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

ii

## Abstract

Research indicates that integrating Information and Communication Technology (ICT) into mathematics education enhances teaching and learning (Das, 2020). However, teachers' skills and technical support significantly influence their instructional strategies, affecting student engagement (Joshi, 2019; Alibakhshi et al., 2020; Maamin et al., 2022). This study investigates the critical mediating role of self-efficacy in the relationship between teachers' ICT skills and student engagement in mathematics among 323 senior high school students, calculated using Slovin’s Formula, based on a confidence level of 95 percent, in Davao City, Philippines selected for the researcher’s convenience. Students in non-academic tracks will be excluded from this study but may be included in future research. The research utilized a descriptive-correlational

approach along with path analysis for mediation. Data analysis included means, Pearson correlation coefficients, and path analysis techniques. The instruments employed were measured on a five-point Likert scale, achieving an impressive internal consistency with a Cronbach's alpha of 0.98. The results revealed a high level of self-efficacy, strong ICT skills among teachers, and high student engagement. Additionally, a strong positive correlation among these variables was identified. The study concluded that self-efficacy partially mediates the relationship between teachers' ICT skills and student engagement. These findings have significant implications for educational policies and academic instruction, particularly concerning effective teaching strategies. Therefore, fostering self-efficacy in educators is vital for their development, as it directly improves student performance, significantly lowers dropout rates, and cultivates an optimal environment for both personal and institutional growth.

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

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

iii

v

# 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 adaptions (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)

2

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

3

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

4

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, & Mâță, 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 selfefficacy 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.

5

A high sense of self-efficacy facilitates constructs that include decisionmaking (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

6

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 the ICT skills of teachers predict

student engagement when Self-efficacy plays a mediating role in the

relationship.

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

7

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 selfefficacy 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. Engagement theory (Tomović, 2021) stated that

the usage of technology and technology-based instructions can lead to

collaboration and critical thinking.

This research suggests the conceptual model illustrated in Figure 1.

Path a

Path c

Teacher ICT Skills

*(Independent Variable)*

Path b

Student Engagement

*(Dependent Variable)*

Self-Efficacy

*(Mediating Variable)*

Fig 1: Conceptual model

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

8

paths will ascertain the mediating role of self-efficacy on the ICT skills 9of 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. However,

this research only focused on senior high school students in the third district of

Davao City, Philippines which is convenient for the researcher. Students not

enrolled in the academic track will not be part of this research study but may be

9

included in future research. This research will only focus on the mediating role

of self-efficacy on teacher ICT integration and its effects on student engagement

in mathematics.

# 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

10

learning challenges or difficulties, and are enrolled in an Academic Track (STEM, HUMSS, GAS, and ABM) for the Second Semester of the SY 20232024 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”

11

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 𝛼 = 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 𝛼 = 0.806; level of significance at 5%), behavioral engagement, which consists of six questions (Cronbach’s 𝛼 = 0.864; level of significance at 5%), and affective engagement which consists of six questions (Cronbach’s 𝛼 = 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

12

questions) to measure teacher self-efficacy. The instrument was converted into a 5-point Likert scale with an overall internal reliability of 𝛼 =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

This measure on teachers’ ICT skills, self-efficacy, and student

4.20 - 5.00 Very High engagement in mathematics is always observed.

This measure on teachers’ ICT skills, self-efficacy, and student

3.40 - 4.19 High

engagement in mathematics is often observed.

This measure on teachers’ ICT skills, self-efficacy, and student

2.60 - 3.39 Moderate engagement in mathematics is sometimes observed.

This measure on teachers’ ICT skills, self-efficacy, and student

1.80 - 2.59 Low engagement in mathematics is seldom observed.

This measure on teachers’ ICT skills, self-efficacy, and student

1.00 - 1.79 Very Low engagement in mathematics is never observed.

