

# Estimating the Percentage Mediation of ICT Utilisation on Information Literacy and Mathematics Performance in Colleges of Education, Ghana

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## Abstract

**Introduction:** Student teachers' (ST) mathematics performance (MP) is still an issue of concern in college. Meanwhile, ICT integration and utilisation has been a policy for almost a decade. This is to enable tertiary learners to breakthrough learning struggles particularly in mathematics.

**Aim:** This paper aims to model the relationship between student teachers' interest in information literacy (IIL) and MP moderated by ICT utilisation (ICTU).

**Methods:** Analytic survey design was adopted using IIL and ICTU Questionnaire and Mathematics Achievement Test (MAT) to collect data. Level 200 student teachers were purposely selected with a random sampling technique to obtain 526 student teachers from two Colleges of Education in the Hohoe Municipality, Volta region.

**Result:** It was revealed that, majority 138 (26.2%) had moderate interest in IIL while only 47(8.9%) of them were extremely interested. Similarly, the majority 135(25.7%) indicated that ICTU was somewhat helpful while only 41(7.8%) expressed that it was very helpful. There was no significant influence of gender and programs of study on MP. There was a significant positive correlation between ICTU and IIL and for MP and IIL, there was a significant inverse correlation directly. The result also shows that in IIL inversely predict student teachers' MP relationship but not moderated by ICTU.

**Conclusion:** The findings suggest that student teachers who show high IIL are more likely to perform less in mathematics and vice versa.

**Keywords:** Interest in Information Literacy, ICT Utilisation, Mathematics, Performance, Interest

## 1. Introduction

ICT refers to a range of digital technologies, tools, and resources that are used to communicate, create, store, process, and manage information. In the context of education, ICT can be used to enhance teaching and learning processes, facilitate access to educational resources, and improve students' academic performance. According to Ullah, et al., (2019), ICT in education encompasses the use of digital technologies to access, process, and communicate information, to create and share knowledge, and

to facilitate teaching and learning processes [1]. This definition highlights the broad scope of ICT in education, including both hardware and software technologies, as well as the social and pedagogical contexts in which they are used. In recent years, the integration of ICT in education has become increasingly important, as digital technologies are transforming the way we live, work, and learn. It is essential for educational institutions to keep up with these changes and ensure that students have the necessary skills and competencies to thrive in the digital age.

Information literacy on the other hand is a critical skill that enables individuals to identify, locate, evaluate, and use information effectively. In the context of ICT usage among students in college, information literacy plays a significant role in determining the extent to which students can leverage the full potential of digital technologies for academic and personal purposes. A recent study by Kim (2018) investigated the influence of information literacy on ICT usage among students in a college in Saudi Arabia [2]. The study found that information literacy significantly influenced students' ICT usage, as students who had higher levels of information literacy were more likely to use ICT for academic and personal purposes. The study also found that students who had received formal information literacy training were more likely to use ICT for academic purposes than those who had not received such training. These findings highlight the importance of information literacy in promoting effective and efficient use of ICT among students in college. Educational institutions should prioritise the development of information literacy skills among students to enhance their ICT usage for academic and personal purposes.

The integration of Information and Communication Technologies (ICT) in education has become increasingly prevalent, and many studies have investigated the relationship between ICT utilisation and academic performance. One area of interest is the relationship between ICT utilisation and mathematics performance. Bature, (2016) and Asampana, et al., (2017) respectively examined the relationship between ICT utilisation and mathematics performance among high school students in Turkey and student (gender and age) influence on mathematics [3, 4]. The study found that ICT utilisation had a positive effect on students' mathematics performance, as students who used ICT more frequently had higher mathematics scores than those who used ICT less frequently. The study also found that students who had more positive attitudes towards ICT usage had higher mathematics scores than those with less positive attitudes. The study suggests that ICT utilisation can be an effective tool for improving mathematics performance among students. By integrating ICT into mathematics instruction, teachers can engage students in interactive and personalised learning experiences that can enhance their understanding and retention of mathematical concepts. However, other studies, for example revealed that there is no statistically significant relationship between male and female students and performance in mathematics [5].

