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Mediating Effects of Students' Study Time on ICT Resource Availability, Teacher Competence and Academic Performance in Programming Languages

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Abstract

This study investigated the mediating role of students' study time in the relationships between the availability of ICT (information and communication technology) resources, teacher competence, and academic performance in programming language courses. The researchers used a sample of 287 undergraduate students and employed structural equation modeling (SEM) to analyze the hypothesized mediating effects. The findings showed that both ICT resource availability and teacher competence had positive and significant indirect effects on academic performance, which were partially mediated by the amount of time students spent studying. Specifically, the indirect effect of ICT resource availability on academic performance through study time was 0.159 ($p < 0.001$), and the indirect effect of teacher competence on academic performance through study time was 0.195 ($p < 0.001$). These results suggest that while ICT resources and teacher competence directly contribute to improved academic performance in programming languages, they also indirectly influence performance by promoting increased study time among students. The mediating role of study time highlights the importance of creating an environment that supports and encourages students to engage in self-directed learning activities, in addition to providing adequate technological resources and competent teaching. The findings have important implications for educational practitioners and policymakers, as they emphasize the need to adopt a holistic approach to enhancing student learning outcomes in programming courses by understanding the complex interplay between various factors and their indirect effects.

Keywords: Students' Study Time; Academic Performance; Ict Resource; Teacher Competency; Basic Programming Languages

1. Introduction

The number of students joining universities in the country is increasing year by year, especially in computer science. Programming language is a common mandatory course taught in the first year of engineering and computer science programs(Sun et al., 2017). Basic programming concepts refer to basic concepts related to structured programming and the algorithms used in programming(Ouahbi et al., 2015). The importance of educational programming languages is increasing day by day in overcoming these obstacles. Students learning basic programming languages often face several challenges that impact their comprehension and progress. Difficulties in grasping fundamental programming concepts can hinder their advancement to more complex topics. Using code editor students can take advantages of code editors such as syntax highlighting, automatic indentation and code autocompleting. Students spent extra time to check codes and add the punctuations marks in the correct places(Gursoy, 2016). Instead of memorizing the code its important students to spend more time for practicing this will be help students to in exam time. However, many programming courses focus heavily on rote memorization instead of allowing students to engage in practical applications of their knowledge. This approach can hinder their ability to process concepts deeply and apply them effectively. A lack of motivation and interest in programming can affect engagement and learning outcomes, while traditional teaching methods may not cater to the diverse learning styles of students, leading to varied levels of understanding. Additionally, limited access to learning resources and tools can impede students' ability to practice and apply programming skills effectively. Moreover, students' perceptions of their programming abilities significantly influence their confidence and willingness to pursue programming further, affecting their overall success in the field. Learning a computer programming language has been known to be difficult for high-school and university students because of the lack of time for practice(Genese, 2005). Students' study time plays a crucial role in the academic success of students, particularly in challenging subjects like programming languages. The complexity of these subjects often mirrors that of learning a second language, requiring extensive practice and understanding. When students invest adequate study time, they not only familiarize themselves with programming syntax and techniques but also develop essential problem-solving skills that are vital in STEM fields (Sun et al., 2017). However, many programming courses focus heavily on rote memorization instead of allowing students to engage in practical applications of their knowledge. This approach can hinder their ability to process concepts deeply and apply them effectively. Moreover, the lack of sufficient study time exacerbates students' struggles, leading to frustration and decreased motivation, as they find it challenging to grasp complex topics without the necessary practice (Lulu C. H. Sun et al., 2017).

The availability of ICT resources in universities has been associated with enhanced learning experiences, fostering student engagement and academic achievement. However, the effectiveness of these technological tools heavily relies on various factors, including teacher competence and the amount of study time that students allocate to their academic pursuits. As educators strive to leverage ICT in teaching methods, understanding how these variables interact becomes crucial for improving educational outcomes. One of the primary obstacles is the lack of adequate learning resources and infrastructure, which adversely affects the quality of education. Many institutions struggle with insufficient access to updated technology and relevant software, making it difficult for students to gain hands-on experience essential for mastering ICT skills. Additionally, the limited availability of qualified instructors exacerbates this issue, as many

educators may not possess the necessary expertise or training to effectively teach complex ICT subjects.

