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Breaking the Code: Unveiling the Impact of Digital Inequality on the Fabric of Education Quality

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Abstract: Digital inequality has become an increasingly important issue in the global education context. In this digital era, access and use of information and communication technology (ICT) is a determining factor in the quality of education. This research aims to investigate how the digital divide impacts the sustainability of educational quality, with a focus on differences in ICT access, digital competence, and student learning outcomes. The investigative method uses a mixed approach, a cross-border survey. Data collection uses a Google form questionnaire. Data analysis uses SEM analysis with PLS warp. The results of this investigation concluded that digital literacy and training have a significant impact on the digital divide. To achieve sustainable quality education, efforts are needed to reduce the digital divide through educational policies and initiatives that support ICT access and the development of students' digital literacy/competence. Only by addressing these disparities can education become a more effective tool in improving the quality of life and opportunity for all individuals

Keywords: demographics, economic status, training support, digital literacy, inequality

1. Introduction

The digital divide reflects inequalities in the access and use of digital technology in society. Although technological developments continue to increase, there are significant differences in individuals' abilities to access and understand these technologies. Factors such as demographics and socioeconomics are often identified as key determinants of digital inequality. However, recent research suggests that these variables may not always be the main factors in explaining the digital divide.

Digital inequality in education can be caused by a variety of complex factors. Some of the main factors contributing to digital inequality in education are:

Differences in physical access to ICT infrastructure are a major cause of digital inequality. Students from urban areas may have better internet access than students in rural areas[1]. These include broadband access, adequate internet speed, and the availability of online resources such as hardware (computers, tablets, smartphones) required for digital learning[2].

Geographical factors such as geographic location or certain environmental conditions, for example, difficulties in installing ICT infrastructure in certain areas, can also lead to digital inequality[3]. Differences in the demographics and social structure of a population can also contribute to digital inequality[4]. Students from certain ethnic or social backgrounds may be more likely to face digital inequalities.

Students from families with limited economic resources may not be able to afford the hardware and internet access necessary for digital learning[5]. Economic disadvantage can also hinder students' ability to take part in training or courses that support the development of digital competencies[6].

Students who lack skills in using technology or who lack digital competency may have difficulty utilizing digital resources effectively[7]. Digital skills include the ability to use hardware, software, the internet, and digital literacy.

Government policies that do not support equitable access to ICT and building digital competencies in education can also be a contributing factor to digital inequality[8][1].

Digital inequality can also be caused by a lack of support and training from educational institutions or the government[9]. Students who do not have access to digital training or support from their schools may be more vulnerable to digital inequalities.

Addressing digital inequality in education requires collaborative efforts from various parties, including governments, schools, communities, and the private sector. This includes providing more equitable access to ICT, training in digital competencies, and developing policies that support digital inclusion in education.

Previous research shows that demographic and socioeconomic factors do not always have a consistent influence on the digital divide. Therefore, it is necessary to delve deeper into this complex relationship and investigate other factors that may play a role, such as digital literacy and training in the use of technology. Further understanding of the factors influencing the digital divide can provide a foundation for the formulation of more effective policies and interventions.

The aims of this research are:

(1) Identifying the Factors Underlying Digital Inequality. Further, examines factors beyond demographics and socioeconomics that may contribute to digital inequality. Focusing on other variables such as digital literacy levels and training can provide a deeper understanding of the dynamics of digital inequality.

2) Analyze the Relationship between Digital Literacy and Inequality. Examining further how the level of digital literacy is related to the level of digital inequality. This goal may involve further understanding the digital skills and knowledge that can influence technology access and use.

3) Examining the Effectiveness of Training in Reducing Digital Inequality. Research to assess the effectiveness of training programs in reducing digital inequality. Identifying the most effective types of training and the target audiences most in need can help develop more efficient intervention strategies.

4) Analyze the Impact of Government Policies on Digital Inequality. Research government policies related to digital access and literacy. Evaluating the impact of government policies can help understand whether any policies may strengthen or harm efforts to reduce digital inequality.

5) Develop Policy Recommendations to Reduce Digital Inequality. Based on research results, develop policy recommendations that can help reduce digital inequality. These recommendations may include strategies to increase digital literacy, support training programs, or formulate more effective government policies.