Education incorporates various tools and technologies, including computers, CD-ROMs, word processors, projection TVs, image graphic software, email, and Internet-based communication technology, all of which come under the umbrella of Information and Communication Technology (ICT) [6]. They also stated that the use of ICT has the potential to bring about a shift from teacher-centred to learner-centred teaching and learning styles, as well as enhancing students' information-reasoning skills, communication skills, creativity, higher thinking skills, and problem-solving abilities. The study indicated that research has not produced consistent findings about the effects of ICT use on learning outcomes, partly due to the lack of differentiation between the pure effects of ICT use and the effects of other variables. Additionally, their study considered the differences in ICT-related variables at the student and school levels. Therefore, to determine the significant variables in relation to ICT use and

its effects, it is essential to examine which variables are most impactful and how they influence learning outcomes. The study's findings indicated that the ICT use variables were responsible for explaining 12.26% of the variance in mathematics achievement at the elementary level, 10.56% at the middle school level, and 18.25% at the high school level. The study considered background and process variables in model 2, and noted that the variance of mathematics variables increased by 25.30% at the student-level and 90.95% at the school-level in elementary schools. The other variables accounted for a 21.51% greater variance at the student-level and 99.42% greater at the school-level in middle school when model 2 was used. Additionally, taking into account the student process, student background, school process, and school background variables led to mathematics variance being 16.55% greater at the student-level and 83.24% greater at the school-level in high schools. When the student-level and school-level variances were collectively considered, the additional independent variables explained 30.79% more variance at the elementary school level, 29.83% more at the middle school level, and 36.58% more at the high school level.

It is widely accepted that Information and Communication Technologies (ICT) are now an integral part of the lives of children and young people. A study on ICT literacy emphasises that it should include Internet literacy, Computer literacy, and Information literacy, as these three forms of literacy are indispensable in many aspects of human life in the 21st century [7]. The study employed the Structural equation models to investigate the relationships between these three dimensions of ICT literacy, the importance of parental and teacher support, and the use of the Internet as a pedagogical tool. The objective was to assess how these factors relate to school performance and explain why ICT literacy influences it. The results of this study suggest that ICT literacy is undoubtedly a factor in the school performance of students in the 3rd cycle of basic education and secondary education (grades 7-12) in the district of Vila Real, Portugal. Furthermore, the use of the Internet as a pedagogical tool is a major factor in school performance, and parental and teacher support positively influence ICT literacy.

Another study by Nwosu, et al., (2018) opined that Information and Communication Technology (ICT) has become a fundamental aspect of almost every human endeavour, including education [8]. Nowadays, teaching, learning, assessment, course registration, and payment, among other things, are all dependent on ICT. People have been utilising technology to enhance their lifespan and the quality of their lives, and education is no exception to this shift. The study examines the information literacy skills and Information and Communication Technology competence of undergraduate students in Ogun State and how these skills relate to their academic achievement. A descriptive survey design was utilised in this study, with a population of 10,713 students from Tai Solarin University of Education (TASUED), comprising four colleges and 10,000 students from Babcock University, comprising nine colleges. The sample for the study was selected through simple random sampling, consisting of 170 respondents from Babcock University and 130 respondents from TASUED, totaling 300 students from levels 100-500. A well-structured questionnaire was the primary instrument used for the collection of primary data. The results

of the study indicate that 80% of the undergraduate students of TASUED and BU possess basic ICT literacy skills, including the ability to locate and access information resources for their research. Additionally, the use of ICT has been found to improve students' academic performance.