Additionally, educators often face the challenge of not being adequately trained to convey these intricate subjects, further complicating students' learning experiences. To combat these issues, institutions must prioritize creating an environment where students have the opportunity to engage in hands-on activities and collaborative learning. Such environments would not only enhance their understanding but also empower them to tackle real-world problems confidently, ultimately leading to greater proficiency in their field. This study aims to explore the mediating effects of students' study time on the relationship between ICT resource availability and teacher competence regarding academic performance. By examining this dynamic interplay, we seek to illuminate critical insights that can inform educational policies and practices aimed at maximizing student success in technology-enhanced learning environments. Thus, the study answers these two questions: *(1) To what extent does students' study time teacher competence and ICT resource availability mediate the relationship between students' study time and academic performance in programming languages? (2) Does the peer relationship effects students' academic performance in programming languages?*

2. Literature Review

2.1 Student academic performance

Student academic performance in programming languages is influenced by various factors. Analyzing programming skills regularly can help students improve their scores and reduce stress (Sunday et al., 2020). Understanding different learning styles and incorporating visual presentations can enhance learning performance in programming courses (Lin et al., 2022). Additionally, the use of collaborative learning strategies has been found effective in improving students' academic performance in solving computational problems related to programming (Adekunle & Adepoju, 2020). Moreover, students with strong mathematical abilities tend to perform better in introductory computer programming courses, highlighting the positive correlation between mathematical skills and academic performance in programming (Sofowora et al., 2022). By considering these factors, educators can design effective teaching methods and learning environments to support students in achieving success in programming languages.

2.2 ICT Resource availability

Resource availability plays a crucial role in students' academic performance in programming languages. The provision of ICT resources, including access to the latest software and general ICT tools, significantly impacts student performance (Papageorgiou & Callaghan, 2014; N. Zhang, 2023). The availability of resources such as computers, IDEs, internet access, and competent instructors significantly impacts students' programming skills and academic performance. Studies have shown that factors like digital literacy level, access to online materials, instructors' competence, and availability of internet and computers play crucial roles in influencing students' academic performance in programming courses (Mbunge et al., 2021). Moreover, the presence of information and communication technology resources, along with a conducive classroom environment and university facilities, positively influences student engagement and academic performance, with student engagement mediating the relationship

between these factors and academic success(Hanaysha et al., 2023)]. Furthermore, access to the latest software has been linked to student academic performance, highlighting the impact of technological resource availability on students' success in programming courses(Tunde, 2022).

2.3 Teacher competence

Teacher's competency concept was described in the literature as a teacher's in-depth subject knowledge, quality of delivery, successful facilitation of the learning process, and quality of assessment. The study found a strong positive relationship between teacher pedagogical competence, planning of instruction, and students' academic achievement in English language(Hamidu, 2022). However, it is hard to find studies that examined the mediating role of students' study time on the relationship between teacher competence and academic performance.

2.4 Students' study time

Students' study time significantly impacts their academic performance in programming languages. Research shows that the time spent coding is crucial for improving programming skills (Qoiriah et al., 2021). Additionally, a positive relationship exists between study time and academic performance, with grades showing improvement as study time increases (Lin et al., 2022). Furthermore, the study of time management behaviors in online programming learning reveals that self-selected spaced practice positively correlates with quiz performance, while procrastination negatively affects performance(Y. Zhang et al., 2024). Predicting student performance in programming courses early on is essential, with machine learning models utilizing factors like grades, delivery time, and the number of attempts in programming labs to accurately predict performance(Llanos et al., 2023). Understanding different learning styles and activities can also enhance performance, with visual presentations and regular practice through assignments and in-class problems significantly improving learning outcomes in programming courses (Lin et al., 2022). Hence, spending more time in practice this enhance students' academic performance.