13

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

## Ranges of r Interpretation

* 1. No correlation, no relationship
	2. 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

14

(10,000 runs) using SPSS. For all the operations, a 𝑝 ≤ 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 ICT 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

15

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 ICTintegrated 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*

|  |  |  |  |
| --- | --- | --- | --- |
| **INDICATORS**Perception of students towards… | **SD** | **Mean** | **Descriptive Level** |
| The input of ICT-integrated pedagogy | 0.633 | 4.088 | High |
| Implementations of ICT-integrated pedagogy | 0.616 | 4.092 | High |

16

|  |  |  |  |
| --- | --- | --- | --- |
| Output of ICT-integrated pedagogy | 0.713 | 4.046 | High |
| **Overall** | **0.591** | **4.082** | **High** |

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, Yasmeen, & 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

17

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*

|  |  |  |  |
| --- | --- | --- | --- |
| **INDICATORS** | **SD** | **Mean** | **Descriptive****Level** |
| Cognitive Engagement | 0.650 | 4.083 | High |
| Emotional Engagement | 0.718 | 4.125 | High |
| Behavioral Engagement | 0.736 | 4.205 | High |
| **Overall** | **0.621** | **4.138** | **High** |

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 adaptions (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

18

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*

|  |  |  |  |
| --- | --- | --- | --- |
| **INDICATORS** | **SD** | **Mean** | **Descriptive****Level** |
| Classroom Management | 0.677 | 4.197 | High |
| Instructional Strategies | 0.648 | 4.259 | Very High |
| Class Engagement | 0.685 | 4.193 | High |
| **Overall** | **0.631** | **4.216** | **Very High** |

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

19

findings demonstrate the pivotal role of teacher ICT skills, selfefficacy 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** | The input of ICTintegratedpedagogy | **ICT Skills of Teachers**n of students ards…Implementations Output of ofICT-integrated ICT- pedagogy integratedpedagogy | **Overall** |
| Cognitive Engagement | .657\*(.000) | .715\*(.000) | .690\*(.000) | .749\*(.000) |
| Behavior Engagement | .581\* (.000) | .669\* (.000) | .622\* (.000) | .683\* (.000) |

20

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Affective Engagement | .524\* (.000) | .572\* (.000) | .525\* (.000) | .592\* (.000) |
| **Overall***\*Significant @ 0.05* | .661\* (.000) | .730\* (.000) | .687\* (.000) | **.757\* (.000)** |

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

21

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*

|  |  |  |
| --- | --- | --- |
| The input of ICTintegratedpedagogy | **ICT Skills of Teachers**of students rds…Implementations Output of ofICT-integrated ICT- pedagogy integratedpedagogy |  |
| **Self- efficacy** |  | **Overall** |
| 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) |
| **Overall***\*Significant @ 0.05* | .594\* (.000) | .658\* (.000) | .603\* (.000) | **.678\* (.000)** |

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

22

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 Selfefficacy 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** | Classroom Management | **Students Self**Instructional Strategies | **-Efficacy**Classroom Engagement | **Overall** |
| Cognitive Engagement | .683\*(.000) | .673\*(.000) | .687\*(.000) | .723\*(.000) |
| Behavior Engagement | .616\*(.000) | .661\*(.000) | .625\*(.000) | .672\*(.000) |

23

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Affective Engagement | .642\* (.000) | .670\* (.000) | .644\* (.001) | .692\* (.000) |
| **Overall***\*Significant @ 0.05* | .728\* (.000) | .747\* (.000) | .734\* (.000) | **.781\* (.000)** |

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.

24

## 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.Lower | I. (a) Upper | 𝛽 | 𝑧 | P |
| Indirect | Teacher ICT Skills⇒Selfefficacy⇒Student Engagement | 0.354 | 0.0360 | 0.283 | 0.424 | 0.337 | 9.82 | <.001 |
| Component | Teacher ICT Skills⇒Selfefficacy | 0.724 | 0.0435 | 0.638 | 0.809 | 0.678 | 16.63 | <.001 |
|  | Self-efficacy⇒Student Engagement | 0.489 | 0.0401 | 0.410 | 0.567 | 0.497 | 12.17 | <.001 |
| Direct | Teacher ICT Skills⇒StudentEngagement | 0.441 | 0.0429 | 0.357 | 0.525 | 0.420 | 10.29 | <.001 |
| Total | Teacher ICT Skills⇒StudentEngagement | 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)

25

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 𝛽= 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 𝑅2= 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

26

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 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.