Gubbels, et al., (2020) indicates that previous studies found that the availability of ICT resources at school has no relation or a negative relation to academic performance, the availability of ICT resources at home has been found to have both positive and negative effects [9]. The frequency of ICT use is also related to academic performance, but the nature of the relationship is ambiguous. Additionally, students' attitudes toward ICT have been found to influence their academic performance. Their study explores how the availability of ICT resources, students' ICT use (at school, outside of school for schoolwork, and outside of school for leisure), and their attitudes toward ICT (interest, perceived competence, and perceived autonomy) relate to individual differences in performance on a digital reading assessment. The study uses data from the Dutch PISA 2015 sample, which includes 5,183 15-year-olds (49.2% male). After controlling for the effects of gender and students' economic, social, and cultural status, the results indicate that moderate access to ICT resources, moderate use of ICT at school or outside of school for schoolwork, and moderate interest in ICT are associated with higher digitally assessed reading performance. In contrast, moderate perceived competence in ICT is associated with lower digitally assessed reading performance. The study also found that frequent use of ICT outside of school for leisure is negatively related to digitally assessed reading performance, while perceived autonomy is positively related. The findings suggest that excessive access to ICT resources, excessive use of ICT, and excessive interest in ICT are associated with lower digitally assessed reading performance.

The integration of Information and Communication Technologies (ICT) in education has become a prevalent trend worldwide. In Ghana, the government has made efforts to introduce ICT in schools to enhance teaching and learning. However, there is a need to evaluate the impact of ICT utilisation on students' academic performance and information literacy. Studies have shown that ICT utilisation can positively influence students' academic performance and information literacy [10, 11]. Furthermore, information literacy is a critical skill for students to succeed in their academic work and beyond [12]. Therefore, it is essential to investigate the extent to which ICT utilisation can mediate information literacy and academic performance.

In the context of Colleges of Education in Ghana, which are responsible for training teachers for basic schools, understanding the relationship between ICT utilisation, information literacy, and academic performance is crucial. This study aims to estimate the percentage mediation of ICT utilisation on information literacy and mathematics performance in Colleges of Education, Ghana. This research will use a quantitative research approach, specifically the mediation analysis method, to estimate the percentage of mediation of ICT utilisation on information literacy and mathematics performance. The study will collect data from a sample of students in Colleges of Education in Ghana

using a structured questionnaire. The questionnaire will collect information on the frequency of ICT utilisation, information literacy skills, and mathematics performance.

The findings of this study will provide insights into the extent to which ICT utilisation mediates information literacy and mathematics performance in Colleges of Education, Ghana. The results can inform policy decisions on the integration of ICT in education and teacher training programs in Ghana.

## 2. Aim and Justification of the Study

The integration of Information and Communication Technology (ICT) into teaching and learning has become a growing trend in education globally, including in Ghana. The use of ICT has been linked to improvements in students' academic performance, particularly in subjects such as mathematics. Additionally, information literacy, which encompasses the ability to locate, evaluate, and use information effectively, has been recognized as a critical component of academic success. However, little research has been conducted on the relationship between ICT utilisation, information literacy, and mathematics performance in Colleges of Education in Ghana.

Therefore, the aim of this study is to estimate the percentage mediation of ICT utilisation on information literacy and mathematics performance in Colleges of Education, Ghana. The study aims to provide insights into the extent to which ICT utilisation mediates the relationship between information literacy and mathematics performance, which will contribute to the development of effective strategies for improving students' academic achievement in Ghanaian Colleges of Education. Ultimately, this research will inform policy decisions on the integration of ICT in teaching and learning practices in Ghanaian educational institutions.

## Research questions

1. What is the influence of student teachers' gender on mathematics performance?
2. What is the influence of student teachers' program of study on mathematics performance?

## Hypothesis

H01: There is no positive relationship in student teachers' IIL course and MP in college.

H02: Student teachers' ICTU mediation has no positive relationship between IIL course and MP in college.

## 3. Method and Materials

Analytic survey design was adopted using Interest in Information Literacy (IIL) and ICT Utilisation Questionnaire (IILICTUQ) and Mathematics Achievement Test (MAT) to collect data. Level 200 student teachers were purposely selected with a convenient sampling technique to obtain 526 out of 721 student teachers from two Colleges of Education in the Hohoe Municipality, Volta region. The sample is a sufficient representation of the population. This made it a fair representative to draw the conclusion of the result based on the study area. The two CoEs in the Hohoe Municipality are among the highly rated colleges in Ghana. One is an all-female while the other is mixed CoE.