It is hoped that the results of this research will contribute to our understanding of the factors underlying the digital divide. These findings can provide a basis for the development of more effective policies and intervention programs to reduce inequalities in technology access and use in society. In addition, this research can provide new and relevant insights for researchers, practitioners, and policymakers who are interested in facing the challenges of the digital divide in the digital era.

2. Method

2.1 Research Design

Cross-border survey research with a quantitative approach. The study population is teachers in the Cirebon area with a total of 100 teacher respondents. The questionnaire will be developed and distributed via Google Forms. The questionnaire will include questions related to demographics, economic status, digital literacy, training support, and perceptions of government policy in the context of digital inequality in education.

2.2 Data Collection

Respondents will be identified and selected from the teacher population in a particular area. The questionnaire will be distributed online via Google Forms. Data will be collected within a certain period according to research needs. This study used mixed methods that included secondary data analysis, surveys, and interviews. Secondary data is used to get an overview of digital inequality in various regions. The survey was conducted on students from various social and economic backgrounds to measure their level of access to information communication technology and digital competence. Interviews were conducted with educators and school administrators to understand their views on the impact of digital inequality in education[10].

2.3 Data Analysis

Data analysis uses Structural Equation Modeling (SEM) using the Warp PLS application. The variables measured in the questionnaire will be used as indicators for larger conceptual constructs, such as “Digital Inequality.”

The SEM model was used to measure the influence of demographic variables, economic status, digital literacy, training support, and government policies on digital inequality in education. Path analysis is used to assess the relationship between these variables. Survey data will be extracted from Google Forms into the Warp PLS application. SEM analysis will be used to examine causal relationships between measured variables[11]. The analysis results will include path parameters (path coefficients), coefficient of determination, and significance tests[12].

2.4 Interpretation of Results

The results of SEM analysis will be used to evaluate the significance of the influence of demographic variables, economic status, digital literacy, training support, and government policies on digital inequality in education. These results will help in understanding the factors that contribute to digital inequality and provide insights for the development of more inclusive education policies.

3. Results

The data description for each variable is presented as follows:

Table 1. Data Description

	N	Minimum	Maximum	Mean	Std. Deviation
Demography (Demo)	141	1.6	5.0	3.75	.662
Economy (Eco)	141	1	5.0	3.08	.721
Digital Literacy (DL)	141	2.0	5.0	3.43	.851
Training (T)	141	2	5.0	4.06	.711
Government Policy (GP)	141	2.3	5.0	3.96	.560
Digital Inequality (I)	141				

Source: Analyzed Data (2023)

Table 1 shows that the average Perception (P) value is 3.75; the average government policy is 3.08; the University Engagement (ENG) of 3.43; the average Technology Literacy (TL) of 4.06; and the average Empowerment of 3.96. From the average value of each variable, information is obtained that all are included in the good/high category because the average value is more than 3.

Measurement Model Analysis

The outer model of the measurement analysis assesses the construct variables, their validity, and reliability. To determine the consistency of results within a test, internal consistency analysis is employed. This analysis uses a composite reliability value, with a variable considered reliable if the value exceeds 0.700 [13][14].

Table 2. Internal Consistency Analysis

	Cronbach's Alpha	Composite reliability	Average Variance Extracted
Demography (Demo)	0.744	0.843	0.587
Economy (Eco)	0.710	0.838	0.634
Digital Literacy (DL)	0.788	0.876	0.703
Training (TR)	0.730	0.848	0.652
Government Policy (GP)	0.854	0.912	0.775
Inequality (ID)	0.831	0.831	0.624

Source: Analyzed Data (2023)

According to the internal consistency analysis data provided in the table, the results indicate that the demography variable is reliable with a composite reliability value of 0.843 > 0.700. Similarly, the economy variable (0.838 > 0.700), and digital literacy variable (0.876 > 0.700) are also found to be reliable. Therefore, the data suggests that these variables demonstrate reliability.