27

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

2

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. Connectivism suggests that

students should combine thoughts, theories, and general information in a useful

manner. Therefore, students should learn how to effectively utilize ICT by

observing their teachers, who demonstrate high self-efficacy in its application

within the classroom. This knowledge empowers students to apply their learning

in any context and situation. Furthermore, it will enhance their attentiveness and

engagement in mathematics while incorporating the use of ICT. Additionally,

researchers have studied how engagement theory applies to learning using

technology. Thus, technology-based learning encourages collaboration and

includes both individual and group projects. This approach helps create

28

meaningful and authentic learning experiences. Hence, 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, selfefficacy 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

29

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.

Future research should explore the relationship between academic self-efficacy

and additional psychological variables, along with student engagement. Studies could

also focus on other grade levels, such as elementary and junior high school, while

increasing the number of participants is strongly encouraged. Moreover, it would be

valuable to consider a range of socio-demographic factors, including gender, age, type

of school, and geographical areas (rural versus urban).

The practical implications for educational strategies of this study are to promote teaching strategies that make better use of ICT that encourage selfefficacy 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,

30

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.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

31

## References

Afari, E., Eksail, F. a. A., Khine, M. S., & Alaam, S. A. (2023). Computer selfefficacy and ICT integration in education: Structural relationship and mediating effects. *Education and Information Technologies*, *28*(9), 12021–12037. https://doi.org/10.1007/s10639-023-11679-8

Aggarwal, M. (2020). TOOLS OF ICT FOR LEARNING AND TEACHING MATHEMATICS. *JOURNAL OF MECHANICS OF CONTINUA AND MATHEMATICAL SCIENCES*, *15*(4).

https://doi.org/10.26782/jmcms.2020.04.00001

Aguhayon, H., Tingson, R., & Pentang, J. (2023). Addressing Students Learning Gaps in Mathematics through Differentiated Instruction. *International Journal of Educational Management and Development Studies*, *4*(1), 69–87. https://doi.org/10.53378/352967

Agyeman, D., Nyarko, J., Opoku-Mensah, N., Fokuo, M. O., Owusu-Mintah, C., Asamoah, R. O., & Asare, S. (2023). The Role of ICT in Teaching and Learning Mathematics at College of Education: A Systematic review. *ResearchGate*. https://doi.org/10.7176/jep/14-12-06

Aidoo, B., Macdonald, A., Gyampoh, A. O., Baah, K. A., & Tsyawo, J. (2022). Factors Influencing Teachers’ Online Teaching Competence in Higher Education. *Social Education Research, 148–160*. https://doi.org/10.37256/ser.3120221315

Ali, M., Yasmeen, R., & Munawar, Z. (2023). The Impact of Technology Integration on Student Engagement and Achievement in Mathematics Education: A Systematic Review. *International Journal of Computer Integrated Manufacturing. 6. 222-232*. https://journals.researchparks.org/index.php/IJIE.

Alibakhshi, G., Nikdel, F., & Labbafi, A. (2020). Exploring the consequences of teachers’ self-efficacy: a case of teachers of English as a foreign language. *Asian-Pacific Journal of Second and Foreign Language Education*, 5(1). https://doi.org/10.1186/s40862-020-00102-1

Alrajeh, T. S., & Shindel, B. W. (2020). STUDENT ENGAGMENT AND MATH

TEACHERS SUPPORT. *Journal on Mathematics Education*, *11*(2), 167–

180. https://doi.org/10.22342/jme.11.2.10282.167-180

Arens, A. K., Frenzel, A. C., & Goetz, T. (2020). Self-Concept and Self-Efficacy in Math: Longitudinal Interrelations and Reciprocal Linkages with Achievement. *Journal of Experimental Education/˜the œJournal of Experimental Education*, 90(3), 615–633. https://doi.org/10.1080/00220973.2020.1786347

Arhin, D., Kwakye, K., Quaynor, L. Q., Boakye, R. O., & Yeboah, J. A. (2022). Influence of Teachers’ Self-Efficacy and Attitude towards the Integration of ICT into Teaching and Learning at the Basic School Level. *American Journal of Education and Practice*, *6*(1), 36–45. https://doi.org/10.47672/ajep.999

Arhin, J., Boateng, F. O., Akosah, E. F., & Gyimah, K. N. G. N. (2024). Perceptions and readiness of high school mathematics teachers for integration of ICT tools in the teaching and learning of mathematics. *Pedagogical Research*, *9*(1), em0179. https://doi.org/10.29333/pr/14032