2.5 Peer relationships

Peer relationships play a significant role in students' academic performance in programming languages. Additionally, peer interactions and peer pressure have been linked to academic achievements, with improved peer relations correlating with increased peer pressure and better academic performance among university students (Khan et al., 2023). Moreover, peer-based evaluation, where students assess each other's work, has been utilized to identify students in need of additional support in understanding Java programming, leading to targeted assistance and enhanced performance through machine learning algorithms (Hegde et al., 2023). These findings underscore the importance of peer relationships, feedback, and support in fostering a conducive learning environment and improving students' proficiency in programming languages. Therefore, this study proposes the relationship between peer relationship and students' academic performance in programming language.

2.6 Mediating role of students' study time

Student engagement, particularly study time, plays a crucial mediating role in the relationship between ICT resource availability, teacher competence, and academic performance in programming languages. Research indicates that teacher competency and ICT resources

positively impact both academic performance and student engagement (Hanaysha et al., 2023; Najera & Osorno, 2023). Additionally, educational ICT resources are linked to increased cognitive-motivational and curriculum-based engagement, while student engagement mediates the relationship between ICT resources and academic performance (Wang & Wang, 2023). Moreover, effective learning time directly influences student performance and indirectly affects positive behavior, attendance, and homework behavior, highlighting the importance of student engagement in academic outcomes (Tomaszewski et al., 2022). Therefore, investing in teacher training, ICT resources, and creating a conducive classroom environment can enhance student engagement and ultimately improve academic performance in programming languages.

Based on the discussion the study proposes the following hypotheses:

- H1.** ICT resources availability have a positive effect on students' academic performance
- H2.** Teacher competency has a positive effect on students' academic performance
- H3.** Students' study time has a positive effect on academic performance
- H4.** Peer relationship has a positive effect on students' academic performance
- H5.** Students' study time mediates the relationship between ICT resources and academic performance.
- H6.** Students' study time mediates the relationship between teacher competency and academic performance.

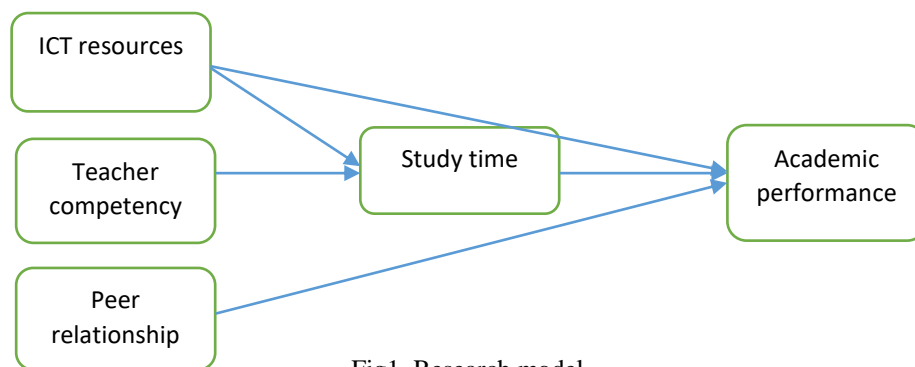


Fig1. Research model

3. Method

3.1 Research design

This study employed a quantitative research design using a structural equation modeling (SEM) approach to investigate the mediating effects of students' study time on the relationships between ICT resource availability, teacher competence, and academic performance in programming languages.

3.2 Participants, Sampling, Data collection and analysis method

The sample consisted of 287 undergraduate students, both male and female, enrolled faculty of computing and engineering in five universities in Mogadishu – Somalia. A non-probability convenience sampling technique was used to recruit the participants. Data was collected using a self-report questionnaire through electronic data collection that measured the following constructs: ICT resource availability, Teacher competence, Peer relationships, Study time, students' Academic performance in programming languages. The questionnaire items were adapted from validated scales in the literature, and the reliability

and validity of the measurement model were assessed through confirmatory factor analysis. Structural equation modeling (SEM) was employed to test the hypothesized mediating effects. The indirect effects were calculated using the bootstrapping method with 5,000 resamples to determine the statistical significance and the 95% confidence intervals.