Table 3. Convergent Validity

	Demo	Eco	DL	TR	GP	ID
Demo1	**0,73**	-0,139	-0,531	0,101	-0,069	0,337
Demo2	**0,912**	0,064	0,351	-0,318	0,144	-0,174
Demo3	**0,881**	0,195	0,018	0,07	-0,127	-0,239
Eco1	0,067	**0,816**	-0,284	-0,339	0,127	0,325
Eco2	-0,334	**0,835**	0,277	-0,298	0,035	-0,047
Eco3	0,305	**0,735**	0,001	0,715	-0,18	-0,307
DL1	0,169	0,033	**0,818**	0,212	-0,022	-0,89
DL2	-0,072	0,136	**0,878**	0,119	-0,096	0,513
DL3	-0,092	-0,179	**0,817**	-0,341	0,126	0,34
TR1	0,108	0,229	0,434	**0,716**	0,14	-0,337
TR2	0,006	-0,023	0,037	**0,837**	-0,26	0,028
TR3	-0,096	-0,168	-0,397	**0,861**	0,136	0,253
GP1	0,303	-0,261	-0,006	0,489	**0,85**	-0,156
GP2	-0,016	-0,109	-0,112	0,017	**0,921**	0,057
GP3	-0,28	0,373	0,125	-0,498	**0,867**	0,092
ID1	0,202	0,035	-1,555	0,248	-0,023	**0,676**
ID2	-0,072	0,136	0,341	0,119	-0,096	**0,881**
ID3	-0,092	-0,179	0,938	-0,341	0,126	**0,8**

Source: Analyzed Data (2023)

The table above reveals that the outer loading values for all indicators are higher than 0.6, so all indicators are valid from the model. After the second stage of the analysis, the loading values obtained for all indicators already have an outer loading value above 0.6 so a structural analysis model can be carried out.

Structural Model Analysis (Inner Model)

The inner model analysis, also known as structural model analysis, is conducted to test the research hypothesis. In this analysis, the coefficient of determination (R Square) is examined to test the hypothesis.

The collinearity test assesses the strength of the correlation between latent or construct variables. If a strong correlation is found, it indicates methodological issues in the model, which can affect the estimated statistical significance. This issue is referred to as collinearity. To analyze collinearity, the Variance Inflation Factor (VIF) value is considered [15]. If the VIF value exceeds 5.00, it indicates the presence of a collinearity problem, whereas a VIF value below 5.00 suggests no collinearity problem[16].

Table 4. Collinearity

Demo	Eco	DL	TR	GP	ID
1.757	2,236	1.859	3,329	2,922	2.029

Source: Analyzed Data (2023)

From the above data, it can be described that all indicators have a VIF of less than 5. Thus, from the data above, the structural model, in this case, does not contain collinearity problems

Testing the Significance of the Structural Model Path Coefficient

The test comprises two stages: examining the hypothesis of direct effect and examining the hypothesis of indirect effect. The image below contains the path coefficients for hypothesis testing.

The purpose of conducting significance testing on the path coefficients of the structural model is to assess the significance of the relationships within the structural model. The objective is to test the significance of all relationships or hypotheses.

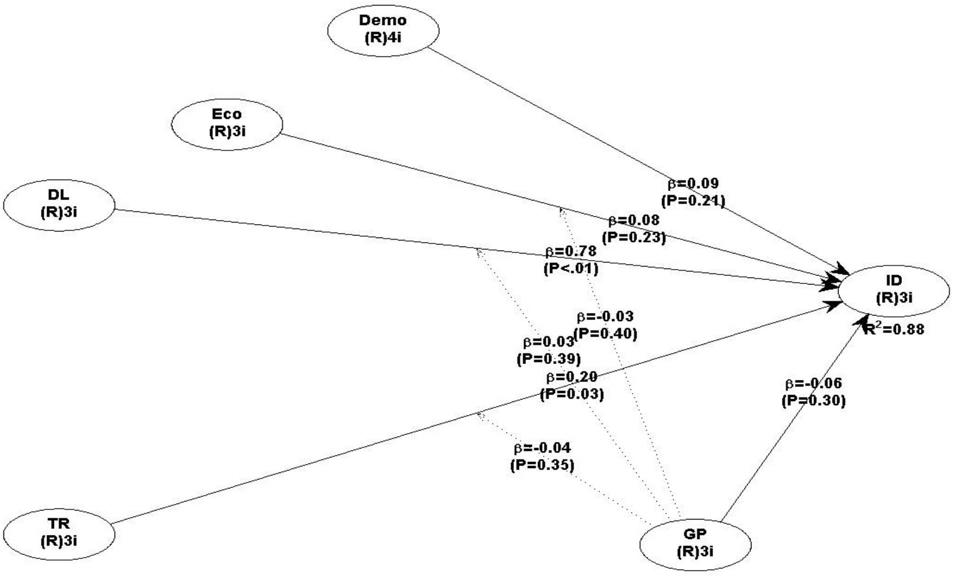

Figure 1. Hypothesis test

Source: Analyzed Data (2023)

Direct Effect Testing

The objective of testing the direct effect hypothesis is to demonstrate the impact of a variable on other variables directly [17]. A positive path coefficient value indicates that an increase in one variable corresponds to an increase in the other variable. Conversely, a negative path coefficient value suggests that an increase in one variable leads to a decrease in the value of the other variable.