32

Attard, C., & Holmes, K. (2020). “It gives you that sense of hope”: An exploration of technology use to mediate student engagement with mathematics. *Heliyon*, *6*(1), e02945. https://doi.org/10.1016/j.heliyon.2019.e02945

Aunzo, R. T. E. D., Anthony, J., Climaco, T., & Aunzo, R. T. (2021). Students’ perception and attitude on ict integration in mathematics classroom. *ResearchGate*.https://[www.researchgate.net/publication/353875491\_St](http://www.researchgate.net/publication/353875491_St) udents%27\_perception\_and\_attitude\_on\_ict\_integration\_in\_mathemati cs\_classroom

Ayuba, I., & Muhammad, S. (2020, July 29). THE BARRIERS OF USING INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) IN TEACHING AND LEARNING OF MATHEMATICS IN TERTIARY INSTITUTIONS OF KATSINA STATE. Ayuba | SAPIENTIA FOUNDATION JOURNAL OF EDUCATION, SCIENCES AND GENDER

STUDIES. https://sfjesgs.com/index.php/SFJESGS/article/view/30 Balol, N. (2023). The Use of ICT to Encourage Student’s Engagement with

Collaborative Learning. *International Journal of Linguistics, Literature and Translation*, *6*(2), 42–49. https://doi.org/10.32996/ijllt.2023.6.2.6

Baltà-Salvador, R., Torre, N. O., Peña, M., & Davids, A. I. R. (2021). Academic and emotional effects of online learning during the COVID-19 pandemic on engineering students. *Education and Information Technologies*, 26(6), 7407–7434. https://doi.org/10.1007/s10639-021-10593-1

Baroudi, S., & Shaya, N. (2022). Exploring predictors of teachers’ self-efficacy for online teaching in the Arab world amid COVID-19. *Education and Information Technologies*, *27*(6), 8093–8110. https://doi.org/10.1007/s10639-022-10946-4

Bergdahl, N., Nouri, J., & Fors, U. (2019). Disengagement, engagement and

digital skills in technology-enhanced learning. *Education and Information Technologies*, 25(2), 957–983. https://doi.org/10.1007/s10639-

01909998-w

Bhattarai, L. N. (2020). Students’ perception on ICT integrated mathematics classes. *Interdisciplinary Research in Education Volume 5, Issue 1 & 2, 2020: 27-38*. doi: [https://doi.org/10.3126/ire.v5i1&2.34732](https://doi.org/10.3126/ire.v5i1%262.34732)

Buchanan, M. T., & Lacey, A. (2019). Using information and communication technology (ICT) to facilitate cognitive engagement. *Elthe Ellīnikī Periodikī Ekdosī Gia Tī Thrīskeutikī Ekpaideusī*, 29–45. https://doi.org/10.30457/031120193

Cayubit, R. F. O. (2021). Why learning environment matters? An analysis on how the learning environment influences the academic motivation, learning strategies and engagement of college students. *Learning Environments Research*, 25(2), 581–599. https://doi.org/10.1007/s10984-021-09382-x

Cevikbas, M., & Kaiser, G. (2021). Student engagement in a flipped secondary mathematics classroom. *International Journal of Science and Mathematical Education/International Journal of Science and Mathematics Education*, *20*(7), 1455–1480. https://doi.org/10.1007/s10763-021-10213-x

33

Chand, S., Chaudhary, K. C., Prasad, A., & Chand, V. (2021). Perceived causes of students’ poor performance in mathematics: a case study at BA and Tavua Secondary Schools. *Frontiers in Applied Mathematics and Statistics*, *7*. https://doi.org/10.3389/fams.2021.614408

Chow, S. K. Y., & Wong, J. L. K. (2020). Supporting Academic Self-Efficacy, academic motivation, and information literacy for students in tertiary institutions. *Education Sciences*, *10*(12), 361. https://doi.org/10.3390/educsci10120361

Clipa, O., Delibas, C., & Mâță, L. (2023). Teachers’ Self-Efficacy and Attitudes towards the Use of Information Technology in Classrooms. *Education Sciences*, *13*(10), 1001. https://doi.org/10.3390/educsci13101001

Courtney, M., Karakuş, M., Ersozlu, Z., & Nurumov, K. (2022). The influence of ICT use and related attitudes on students’ math and science performance: multilevel analyses of the last decade’s PISA surveys.