They all run 4 - year B. Ed. programs as accredited by the Ghana National Teachers Council (GTEC) and also affiliated to the same university. Data was analysed using Jamovi statistical software. Participants were recruited for the study upon invitation to participate in this study. An interaction forum was held with the participants indicating the aims to investigate mediation of ICT usage on Information literacy and Mathematics performance. The questionnaire took approximately 20 minutes averagely for every participant to complete. Participation in this study was voluntary, and the participants have the right to withdraw at any time. There are no known risks associated with participating in this study. However, the participants may benefit from contributing to scientific knowledge in the field of ICT, Information literacy and Mathematics education. Again, participation in this study was kept confidential. Personal information was kept anonymous, and responses were reported in aggregate form. Only the researcher has access to the data

collected during this study. participants acknowledge that they understand the procedures involved in the study and that participation was voluntary, and have the right to withdraw at any time.

#### 4. Data Analysis and Results

Preliminary are the descriptive statistics presented to show the frequency counts and percentage distribution of the demographic variables (gender and programme of study).

It was noted that 293(55.7%) male and 233(44.3%) female student teachers from the selected colleges of education in the Volta region took part in the study. The distribution of participants regarding their programs of study in colleges was 205(39.0%) participants offering Primary Education, 177(33.7%) were Junior High School Education options and 144(27.4%) were Early Childhood Education student teachers.

	Sum of Squares	df	Mean Square	F	p
Overall model	1358.92	5	271.78	0.66089	0.653
gender	1023.15	1	1023.15	2.24079	0.135
program of study	8.30	2	4.15	0.00909	0.991
gender * program	327.47	2	163.73	0.35859	0.699
Residuals	237433.34	520	456.60		

**Table 1: ANOVA - Mathematics Performance**

One - way ANOVA was computed to compare the influence of gender and program of study on mathematics performance among student teachers in three selected colleges of education. From table 1, the test revealed that there was no significant influence of gender [F(2.243, p = 0.135)] and programs of study [F(0.009, p=0.699)] on mathematics performance in college.

This indicates that there is no mean difference between male and female student teachers' performance in college regarding their mathematics performance. Similarly, there is no significant difference in student teachers' programs of study in relation to their mathematics performance.

Levels	Counts	% of Total	Cumulative %
Not interested	124	23.6%	23.6%
Slightly interested	131	24.9%	48.5%
Somewhat interested	138	26.2%	74.7%
Moderately interested	32	6.1%	80.8%
Very interested	54	10.3%	91.1%
Extremely interested	47	8.9%	100.0%

**Table 2: Frequencies of Student Teachers Interest in Information Literacy**

Table 2 shows the descriptive result of student teachers' interest levels in information literacy. It can be observed that the majority 138 (26.2%) had somewhat interest in the course compared to only 47(8.9%) who were extremely interested.

It can also be observed that interest level decreases from not interest to extremely interested. This posted a very bad nature of the student teachers' poor attitude towards effective utilisation of ICT and digitising the physical classroom.

Levels	Counts	% of Total	Cumulative %
Not helpful	133	25.3%	25.3%
Slightly helpful	129	24.5%	49.8%
Somewhat helpful	135	25.7%	75.5%
Moderately helpful	35	6.7%	82.1%
Very helpful	41	7.8%	89.9%
Extremely helpful	53	10.1%	100.0%

**Table 3: How helpful or are you able to Utilisation ICT in relation to the Study of Mathematics**

In table 3, it is interesting to note that student teachers seem to have some level of consistency in the application ICT knowledge and the interest shown in the course in studying mathematics. The result shows that the majority 135(25.7%) indicated that

ICTU was somewhat helpful while only 41(7.8%) expressed that it was very helpful. Again, the number of student teachers reduced from not helpful to extremely helpful.