If the probability value (p-value) is less than the significance level (Alpha) of 0.05, the null hypothesis (Ho) is rejected, indicating a significant influence of the variable on other variables. On the other hand, if the probability value (P-Value) is greater than Alpha (0.05), the null hypothesis (Ho) is not rejected, implying that the effect of the variable on other variables is not significant [18].

Table 5. Path Coefficient

Relationship between Variable	Original sample (O)	P-values
Demography (Demo) -> Digital Inequality (ID)	0.088	0.212
Economy (Eco) -> Digital Inequality (ID)	0.081	0.23
Digital Literacy (DL) -> Digital Inequality (ID)	**0.782**	**< 0.001**
Training (TR) -> Digital Inequality (ID)	**0.197**	**0.033**
Government Policy (GP)-> Digital Inequality (ID)	-0.059	0.297

Source: Analyzed Data (2023)

4. Discussion

4.1 The Influence of Demographics on Digital Inequality

Demographic factors can influence digital inequality in several ways, as demographics encompass a wide range of individual characteristics that can influence access and use of information and communications technologies (ICT). Here are some reasons why demographic factors may influence digital inequality:

Demographics can include geographic location or the geography of where an individual lives. People living in urban areas may have better and more extensive internet access compared to those living in rural areas. ICT infrastructure and internet service availability can vary significantly based on geographic location[19].

The age factor can also be part of demographics. Young students may be more skilled in the use of technology than older generations. This can impact their digital literacy and ability to cope with ICT devices and applications used in education[20].

Demographics also include ethnic and cultural differences. People from different ethnic backgrounds may face challenges in accessing or using ICT, especially if there are language or cultural barriers to technology use[21].

Gender is a demographic factor that can also influence digital inequality. Some studies suggest that women may face barriers to accessing and using ICTs in some cultures or communities[22].

Education: Education level is another significant demographic factor. People with higher levels of education tend to have better digital literacy and the ability to utilize ICT effectively in education[23].

These demographic factors can collectively create differences in access, competency, and use of ICT in education. Digital inequalities can become more complex when these various demographic factors interact. Therefore, it is important for education policy and society at large to understand how demographic factors can influence digital inequality to take more inclusive and equitable action in ensuring equitable and effective access to ICT in education.

However, the results of this study show that demographic factors do not influence digital inequality. The reason for the lack of influence of demographic factors on digital inequality in research can be due to several reasons, namely:

There may be problems with the way demographic variables are measured. It may be that the definitions or measurements of demographic factors used in the research are not accurate or relevant enough to capture significant differences in digital inequality.

Differences in digital inequality may be influenced by regional or local factors not taken into account in the research. Certain geographic contexts or social environments may have a more significant impact on digital inequality than demographic factors[24].

There may be differences in the accessibility of technology and digital infrastructure between different demographic groups, which are not captured in the demographic variables studied. Different demographic groups may use technology in similar ways, reducing differences in digital inequality. For example, if all age groups are equally accustomed to using digital technology, then the inequality may not be so striking.

Technology continues to develop rapidly, and digital inequality can be influenced by factors other than demographics, such as education level, digital skills, and adaptation to innovations. Demographics may no longer be the main factor influencing digital inequality.

Individual Differences in Demographic Groups. Within the same demographic group, there may still be significant individual differences in technology access and use. There may be other factors, such as an individual's income level or level of education, that influence digital inequality to a greater extent.

4.2 The Influence of Socioeconomic Status on Digital Inequality

Economic status, such as income and employment. People with more limited economic resources may not be able to afford the necessary ICT hardware or pay internet subscription fees. This can lead to inequalities in ICT access[25].