*Large-scale Assessments in Education*, *10*(1). https://doi.org/10.1186/s40536-022-00128-6

Das, K. (2020). Role of ICT for better Mathematics Teaching. *Shanlax International Journal of Education*, *7*(4), 19–28. https://doi.org/10.34293/education.v7i4.641

Dellomos, C., Dela Cruz, M. A., Martinez, S., Miciano, K. N., Tiongson, R. J., Ty, J., Faylona, M. G. P., Tumaob, J. M., Tan, S., & Castro, B. (2023). Levels of self-efficacy and adjustment among Filipino elementary teachers in the re-opening of face-to-face classes. *International Research Journal of Science, Technology, Eduaction, and Management*, *3(4)*, 166–179. https://doi.org/10.5281/zenodo.10516518

Dhakal, P. K. (n.d.). *Use of ICT tools in teaching mathematics in higher education: a case of Mid-Western University.* https://eric.ed.gov/?id=EJ1227269

Doğan, S., Dogan, N., & Çelik, İ. (2020). Teachers’ skills to integrate technology in education: Two path models explaining instructional and application software use. *Education and Information Technologies*, *26*(1), 1311– 1332. https://doi.org/10.1007/s10639-020-10310-4

Emiru, E. K., & Gedifew, M. T. (2024). The effect of teacher self-efficacy on learning engagement of secondary school students. *Cogent Education*,

*11*(1). https://doi.org/10.1080/2331186x.2024.2308432

García, A. G., & Velázquez, M. L. (2020). Relationship between academic selfefficacy, performance and anxious and depressive symptoms in emerging adult college students. *Educación/EducacióN*, *29*(57). https://doi.org/10.18800/educacion.202002.005

Garg, Rekha. (2021, March 9). ROLE OF ICT IN TEACHING AND LEARNING.

*ResearchGate. https://*[*www.researchgate.net/publication/349924124\_ROLE\_OF\_ICT\_I*](http://www.researchgate.net/publication/349924124_ROLE_OF_ICT_I) *N\_TEACHING\_AND\_LEARNING*

Garzon, J. & Garzon, J. (2023). Teachers’ Digital Literacy and Self-Efficacy in Blended Learning. International Journal of Multidisciplinary Educational Research and Innovation, *01*(04), 12. https://doi.org/10.17613/cmjv1386

34

Goldhaber, A. B. (2021). Impact of ICT Integration on Quality of Education among Secondary Schools in USA. *Journal of Education*, *4*(6), 53–61. https://doi.org/10.53819/81018102t5015

Guerrero, C. E. D. (2022, November 4). *Computer self-efficacy, knowledge, and use of technological pedagogical and content knowledge among faculty post-graduate students*. Guerrero | Philippine Journal of Health Research and Development. https://pjhrd.upm.edu.ph/index.php/main/article/view/644

Gustiani, S. (2020, December 30). *STUDENTS’ MOTIVATION IN ONLINE LEARNING DURING COVID-19 PANDEMIC ERA: a CASE STUDY*.

https://jurnal.polsri.ac.id/index.php/holistic/article/view/3029

Hanaysha, J. R., Shriedeh, F. B., & Inairat, M. (2023). Impact of classroom environment, teacher competency, information and communication technology resources, and university facilities on student engagement and academic performance. *International Journal of Information Management Data Insights*, *3*(2), 100188.

https://doi.org/10.1016/j.jjimei.2023.100188

Hayat, A. A., Shateri, K., Amini, M., & Shokrpour, N. (2020). Relationships between academic self-efficacy, learning-related emotions, and metacognitive learning strategies with academic performance in medical students: a structural equation model. *BMC Medical Education*, *20*(1). https://doi.org/10.1186/s12909-020-01995-9

Hersh, M. (2020). Technology for inclusion. *UNESCO Digital Library*. https://unesdoc.unesco.org/ark:/48223/pf0000373655

Hettinger, K., Lazarides, R., & Schiefele, U. (2022). Motivational climate in mathematics classrooms: teacher self-efficacy for student engagement, student- and teacher-reported emotional support and student interest. *ZDM*, *55*(2), 413–426. https://doi.org/10.1007/s11858-022-01430-x

Hortelano, J., Ramos, R., Gutierrez, M., Catapang, H. (2021). MEDIATING ROLE OF SELF-EFFICACY TO USE ICT ON THE RELATIONSHIP BETWEEN DIGITAL PROFILE AND COMPETENCE. *Journal of Applied*

