associated

with the ICT skills of teachers, with an overall correlation of 0.749 ( $p < 0.05$ ) and 0.683 ( $p < 0.05$ ), respectively.

**Table 4.**

*Correlation Matrix on the Relationship between ICT Skills of Teachers and Student Engagement in Mathematics*

Student Engagement	ICT Skills of Teachers			Overall
	Perception of students towards...			
	The input of ICT-integrated pedagogy	Implementations of ICT-integrated pedagogy	Output of ICT-integrated pedagogy	
Cognitive Engagement	.657* (.000)	.715* (.000)	.690* (.000)	.749* (.000)
Behavior Engagement	.581* (.000)	.669* (.000)	.622* (.000)	.683* (.000)
Affective Engagement	.524* (.000)	.572* (.000)	.525* (.000)	.592* (.000)
<b>Overall</b>	.661* (.000)	.730* (.000)	.687* (.000)	<b>.757*</b> <b>(.000)</b>

\*Significant @ 0.05

On the other hand, Affective Engagement is moderately associated with the indicators of ICT skills of teachers with an overall correlation of 0.592 ( $p < 0.05$ ). The values in this data indicate that the hypothesis of this research, stating that the ICT skills of teachers are related to student engagement, should not be rejected.

The results also indicated a positive correlation between teachers' high descriptive level of ICT skills and student engagement. It agrees with the existing literature stating a significant relationship between technology integration and student engagement (Llorente & Tado, 2024), which encourages student teamwork and motivation (Balol, 2023). Just as Bergdahl, Nouri, and Fors (2019) argued, high levels of digital skills are related to high



levels of student engagement. Consequently, high levels of student engagement are related to students' learning and achievement (Joshi et al., 2022). However, it should be considered that there are factors affecting ICT integration in Mathematics teaching, such as the age of teachers (Murithi & Yoo, 2021), lack of confidence, and frustration (Ayuba & Muhammad, 2020; Winter, et. al., 2021; Sen, 2022), stress and anxiety (Dogan, Dogan, & Celik, 2020), and skills and technical support (Joshi, 2019).

### **Significance of the Relationship between ICT Skills of Teachers and Students' Self-efficacy in Mathematics**

The data in Table 5 shows the correlation between ICT Skills of Teachers and Student Self-efficacy in Mathematics.

**Table 5**

*Correlation Matrix on the Relationship between ICT Skills of Teachers and Students' Self-efficacy in Mathematics*

<b>Self- efficacy</b>	<b>ICT Skills of Teachers</b>			<b>Overall</b>
	Perception of students towards... The input of ICT- integrated pedagogy	Implementations of ICT-integrated pedagogy	Output of ICT- integrated pedagogy	
Classroom Management	.545* (.000)	.616* (.000)	.562* (.000)	.630* (.000)
Instructional Strategies	.583* (.000)	.651* (.000)	.588* (.000)	.667* (.000)
Classroom Engagement	.551* (.000)	.593* (.000)	.557* (.001)	.620* (.000)
<b>Overall</b>	.594* (.000)	.658* (.000)	.603* (.000)	<b>.678*</b> <b>(.000)</b>

*\*Significant @ 0.05*

It can be seen from the results that there was a significant positive, strong relationship between the ICT Skills of Teachers and Student Self-

efficacy in Mathematics as reflected in the correlation coefficient of 0.678 and a probability value of 0.000 as tested at 0.5 level of significance. The indicators of Self-efficacy, such as Classroom Management, Instructional Strategies, and Classroom Engagement, are strongly correlated and associated with the ICT skills of teachers with an overall correlation of 0.630 ( $p < 0.05$ ), 0.667 ( $p < 0.05$ ), and 0.620 ( $p < 0.05$ ) respectively. The values in this data indicate that the hypothesis of this research, stating that the ICT skills of teachers are related to student self-efficacy, should not be rejected.