Our research results show that socioeconomic factors do not influence digital inequality. Several reasons for the lack of influence of socio-economic factors on digital inequality in this research could be due to:

The research methodology used may not be sensitive enough to detect the influence of socioeconomic factors[26]. This can include inaccurate measurements or inadequate statistical models to capture the complexity of the relationship between socioeconomic factors and digital inequality. Just as in the case of demographic factors, there may be problems with the way socioeconomic variables are measured. Imprecise or inadequate measurement of socioeconomic factors can lead to inaccurate results.

The influence of socioeconomic factors on digital inequality may vary depending on the regional or social context. It is possible that socioeconomic factors do not influence digital inequality in general, but that there is certain regional or social variability that is not covered in the research[27]. Although a person may have a low socioeconomic status, if general technology accessibility is high in a population, digital inequality can become less pronounced. These factors may influence the relationship between socioeconomic and digital inequality.

It is possible that technology use among lower socio-economic groups is not much different from higher groups, reducing differences in digital inequality. Rapid technological developments may mean that socioeconomic factors have a more limited impact on digital inequality[28]. People with lower socioeconomic status may be able to access technology more easily over time.

Overall macroeconomic conditions can play a role in digital inequality. If there is equitable economic growth or government initiatives to increase digital access and literacy across all levels of society, then the socio-economic impact may be less significant. To understand further, a more in-depth analysis is needed, involving consideration of regional context and variability, as well as examining other potential factors that may influence the relationship between socioeconomic and digital inequality.

4.3 The Effect of Digital Literacy on Digital Inequality

Digital literacy has a significant influence on digital inequality in education because digital literacy measures an individual's ability to use and understand information and communication technology (ICT). Digital inequalities in digital literacy can lead to differences in access, understanding, and use of ICT in educational contexts. Here are some reasons why digital literacy influences digital inequality in education:

Individuals with greater digital literacy tend to be better able to utilize the variety of digital resources available in education[29], such as online learning platforms, digital libraries, and digital educational resources. They can access, evaluate, and use these resources effectively.

Digital literacy is not only about technical abilities but also the ability to think critically in dealing with digital information[30]. Individuals with good digital literacy tend to be better able to identify trustworthy information, sort out relevant information, and avoid false or biased information. This ability is very important in learning and developing knowledge.

Digital literacy includes the ability to communicate effectively through digital media. Individuals with good digital literacy may be better able to participate in online forums, collaborate with peers, and communicate their ideas and discoveries well[31].

Digital literacy also includes the ability to resolve technical problems that arise in the use of ICT. People with good digital literacy are better able to overcome technical problems that may arise during online learning or the use of ICT devices[32]. Digital literacy enables individuals to effectively learn independently and continuously. This is especially important in lifelong education, where individuals need to constantly update their knowledge and skills using digital resources[33].

People with good digital literacy are more likely to have creativity and innovation in using ICT in education. They can develop new solutions, creative ideas, and innovative projects with the help of technology[34]. When there are inequalities in digital literacy, students who are less skilled in the use of ICT may have difficulty accessing and taking advantage of digital educational opportunities[1]. This can lead to disparities in educational attainment and access to better educational opportunities. Therefore, increasing digital literacy through formal education, training, and support is key to reducing digital inequality in education. A focus on developing inclusive digital literacy skills can help ensure that every student can utilize technology to reach their potential in education.

4.4 The Effect of Training Support on Digital Inequality

Training support influences digital inequality in education because it can help reduce differences in individual abilities and knowledge in dealing with information and communication technology (ICT). This factor plays an important role in overcoming digital inequalities, especially as not all individuals have the same opportunities to obtain training or support in the use of ICT. Here are some reasons why training support impacts digital inequality in education:

Students or individuals who get access to ICT-related training and learning have the opportunity to improve their digital skills and knowledge[35]. Training support can help overcome obstacles in accessing digital resources and information. ICT training can help improve digital literacy, including understanding how to use ICT devices, software, and the internet correctly[36]. It helps individuals overcome barriers to using technology effectively in education. Training support often includes the development of critical skills, such as critical thinking abilities, information analysis, and digital resource evaluation. This is important in dealing with online information wisely and critically.

ICT training can help individuals overcome technical problems or obstacles that may arise in the use of ICT. This can help reduce inequalities in addressing technical issues. Training support can encourage individuals to develop creative and innovative projects with the help of technology. It helps in the development of creative skills and the ability to innovate[37].