*Structural Equation Modeling: 5(1),19-39*. https://doi.org/ 10.47263/JASEM.5(1)04

Hussain, M. S., & Khan, S. A. (2022). SELF-EFFICACY OF TEACHERS: A REVIEW OF THE LITERATURE. *ResearchGate*.

https://[www.researchgate.net/publication/358368223](http://www.researchgate.net/publication/358368223)

*Integrating ICT for teaching and learning in selected SEAMEO countries*. (2023). https://doi.org/10.54676/bbic8850

Jansen, A., Curtis, K., Mirzaei, A. M., Cullicott, C. E., Smith, E. P., & Middleton,

J. A. (2023). Secondary mathematics teachers’ descriptions of student engagement. *Educational Studies in Mathematics*, *113*(3), 425–442. https://doi.org/10.1007/s10649-023-10228-x

Jewnandan, A. (2021). Faculty’s perspective on student engagement for synchronized online graduate level courses. *ProQuest Central*.

35

(2626931299). https://[www.proquest.com/dissertations-theses/facultys-](http://www.proquest.com/dissertations-theses/facultys-) perspective-on-student-engagement/docview/2626931299/se-2

Johnson, R. L. (2019). The influence of teacher technology self-efficacy on computer-assisted instruction in urban elementary schools. *ProQuest Central*. (2364139701).

[https://www.proquest.com/dissertationstheses/influence-teacher-](https://www.proquest.com/dissertations-theses/influence-teacher-technology-self-efficacy-on/docview/2364139701/se-2) [technology-self-efficacyon/docview/2364139701/se-2](https://www.proquest.com/dissertations-theses/influence-teacher-technology-self-efficacy-on/docview/2364139701/se-2)

Joshi, D. R. (2019). Effect of Problems of Mathematics Teachers in Using ICT on their Purposes to its Use. *Rainbow Journal*, *8*(1), 29–35. https://doi.org/10.3126/rainbowj.v8i1.44248

Joshi, D. R., Adhikari, K. P., Khanal, B., Khadka, J., & Belbase, S. (2022). Behavioral, cognitive, emotional and social engagement in mathematics learning during COVID-19 pandemic. *PloS One*, *17*(11), e0278052. https://doi.org/10.1371/journal.pone.0278052

Kundu, A., Bej, T., & Dey, K. N. (2021). Time to grow efficacious: effect of teacher efficacy on students’ classroom engagement. *SN Social Sciences*, *1*(11). https://doi.org/10.1007/s43545-021-00270-y

Lee, Y., Hwang, G., & Chen, P. (2022). Impacts of an AI-based chabot on college students’ after-class review, academic performance, selfefficacy, learning attitude, and motivation. *Educational Technology*

*Research and Development*, *70*(5), 1843–1865. https://doi.org/10.1007/s11423-022-10142-8

Llorente, H. M. C., & Tado, P. P. (2024). The Mediating Effect of Problem-based Learning on the Relationship between Technology Integration and Student Engagement in Mathematics. *Asian Journal of Education and Social Studies*, *50*(4), 54–69. https://doi.org/10.9734/ajess/2024/v50i41310

López, C. M., Hartmann, P., & Apaolaza, V. (2017). Gratifications on social networking sites: The role of secondary school students’ individual differences in loneliness. *Journal of Educational Computing Research*, *57*(1), 58–82. https://doi.org/10.1177/0735633117743917

M. Pineda, V., M. Asuncion, S., D. Baclig, I., W. Agbayani, R., & T. Capinding,

A. (2023). Learning engagement in mathematics during the PostPandemic transition. *International Journal of Research Publication and*

*Reviews*, *Vol 4*(5), 6270–6293. https://ijrpr.com/uploads/V4ISSUE5/IJRPR13669.pdf

Maamin, M., Maat, S. M., & Iksan, Z. H. (2021). The Influence of Student Engagement on Mathematical Achievement among Secondary School Students. *Mathematics*, *10*(1), 41. https://doi.org/10.3390/math10010041

Martínez-Borreguero, G., Naranjo-Correa, F. L., & Mateos-Núñez, M. (2022). Cognitive and Emotional Development of STEM Skills in Primary School Teacher Training through Practical Work. Education Sciences, 12(7),

470. https://doi.org/10.3390/educsci12070470

Mathews, B. P. (2022). Adolescent Capacity to Consent to Participate in Research: A review and analysis informed by law, human rights, ethics, and developmental science. *Laws*, *12*(1), 2.