4. Results

4.1 Profile data

The sample is predominantly male, with 195 male students (67.90%) and 92 female students (32.10%). The majority of students are in the 18-23 age range (57.50%), followed by those aged 24-24 (36.20%) and 29-35 (2.80%). Most students are either freshmen (36.60%) or sophomores (35.90%), with fewer juniors (27.50%) and only 3 students (1.00%) at the 39-above level. The most common majors are computer science (50.20%) and information technology (43.20%), with a smaller proportion in business information system (5.90%) and enterprise networking (0.30%). The majority of students (43.90%) report spending 1 hour per week on teaching, with smaller proportions spending 1.5 hours (19.90%), 2 hours (11.50%), 2.5 hours (9.40%), and 3 hours (6.30%). Most students (24.00%) report 1-3 hours of practice per week, with 24.40% spending 4.7 hours and 7.00% spending 4 hours. The majority of students (63.40%) report being "Not confident" in their coding skills, with 22.30% "Somewhat confident" and only 4.20% "Very confident"

Table 1 Profile data

		Frequency	Percentage (%)
Gender	Male	195	67.90%
	Female	92	32.10%
Age	18 - 23	165	57.50%
	24 - 24	104	36.20%
	29-33	8	2.80%
	34-38	7	2.40%
	39 Above	3	1.00%
Grade level	Freshmen	105	36.60%
	sophomores	103	35.90%
	Juniors	79	27.50%
Major field	Computer science	144	50.20%
	Information technology	124	43.20%
	Business Information System	17	5.90%
	Enterprise networking	1	0.30%
	Software engineering	1	0.30%
Teaching hours per week	An hour	126	43.90%
	1.5 hours	57	19.90%
	2 hours	33	11.50%
	2.5 hours	27	9.40%
	3 hours	18	6.30%
	3.5 hours	6	2.10%
	4 hours	20	7.00%

Practicing hours per week	1-3 hours	69	24.00%
	4.7 hours	70	24.40%
	Above 8 hours	20	7.00%
	No practice	128	44.60%
Confident in writing code	Very confidence	12	4.20%
	Mostly confident	29	10.10%
	Somewhat confident	64	22.30%
	Not confident	182	63.40%

4.2 Structural Equation Model

A Structural Equation Model in neuroscience refers to a statistical modeling technique that combines factor analysis principles with path analysis to represent hypothesized relationships among latent constructs and their observed indicators. It consists of a measurement model, which describes the measurement properties of the indicators, and a structural model, which specifies the causal relationships among the latent variables. The model estimates the parameters and goodness-of-fit indexes based on empirical data (Knoke, 2004). The study workout both measurement model and structural model.

4.2.1 Measurement Model

As part of the measurement model evaluation, indicators with low factor loadings (< 0.60) were removed (Gefen & Straub, 2005). Those not meeting the criteria were removed from further analysis. The factor loadings, Cronbach's alpha, and composite reliability (CR) values indicate that the measurement model has good internal consistency and reliability, supporting the validity of the constructs used in the study (Fornell & Larcker, 1981; Hair et al., 2019). The table indicates range of factor loadings between 0.604 and 0.903, indicating good internal consistency and reliability. Factor loadings indicate strong relationships between items and their respective factors (ICT Resources, Academic Performance, Study Time, Peer Relationships, Teacher Competency). Cronbach's Alpha values suggest good internal consistency reliability for all factors and above 0.844. Composite Reliability (CR) and Average Variance Extracted (AVE) values further support the reliability and validity of the measurement model, indicating that the factors adequately represent their underlying constructs and they are above 0.853 and 0.538 respectively. Discriminant validity ensures that a scale or measure is accurately capturing the intended concept and not inadvertently measuring something else. Regarding to the study discriminant validity was reached as in shown in Table 4.