Through training and support, individuals may feel more confident in using ICT. This can help overcome psychological barriers that may prevent individuals from taking steps into the digital world. ICT training support also opens the door to lifelong learning, where individuals can continue to improve their digital skills and knowledge over time[38].

When individuals have no access or limited access to ICT training, they may struggle to develop digital literacy and address digital inequalities in education. Therefore, educational institutions and governments need to provide equitable and inclusive ICT training. This helps ensure that all students have an equal opportunity to harness the potential of digital education and address any digital inequalities that may arise.

4.5 The Influence of Perceptions of Government Policy on Digital Inequality

Perceptions of government policy influence digital inequality in education because government policy can have a direct impact on the access, use, and benefits of information and communication technology (ICT) in society. Individuals' perceptions of government policies can influence their attitudes and actions regarding ICT in education. Here are some reasons why perceptions of government policy influence digital inequality in education:

Government policies that support equitable ICT access can help reduce digital inequality. However, if individuals are unaware of or have negative perceptions of such policies, they may not take full advantage of them[39]. Some governments subsidize ICT devices or internet access for certain groups of people, such as students or low-income families. Individuals' perceptions of the effectiveness of such policies may influence the extent to which they will benefit from such subsidies[40].

The government can launch training programs that support increasing digital literacy. Individuals' perceptions of the benefits and quality of such programs may influence their participation in such training programs[41]. Government policies related to data security and privacy in the context of ICT can influence individuals' perceptions of the extent to which they feel safe using such technologies. Negative perceptions about security and privacy issues can hinder the use of ICT.

The government can provide funds for the development of digital education infrastructure, such as improving internet networks in schools. Perceptions of the importance of this funding and how it is used can influence how technology is used in education. Government policies on digital content regulation and online learning curricula can also influence individual perceptions and participation in the use of ICT in education[2].

Individual perceptions of government policies can include beliefs about the quality, relevance, fairness, and effectiveness of those policies[42]. If individuals have positive perceptions of policies that support digital access and literacy, they are more likely to make good use of technology in education. Conversely, if individuals have negative perceptions or are unaware of existing policies, they may experience difficulty in addressing digital inequality. Therefore, governments and educational institutions need to communicate well and support positive perceptions about policies that support digital inclusion in education.

4.6 The Moderating Effect of Government Policy on Digital Inequality

In this research, government policy does not act as a moderator variable that influences the relationship between socio-economic factors, digital literacy, and training and the digital divide. Some possible reasons why government policy does not act as a moderator variable that influences the relationship between socio-economic factors, digital literacy, and training with the digital divide involve the following aspects:

Perhaps existing government policies do not explicitly target variables such as socio-economics, digital literacy, or training to reduce the digital divide. Ambiguity or unpredictability in the role of government policy can make it difficult to identify as a significant moderator variable[43]. While there are policies that should play a moderating role, there may be shortcomings in their implementation. Ineffective implementation or lack of resources can reduce the expected positive impact of the policy.

Government policies may be more general in nature and not specifically focused on specific variables that can moderate the relationship between certain factors and the digital divide. This may result in policies not having a direct impact on the relationship[44].

Changing contextual conditions, such as rapid technological developments or changes in societal needs, can make government policy no longer relevant or effective in moderating the relationship between the variables studied[45]. The lack of sufficient data or relevant information about policy implementation or its impact can make it difficult for research to identify the role of government policy as a moderator variable. The research approach used may not be sufficient to capture the role of government policy as a moderator[46]. Certain research methodologies may not allow for in-depth analysis of the impact of government policies.

The lack of collaboration or involvement of government parties in research may hinder further understanding of the role of their policies as moderator variables. Collaboration can help researchers better understand policy implementation and its impact[47].

To understand further, additional analysis, literature review, and possibly interviews with related parties can be carried out to identify factors that might influence the role of government policy in the context of the digital divide.

5. Conclusion

Digital inequality has a significant impact on the sustainability of the quality of education. To achieve sustainable quality education, efforts are needed to reduce the digital divide through educational policies and initiatives that support ICT access and the development of students' digital competencies. The results of this research conclude that: (1) demographics have no effect on digital inequality, (2) socio-economic factors have no effect on digital inequality, (3) digital literacy has a significant effect on digital inequality, (4) Training has a significant effect on digital inequality, (5) government policy has no effect against digital inequality.

Credit Statements

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

Declarations of interest

The author declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article

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All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all aspects of this work

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