There is also a positive correlation between a high descriptive level of ICT Skills of Teachers and Students' Self-efficacy in the teacher's skills. It concurs with Courtney et al. (2022) idea that students' positive attitudes toward ICT demonstrated a strong positive relationship with teachers' ICT integration contrast to Dogan, et al. (2020), which indicated that there is a weak but significant indirect effect of self-efficacy on technology use. Studies emphasize the close relationship between self-efficacy and ICT skills of teachers in Mathematics classes, which can stimulate the students to be involved in the learning process (Joshi, 2019). However, the result contradicted the idea of Arhin et al. (2022) that there is no significant relationship between self-efficacy and teachers' attitudes toward integrating ICT in teaching and learning.

### **Significance of the Relationship between Students' Self-efficacy and Engagement in Mathematics**

The data in Table 6 shows the correlation between Student Self-efficacy and Student Engagement in Mathematics. It can be seen from the results that there was a significant positive, strong relationship between the ICT Skills of Teachers and Student Self-efficacy in Mathematics as reflected in the

correlation coefficient of 0.781 and a probability value of 0.000 as tested at 0.5 level of significance.

**Table 6**

*Correlation Matrix on the Relationship between Students' Self-efficacy and Engagement in Mathematics*

Student Engagement	Students Self-Efficacy			Overall
	Classroom Management	Instructional Strategies	Classroom Engagement	
Cognitive Engagement	.683* (.000)	.673* (.000)	.687* (.000)	.723* (.000)
Behavior Engagement	.616* (.000)	.661* (.000)	.625* (.000)	.672* (.000)
Affective Engagement	.642* (.000)	.670* (.000)	.644* (.001)	.692* (.000)
<b>Overall</b>	<b>.728*</b> <b>(.000)</b>	<b>.747*</b> <b>(.000)</b>	<b>.734*</b> <b>(.000)</b>	<b>.781*</b> <b>(.000)</b>

\*Significant @ 0.05

The indicators of Student engagement, such as Cognitive Engagement, Behavior Engagement, and Affective Engagement, are highly correlated and associated with Students' Self-efficacy with an overall correlation of 0.723 ( $p < 0.05$ ), 0.672 ( $p < 0.05$ ), and 0.692 ( $p < 0.05$ ) respectively. The values in this data indicate that the hypothesis of this research, stating that the Students' engagement in mathematics is related to student self-efficacy, is not rejected.

There is also a positive correlation between high descriptive levels of students' self-efficacy and engagement in mathematics. Research suggests that teachers' mathematics self-efficacy affects students' academic behavior (Arens, Frenzel, and Goetz, 2022) and can change student engagement (Emiru & Gedefaw, 2024). Kundu, Bej, and Dey (2021) and Baroudi and Shaya (2022) stated that the teacher's self-efficacy positively correlated with students' classroom engagement. Moreover, Hettinger, Lazarides, and Schiefele (2023)

suggest that teacher self-efficacy positively predicts students' mathematics interests.