		IIL	ICTU
Interest in INFOLIT (IIL)	Pearson's r	—	
ICT Utilisation (ICTU)	Pearson's r	0.439***	—
Mathematics Performance (MP)	Pearson's r	-0.117**	-0.03
Note. * $p < .05$ , ** $p < .01$ , *** $p < .001$			

**Table 4: Correlation Matrix**

Spearman's rank correlation was computed to assess the relationship between the three variables in table 4. For ICTU and IIL courses, there was a strong positive correlation between the two variables,  $r = .44$ ,  $p < .001$ , and for MP and interest in the course, there was an inverse correlation between the

two variables,  $r = -0.12$ ,  $p < 0.05$ . Meanwhile, there was an insignificant inverse weak correlation established between ICTU and mathematics performance. To ascertain the correlation result, a series of regression analysis was computed to test if there is a relationship between variables based on mediation estimates.

Effect	Label	Estimate	SE	Z	p	% Mediation
Indirect	$a \times b$	0.154	0.263	0.585	0.558	8.08
Direct	c	-1.750	0.644	-2.717	0.007	91.92
Total	$c + a \times b$	-1.596	0.614	-2.600	0.009	100.00

**Table 5: Mediation Estimates**

			Label	Estimate	SE	Z	p
IIL	→	ICTU	a	0.444	0.0411	10.800	<.001
ICTU	→	MP	b	0.347	0.5925	0.586	0.558
IIL	→	MP	c	-1.750	0.6441	-2.717	0.007

**Table 6: Path Estimates**

It was hypothesised that being interested and motivated in an IIL course will positively predict the student teacher's mathematics performance. In addition, it was hypothesised that ICTU will mediate the association. Series of regression analysis were computed to test the hypothesis. The result shows that interest in IIL inversely predict student teachers' mathematics performance relationship,  $B = -1.59$ ,  $Z = -2.60$ ,  $p = 0.009$ . Considering the indirect effect, the result shows that ICTU did not significantly mediates the relationship between interest and mathematics performance,  $ab = 0.154$ ,  $Z = 0.59$ ,  $p = 0.56$ . However, IIL have a positive and significant influence on ICTU,  $B = 0.154$ ,  $Z = 10.8$ ,  $p < 0.001$ . Nevertheless, after accounting the role mediating effect, the result still suggests that there is an inverse relationship between interest and mathematics performance,  $B = -1.75$ ,  $Z = -2.72$ ,  $p = 0.007$ . ICTU accounts for only 8.08% of total influence. The findings suggest that student teachers who show high interest in IIL are more likely to perform less in mathematics. this is because IIL is associated with MP. However, the fact that a student teacher shows interest in IIL does necessarily mean that the student teacher can utilise ICT to perform well in mathematics. It is therefore suggested that ICTU account for 8.08% mediation (indirect) influence on student teachers' mathematics performance and IIL account for 91.92% direct influence on student teachers' mathematics performance. Additionally, the significant direct effect of IIL on MP suggests that IIL is an important predictor of MP, regardless of its effect on ICTU. This finding has practical implications for interventions

aimed at improving MP, as it suggests that targeting IIL directly may be an effective approach.

## 5. Findings and Discussion

This study found that there was no significant difference between gender (male and female) students and programmes of study on mathematics performance in college of education. In line with the finding on gender influence on mathematics, a study by Adebule, and Aborisade, (2014) is in support by indicating that in the research study that was conducted, the gender of the students did not have a significant impact on their attitudes towards mathematics. This suggests that male and female students had similar attitudes towards mathematics, and any differences that were observed were not strongly influenced by gender. Similarly, Ding, et al., (2006) found that there was no significant difference in the improvement of mathematics between male and female students. The study found that both male and female students showed a similar rate of progress in their mathematics performance over time, indicating that gender did not have a significant impact on their ability to learn and improve in mathematics. These findings suggest that there is no inherent advantage or disadvantage in being male or female when it comes to learning mathematics, and that individual factors such as motivation, learning style, and prior knowledge may have a greater impact on mathematics performance than gender. Contrary to the insignificant gender influence on academic performance, Asampana, et al., (2017) investigated

the factors that predict academic performance in mathematics. The results show that two factors are significant predictors of good academic performance in mathematics: gender of students and age of students. Specifically, male students tend to perform better in mathematics than female students. Moreover, the age of students is also a significant predictor, indicating that older students perform better in mathematics than younger students.