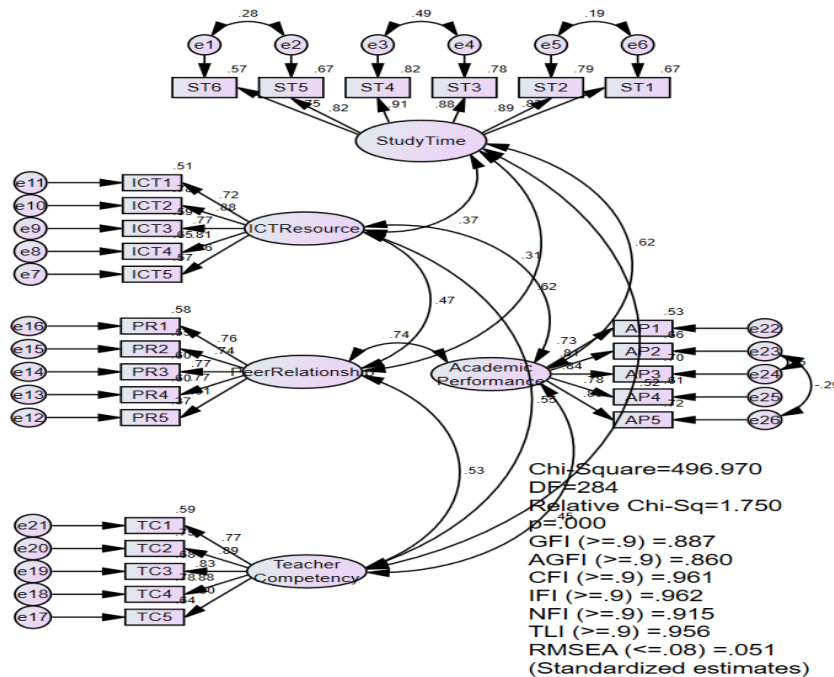


Fig2. Measurement model

Table 2. factor loading, Cronbach's Alpha, Composite reliability, Average Variance Extract

	Factor loading	Alpha	CR	AVE
ICT Resources		0.890	0.891	0.623
ICT1	0.759			
ICT2	0.808			
ICT3	0.77			
ICT4	0.882			
ICT5	0.718			
Academic Performance		0.898	0.901	0.647
AP1	0.798			
AP2	0.766			
AP3	0.889			
AP4	0.838			
AP5	0.721			
Study time		0.943	0.938	0.717
ST1	0.892			
ST2	0.88			
ST3	0.903			
ST4	0.822			
ST5	0.755			
ST6	0.819			
Peer relationships		0.844	0.853	0.538
PI1	0.604			
PI2	0.771			
PI3	0.772			
PI4	0.744			
PI5	0.762			
Teacher competency		0.917	0.920	0.697
TC1	0.767			
TC2	0.89			
TC3	0.827			
TC4	0.881			
TC5	0.802			

Factor loading, Cronbach's Alpha, CR: Composite reliability, AVE: Average Variance Extract

Table3. Discriminant validity

	MSV	MaxR(H)	TC	ICT	PR	AP	ST
TC	0.308	0.927	0.835				
ICT	0.308	0.903	0.555	0.789			
PR	0.554	0.860	0.527	0.465	0.734		
AP	0.554	0.905	0.449	0.314	0.744	0.802	
ST	0.381	0.945	0.523	0.369	0.616	0.617	0.846

MSV: Maximum Shared Variance; TC: Teacher Competence; PR: Peer relationship; AP: Academic Performance; ST: Study Time

4.2.2 Structural model

The structural model confirmed the relationships hypothesized in the literature review. The results in Table, teacher competency has a significant impact on academic performance ($\beta = 0.421, C.R = 10.126, p < 0.001$), therefore H1 is supported. ICT resource availability has a positive impact on academic performance ($\beta = 0.109, C.R = 3.223, p = 0.001$). The result proposes indicate that peer relationships have a positive and statistically significant effect on academic performance ($\beta = .083, C.R = 2.318, p = 0.020$). Furthermore, the finding suggests that study time has a positive and statistically significant effect on academic performance ($\beta = .083, C.R = 2.318, p = 0.020$). These findings highlight the importance of these factors in supporting and improving students' academic success.