**Mediation Using Path Analysis**

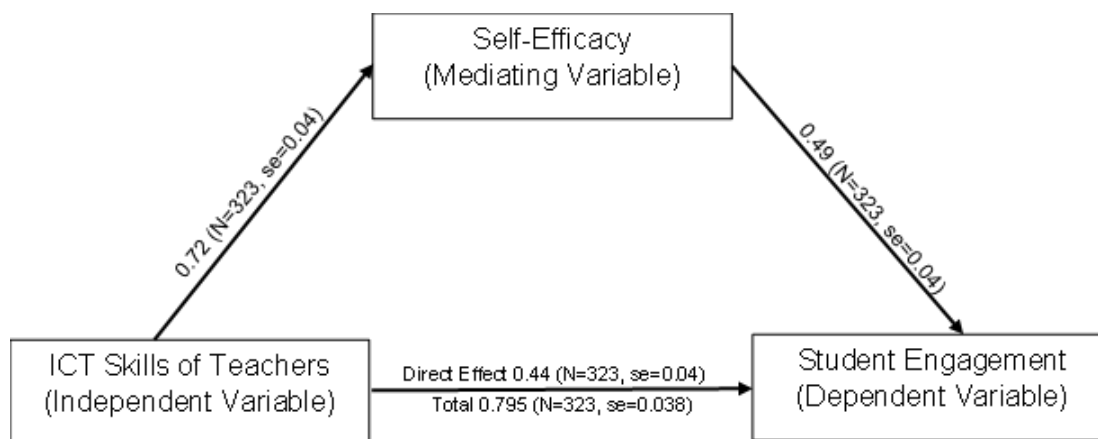


Figure 2. Statistical Diagram of the Mediating Effect

**Table 7**  
Mediation

Indirect and Total Effects									
Type	Effect	Estimate	SE	95% C.I. (a)		$\beta$	z	P	
				Lower	Upper				
Indirect	Teacher ICT Skills $\Rightarrow$ Self-efficacy $\Rightarrow$ Student Engagement	0.354	0.0360	0.283	0.424	0.337	9.82	<.001	
Component	Teacher ICT Skills $\Rightarrow$ Self-efficacy	0.724	0.0435	0.638	0.809	0.678	16.63	<.001	
	Self-efficacy $\Rightarrow$ Student Engagement	0.489	0.0401	0.410	0.567	0.497	12.17	<.001	
Direct	Teacher ICT Skills $\Rightarrow$ Student Engagement	0.441	0.0429	0.357	0.525	0.420	10.29	<.001	
Total	Teacher ICT Skills $\Rightarrow$ Student Engagement	0.795	0.0381	0.720	0.870	0.757	20.86	<.001	

Note. Confidence intervals computed with method: Standard (Delta method)

Note. Betas are completely standardized effect sizes

The Mediating Role of Self-efficacy in the relationship between the ICT skills of teachers and student engagement in Mathematics is depicted in the

path analysis. Figure 2 indicates a mediating effect of ICT skills of teachers (VI) on self-efficacy of 0.72 and a mediating effect on academic performance (VD) of 0.49. In both cases  $p < 0.05$ . Self-efficacy was found to play a partial mediating role between the ICT skills of teachers and student engagement.

As seen in Table 7, the mediation table of values indicates that zero (0) was not included in the bootstrap interval, and the values  $\beta = 0.76$ ,  $SE = 0.0381$ , and 0.5 level of significance argue that self-efficacy partially mediates the relationship between the ICT skills of teachers and Student Engagement in Mathematics. These results suggest that, in and by themselves, the ICT skills of teachers have a direct significant effect on student engagement (0.44,  $p < .05$ ), but its combination with self-efficacy yields a value of 0.795,  $p < .001$  (direct effect + indirect effect) showing an increased result of self-efficacy's involvement in the path. The ratio index of 0.906, acquired by dividing 0.72 from path A and the total direct effect of 0.795, shows that 90.6% of the ICT skills of teachers go through Self-Efficacy. It shows a partial mediation of self-efficacy to the effect of the ICT skills of teachers on student engagement.

**Table 8**  
*Regression Results*

Total effects				
ANOVA Table				
R-squared	F	df1	df2	P
0.573	434	1.00	324	<.001

The proportion of variance being explained by model  $R^2 = 0.573$ , as shown in Table 8, suggests that self-efficacy plays a partially mediating role in the relationship between the ICT skills of teachers and Student engagement and that the hypothesis stating that Self-efficacy plays a partially mediating role

in the relationship between teacher ICT skills and student engagement should not be rejected.

The second hypothesis, stating that self-efficacy plays a mediating role in the relationship between the ICT skills of teachers and student engagement, should not be rejected as self-efficacy was found to affect the other two variables. The mediation analysis suggests that the ICT skills of teachers are a good predictor of student engagement; that is, the direct effect of the ICT skills of teachers over student engagement is statistically significant. Moreover, the mediating role of self-efficacy in the relationship between the ICT skills of teachers and Student engagement was also found to be significant. It confirms the importance of self-efficacy for teachers' ICT usage and has important practical implications for the students. As the literature suggests, no previous study has directly addressed the mediating role of self-efficacy in that relationship, as all existing studies have limited their analysis to the bidirectional correlations between the constructs. However, some research studied the mediating role of self-efficacy in resilience and academic performance (Supervia, Bordas, & Robres, 2022), digital profile and competence (Hortelano et al., 2021), and other variables but not on ICT skills of teachers and Student engagement. On the other hand, ample research has studied the influence of the ICT Skills of Teachers on Student engagement (Johnson, 2019; Aidoo et al., 2022; Jewnandan, 2022; Bergdahl, Nouri, & Fors, 2019; Hanaysha, Shriedeh, & In'airat, 2023; Shabnam & Mahat, 2022; Goldhaber, Khuan, & Allysa, 2021; Llorente & Tado, 2024), Teacher ICT skills on Self-efficacy (Martínez-Borreguero et al., 2022; Herch, 2020; Motongo, 2022; J. Garzon & J. Garzon, 2023; Morales et al., 2023; Peng, et al., 2023; Nagy & Dringó-Horváth,