36

https://doi.org/10.3390/laws12010002

Matongo, M. (2022). Teacher readiness to teach using ICT in classroom pedagogy in Zimbabwean primary schools. *Journal of African Education*, *3*(2), 45–66. https://doi.org/10.31920/2633-2930/2022/v3n2a2

Merillo, J., & Domingo, P. (2019). Technology in Pedagogy: Teachers’

perception towards the effectiveness of ICT integration in langua3ge teaching. *Social Science Research Network*.

https://doi.org/10.2139/ssrn.3442432

Minga, C., & Ghosh, S. (2024). Student perceptions on ICT use in teaching and learning in public secondary schools in Mbeya District, Tanzania. *Journal of Education Society and Behavioural Science*, *37*(6), 26–39. https://doi.org/10.9734/jesbs/2024/v37i61325

Morales, J. B., Llanes, W. L. L., Cabaluna, J. M. M., Cordero, R. D., Jr, & Bacatan, J. R. (2024). Analyzing the relationship between the sense of efficacy and technological pedagogical content knowledge of teachers. *Morales | Indonesian Journal of Multidiciplinary Research*. https://doi.org/10.17509/ijomr.v4i1.67759

Munir, S., Erlinda, R., & Afrinursalim, H. (2021). *Students’ Views on the Use of WhatsApp during COVID-19 Pandemic: A Study at IAIN Batusangkar.* https://eric.ed.gov/?id=EJ1297663

Murithi, J., & Yoo, J. E. (2021). Teachers’ use of ICT in implementing the competency-based curriculum in Kenyan public primary schools.

*Innovation and Education*, *3*(1). https://doi.org/10.1186/s42862- 02100012-0

Nagy, J., & Dringó-Horváth, I. (2024). Factors influencing university teachers’ technological integration. *Education Sciences*, *14*(1), 55. https://doi.org/10.3390/educsci14010055

Peng, R., Razak, R. A., & Halili, S. H. (2023). Investigating the factors affecting ICT integration of in-service teachers in Henan Province, China: structural equation modeling. *Humanities & Social Sciences Communications*, *10*(1). https://doi.org/10.1057/s41599-023-01871-z

*PISA 2022: Factsheets PHILIPPINES*. (2023, December 5). OECD.org.

Retrieved June 6, 2024, from https://[www.oecd.org/publication/pisa-](http://www.oecd.org/publication/pisa-) 2022-results/country-notes/philippines-a0882a2d/

Quintero, M., Hasty, L. M., Li, T., Song, S., & Wang, Z. (2021). A multidimensional examination of math anxiety and engagement on math achievement. *British Journal of Educational Psychology*, *92*(3), 955– 973. https://doi.org/10.1111/bjep.12482

Ryan, V., O’Donoghue, J., & Fitzmaurice, O. (2022). Student interest and engagement in mathematics after the first year of secondary education. *European Journal of Science and Mathematics Education*, *10*(4), 436–

454. https://doi.org/10.30935/scimath/12180

Santi, E. A., Gorghiu, G., & Pribeanu, C. (2022). Students’ engagement and active participation during the pandemic. *Informatică Economică*, *26*(1/2022), 5–15. https://doi.org/10.24818/issn14531305/26.1.2022.01

Şen, E. Ö. (2022). Middle school students’ engagement in mathematics and learning Approaches: Structural equation modeling. *Pedagogical Research*, *7*(2), em0124. https://doi.org/10.29333/pr/11908

37

Seneviratne, K. P., Hamid, J. A., Khatibi, A., Azam, F., & Sudasinghe, S. (2019, November 26). *Teachers’ Sense of efficacy: A Challenge for professional development towards teaching science as inquiry*. https://[www.icaseonline.net/journal/index.php/sei/article/view/163](http://www.icaseonline.net/journal/index.php/sei/article/view/163) Sesmiyanti,

S. (2018). Student’s cognitive engagement in learning process. *Journal Polingua: Scientific Journal of Linguistic Literatura and Education*, *5*(2), 48–51. https://doi.org/10.30630/polingua.v5i2.34