This study also found that there was a positive moderate correlation between student interest in information literacy and ICT utilisation, but has a weak inverse relationship with mathematics performance in college of education. This was further confirmed using the mediation analysis, which suggests that interest in information literacy directly has an inverse relationship to mathematics performance, however, when mediated by ICT usage (indirect) there is weak positive but insignificant relationship between interest in information literacy and mathematics performance.

There is an inverse relationship between interest in information literacy and mathematics performance, with a coefficient (B) of -1.59 and a significance level (p) of 0.009. This suggests that as interest in information literacy increases, mathematics performance tends to decrease. Furthermore, ICT usage did not significantly mediate (i.e., explain) the relationship between interest in information literacy and mathematics performance, with a coefficient (ab) of 0.154 and a non-significant p-value of 0.56. This means that the use of ICT did not appear to play a significant role in the relationship between interest in information literacy and mathematics performance. However, interest in information literacy had a positive and significant influence on ICT usage, with a coefficient (B) of 0.154, a large Z-score of 10.8, and a very low p-value of less than 0.001. This suggests that as interest in information literacy increases, so does the use of ICT. This reinforces the finding that student teachers with more interest in information literacy tend to perform worse in mathematics. To support and contrary to the findings of this study the following literature were cited: Bature, (2016) and Nwosu, et al., (2018), suggests that students who use ICT, such as digital tools or educational software, tend to perform better in mathematics and develop better problem-solving skills compared to those who do not use ICT. Partially in line with this study, Kim, (2018), indicates that ICT usage has direct, indirect, and total effects on mathematics performance. Direct effects refer to the immediate impact of ICT access or use on mathematics performance, while indirect effects may operate through other variables or factors. Total effects refer to the combined impact of both direct and indirect effects.

## 6. Conclusion and Recommendation

The study findings established that ICTU has an insignificant mediation effect on student teachers' interest in information literacy and mathematics performance in CoEs in the Hohoe Municipality. It is also concluded that gender and program of study have no significant percentage ICT interest and utilisation influence on student teachers' mathematics performance. based on the results, it is recommended that;

i. The mentoring university and colleges of education should examine Information literacy courses practically so that student

teachers can acquire the skill instead of the theory, which positioned them to just pass the course.

ii. The government of Ghana in collaboration with other stakeholders should support student teachers to acquire personal laptops for their academic work and research. This may force them to develop interest and use of ICT for academic work.

iii. Finally, colleges of education should regularly organise ICT integration seminars and workshop for student and teachers to develop interest information literacy (research) and usage of ICT

## Areas of further research

This study solely investigated the mediation effect of ICT utilisation on student teachers' interest in information literacy courses and mathematics performance in college without accounting for other contributing factors that may cause students to have high interest in information literacy and ICT usage. Therefore, future studies should investigate why students have interest in information literacy and ICT usage. Examine what student use information literacy and ICT for apart from academic work.

## Ethical Approval

Ethics approval for this study was obtained from the Institutional Review Board (IRB) of St. Teresa's College of Education, Hohoe. The study adhered to the ethical principles and guidelines of the St. Teresa's College of Education, Hohoe research ethics committee. Participants provided informed consent before their inclusion in the study, and all personal identifying information was kept confidential throughout the study. The study was conducted with the utmost respect for the dignity, privacy, and well-being of human subjects. The IRB approved the study with the condition that participants be provided with the option to withdraw from the study at any time without penalty. All study procedures were carried out in accordance with the approved protocol and any deviations were reported to the IRB as required.

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