2024), and self-efficacy on student engagement (Santi, et al., 2022; Joshi, et al., 2022; Kundu, Bej, & Dey, 2021; Baroudi & Shaya, 2022; Emiru & Gedefaw, 2024).

## **CONCLUSION AND RECOMMENDATION**

The findings of this research support the Connectivism and Engagement theory, explaining the relationship between ICT usage and Student Engagement.

Based on the results and the literature supporting it, it is evident that the level of teachers' ICT skills in teaching mathematics, student engagement in a mathematics class, and students' self-efficacy play a significant role in the classroom setting for learning mathematics. Students are observant and highly involved in learning mathematics. Their participation is influenced by how they perceive their surroundings, especially when the teacher takes charge of the class activity. The theory of connectivism and engagement explains the involvement of technology in teaching methods, which in turn help the students to be more attentive and engage in learning mathematics. Therefore, teachers should implement teaching strategies that effectively utilize ICT and capitalize on the students' active participation when technology is involved to encourage self-efficacy in teaching mathematics and enhance student engagement.

The teacher's ICT skills, self-efficacy, and student engagement are significantly and positively correlated, as the results suggest in this research. ICT use in classroom instruction greatly impacts student engagement, especially in Mathematics (Jewnandan, 2022; Hanaysha, Shriedeh, & In'airat, 2023; Llorente & Tado, 2024). The teacher's self-efficacy also influences the use of ICT for teaching and learning. It means that these three factors are

related and can influence each other. Thus, if one factor increases, the other factor also increases. Therefore, teachers and schools need to improve teachers' ICT skills to enhance student engagement in learning mathematics.

Given the relation among the variables, it was evident that with the increase of one unit of teacher ICT skills, there is a 0.76 unit increase in student engagement when self-efficacy is involved as a result of the mediation using path analysis. Therefore, the higher the effects of teacher ICT skills, the greater the increase in the student's engagement in learning mathematics. Thus, self-efficacy mediates the teachers' ICT skills in integrating ICT into teaching, as students are actively engaged in the learning process and feel confident that the teacher is utilizing the best ICT in their mathematics class. With this, the school administration or the concerned departments should offer various upskilling activities for teachers to integrate ICT into classroom teaching to enhance student engagement. It should be beneficial to introduce inter-active ICT tools and applications, such as GeoGebra, Smart Classroom, social media, Math Guide (Aggarwal, 2020), and Quizzis, that the teachers can use in the classroom for better mathematics instruction. Teachers can also develop their own interactive ICT tools, which they can integrate in the context of their lesson and the availability of resources in their schools or classrooms.

The practical implications for educational strategies of this study are to promote teaching strategies that make better use of ICT that encourage self-efficacy in teaching Mathematics that will ignite student engagement. In this way, teachers will have better insight into the factors that can affect mathematics teaching and learning, and they can enhance their strategies to suit the needs of their students, thus making teachers more flexible in their



teaching strategies. Moreover, programs directed by educational professionals and government policymakers to upskill teachers in using ICT can also help to improve students' overall experience and achieve the quality education they envisioned. As teachers have a better hold of their faculties in using ICT in their classes, it might decrease the risk of school dropouts due to their engagement in the learning process. With this, stakeholders will be ensured that they have a proper education in their community as the school will produce good examples and an optimal climate for adequate personal and school development. Further research on Education and Psychology can be done, especially on the mediating role of Self-efficacy on other variables, such as the Output of ICT-integrated pedagogy and Cognitive Engagement or other variables, to broaden the scope and enrich the literature of this research study.

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