Table 4. Hypotheses testing

	Estimate	S.E.	C.R.	P
H1 Teacher competency → Academic Performance	.421	.042	10.126	***
H2 ICT resource availability → Academic Performance	.109	.034	3.223	.001
H3 Peer Relationship → Academic Performance	.083	.036	2.318	.020
H4 Study time → Academic Performance	.137	.044	3.138	.002

S.E: Standard error; C.R= critical ratio; p – value

4.2.3 Mediation Analysis

The study assessed the mediating role of study time on the relationship among ICT resources, Teacher competency on student academic performance in programming language. The findings indicated a significant indirect effect of ICT resources on academic performance was positive and significant ($\beta = 0.159, p < 0.001$), supporting H5. Furthermore, the direct effect of ICT resources on study time in presence of the mediator was also found significant ($\beta = 0.279, p < 0.001$). Similarly, the study found a significant indirect effect of teacher competency on academic performance was positive and significant ($\beta = 0.195, p < 0.001$). Therefore, the direct effect of teacher competency on study time in exist of the mediator was significant ($\beta = 0.124, p = 0.014$). Hence, study time partially mediated both relationship ICT resources, teacher competency and academic performance.

Table 5. Mediating effects

	Hypotheses	Indirect Effect	P – value	95%LL	95%UL	Decision
H5	ICTR →ST→AP	.159	0.000	0.099	0.241	Partially mediation
H6	TC→ST→AP	.195	0.000	0.133	0.279	

Note: ICTR: ICT Resource; ST: Students' Study Time; AP: Academic Performance; TC: Teacher Competency

4.2.4 Evaluation of model fit

The Goodness of Fit Index (GFI) is a measure used in structural equation modeling (SEM) to assess how well the proposed model fits the observed data. It ranges from 0 to 1, with values closer to 1 indicating a better fit. **Chi-square (χ^2) and Degrees of Freedom (df):** these two traditional fit indices, but it's sensitive to sample size and often becomes significant with larger samples, even for good models. Here, χ^2 is 715.708 with 116 df, and the associated p-value is 0.000, indicating a significant result. The relative chi-square (chi-square/df) is 1.720, which is less than the recommended value of 5, suggesting a good

model fit. The goodness-of-fit index (GFI) is 0.866, which exceeds the recommended threshold of 0.90, indicating a good fit. The adjusted goodness-of-fit index (AGFI) is 0.840, also above the recommended level of 0.90, further supporting the model's goodness of fit. Additionally, the comparative fit index (CFI) is 0.956, the incremental fit index (IFI) is 0.956, and the normed fit index (NFI) is 0.901, all of which exceed the recommended value of 0.90, indicating that the model provides a good fit to the observed data. The Tucker-Lewis index (TLI) of 0.950 is also greater than the recommended threshold of 0.90, further confirming the overall fit of the structural model. These results suggest that the hypothesized model adequately represents the relationships among the study variables.

Table 6. Goodness fit indices

	Recommended	Result
Chi – square = 715.708 Df=116 P=0.000		
Relative Chi-Sq	<i>Chi < 5</i>	1.720
Goodness fit index (GFI)	<i>GFI ≥ .90</i>	0.866
Adjusted goodness fit index (AGFI)	<i>AGFI ≥ .90</i>	0.840
Comparative fit index (CFI)	<i>CFI ≥ .90</i>	0.956
Incremental fit index (IFI)	<i>IFI ≥ .90</i>	0.956
Normed fit index (NFI)	<i>NFI ≥ .90</i>	0.901
Tucker-Lewis Index	<i>TFI ≥ .90</i>	0.950
Root Mean Square Error of Approximation (RMSEA)	<i>RMSEA ≤ 0.08</i>	0.050
Standard RMR	<i>SRMR ≤ 0.05</i>	0.0421

Table 4.1 Goodness fit

5. Discussion

The study found a positive correlation between academic performance and four key factors: teacher competency, availability of ICT resources, positive peer relationships, and dedicated study time. These findings suggest that improving any of these areas could potentially enhance student outcomes. Teacher competency exhibits the strongest positive effect on academic performance, highlighting the critical role of skilled and knowledgeable instructors in student achievement. Effective teaching practices, clear explanations, and adequate support directly contribute to better academic outcomes in programming languages. Numerous studies have consistently shown that teacher competency significantly influences student academic performance. For instance, Hanaysha et al. (2023) emphasized that teacher quality is one of the most significant factors affecting student learning outcomes.