Shabnam, M., & Mahat, S. (2022). A STUDY OF TEACHERS OPINION: ICT

TEACHING PROCESS. *Research Gate* https://[www.researchgate.net/publication/362712385\_A\_Study\_of\_teac](http://www.researchgate.net/publication/362712385_A_Study_of_teac) hers\_Opinion\_ICT\_teaching\_process/citation/download

Shahzad, K., & Naureen, S. (n.d.). *Impact of Teacher Self-Efficacy on Secondary school students’ academic achievement.* https://eric.ed.gov/?id=EJ1161518

Shé, C. N., Fhloinn, E. N., & Mac an Bhaird, C. (2023). Student Engagement with Technology-Enhanced Resources in Mathematics in Higher Education: A Review. *Mathematics*, *11*(3), 787. https://doi.org/10.3390/math11030787

Sidhu, A., Bhalla, P., & Zafar, S. (2021). Mediating effect and review of its statistical measures. *The Empirical Economics Letters*. 20. 29-40. [https://www.researchgate.net/publication/355376494\_Mediating\_Effect](https://www.researchgate.net/publication/355376494_Mediating_Effect_and_Review_of_its_Statistical_Measures)

[\_and\_Review\_of\_its\_Statistical\_Measures](https://www.researchgate.net/publication/355376494_Mediating_Effect_and_Review_of_its_Statistical_Measures)

Siregar, E., Nurtanto, M., Mutohhari, F., Majid, N. W. A., & Kurdi, M. S. (2022). Mediating Role of Teachers’ Self-Efficacy and Psychological Capital in determining Success during Learning Transition Periods in Vocational Education. *Journal of Education and E-learning Research*, *9*(3), 207–

215. https://doi.org/10.20448/jeelr.v9i3.4193n

Slater, E., Norris, C. M., & Morris, J. E. (2021). The validity of the science teacher efficacy belief instrument (STEBI-B) for postgraduate, preservice, primary teachers. *Heliyon*, *7*(9), e07882. https://doi.org/10.1016/j.heliyon.2021.e07882

Supervía, U. P., Bordás, S. C., & Robres, Q. A. (2022). The mediating role of self-efficacy in the relationship between resilience and academic performance in adolescence. *Learning and Motivation*, *78*, 101814. https://doi.org/10.1016/j.lmot.2022.101814

Tang, Y., & Hew, K. F. (2022). Effects of using mobile instant messaging on student behavioral, emotional, and cognitive engagement: a quasiexperimental study. *International Journal of Educational Technology in Higher Education*, *19*(1). https://doi.org/10.1186/s41239- 021-00306-6

Tomaro, Q. P. V. (2018). ICT integration in the educational system of Philippines. *Journal of Governance and Public Policy/Journal of Governance and Public Policy*, *5*(3). https://doi.org/10.18196/jgpp.5399

Tomović, A. (2021). *Engagement Theory based Interpretative Phenomenological Analysis of Computer Science Students’ Perceptions of Their Learning Engagement Using Mobile Devices. The Repository at St. Cloud State*. https://repository.stcloudstate.edu/hied\_etds/52/?utm\_source=repositor

38

y.stcloudstate.edu%2Fhied\_etds%2F52&utm\_medium=PDF&utm\_cam paign=PDFCoverPages

Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students’ academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. *Heliyon*, *8*(12), e12657. https://doi.org/10.1016/j.heliyon.2022.e12657

Wester, E. R., Walsh, L. L., Arango-Caro, S., & Callis‐Duehl, K. (2021). Student Engagement Declines in STEM Undergraduates during COVID-19– Driven Remote Learning. *Journal of Microbiology & Biology Education*,

*22*(1). https://doi.org/10.1128/jmbe.v22i1.2385

Winter, E., Costello, A., O’Brien, M., & Hickey, G. (2021). Teachers’ use of technology and the impact of Covid-19. *Irish Educational Studies*, *40*(2), 235–246. https://doi.org/10.1080/03323315.2021.1916559

Wu, F., & Teets, T. S. (2021). Effects of the COVID-19 pandemic on student engagement in a general chemistry course. *Journal of Chemical Education*, *98*(12), 3633–3642.

https://doi.org/10.1021/acs.jchemed.1c00665