The availability of ICT resources also significantly affects academic performance, although to a lesser extent compared to teacher competency. Access to computers, software, and internet resources facilitates learning by providing students with essential tools and materials necessary for understanding and practicing programming concepts. Consistent with previous findings, studies such as those by (Basri et al., 2018; Youssef et al., 2022) indicated that access to technology positively impacts student performance, particularly in subjects that heavily rely on such resources.

Peer relationships have a positive but moderate impact on academic performance. Collaborative learning, group discussions, and peer support contribute to a conducive learning environment, allowing students to share knowledge and tackle programming challenges collectively. This finding aligns with studies such as Llorca et al. (2017) which suggest that positive peer interactions and relationships can enhance academic motivation and performance.

The amount of time students dedicate to studying significantly influences their academic performance. Regular and consistent study habits enable students to practice and reinforce programming skills, leading to better understanding and proficiency. The positive effect of study time on academic performance is well-documented, with studies such as those by Nonis & Hudson (2006) supporting the notion that increased study time correlates with higher academic achievement.

The partial mediation effect of study time indicates that ICT resource availability indirectly enhances academic performance by promoting increased study time. When students have access to ICT resources, they are more likely to spend additional time studying, which in turn improves their academic outcomes in programming languages. This finding is consistent with studies by (Talysheva et al., 2021; Wang & Wang, 2023) which highlight that access to ICT resources can motivate students to allocate more time to studying and practicing.

Study time also partially mediates the relationship between teacher competency and academic performance. Competent teachers not only directly boost academic performance but also encourage students to invest more time in studying, thereby enhancing their programming skills and knowledge through increased practice. This is in line with research by (Hanaysha et al., 2023; Rashid & Asghar, 2016), which indicates that effective teachers can significantly influence students' study habits and motivation.

6. Conclusions and Recommendations

The study examined the mediating effects of students' study time on the relationship between ICT resource availability, teacher competence, and academic performance in programming languages. The findings reveal a positive relationship between peer relationships and students' academic performance in programming languages. Additionally, the study found that students' study time partially mediates the relationship between both teacher competency and ICT resource availability on students' academic performance.

These results indicate that teacher competency and the availability of ICT resources are important factors influencing students' academic performance in programming languages. However, the extent of their impact is influenced by the amount of time students dedicate to studying and practicing programming concepts. The mediating role of study time suggests that improving teacher competency and increasing ICT resource availability alone may not be sufficient to enhance student learning and achievement in programming languages. Encouraging and supporting students to devote more time to studying and practicing programming is also crucial.

Based on the findings, the study recommends the following:

- 1- Strengthen teacher training and development programs to enhance the competency of programming language instructors. This will ensure teachers can effectively deliver the curriculum and support student learning.
- 2- Invest in expanding the availability and accessibility of ICT resources, such as computers, software, and online learning platforms, in educational institutions. This will provide students with the necessary tools to engage with programming content.
- 3- Implement strategies to foster peer relationships and collaborative learning among students. This can create a positive learning environment that encourages students to support each other and engage in programming-related activities.
- 4- Develop and promote programs that emphasize the importance of dedicated study time for programming courses. This may involve providing structured study sessions, peer-assisted

learning opportunities, and encouraging students to devote more time to practicing programming concepts.

7. Future Research Directions

This study has a limitation with other studies, first limitation the study conducted cross – sectional method which nature limited. Future study conducting longitudinal studies to examine how the impact of teacher competency, ICT resources, peer relationships, and study time on academic performance evolves over time. The second its limited freshmen, sophomore students and limited factors in the future study Investigating the effects of these factors in different educational contexts, such as online learning environments, hybrid models, and various educational levels (e.g., high school, university).

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