

Digital Literacy and Student Academic Performance in Universities: A Meta-analysis

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ABSTRAK

Kinerja akademik menjadi fokus penting bagi Lembaga Pendidikan, dosen, peserta didik, maupun mejadi isu utama dalam penelitian untuk menentukan faktor yang dapat mempengaruhi. Seiring berkembangnya internet dan teknologi informasi & komunikasi penelitian sebelumnya menunjukkan korelasi antara literasi digital sebagai faktor yang dimiliki mahasiswa dalam kecakapan digital yang berpengaruh terhadap kinerja akademik, namun belum ada penelitian yang memfokuskan pada seberapa besar pengaruh r dan size dari korelasi kedua variabel khusus pada mahasiswa di tingkat universitas. Penelitian ini bertujuan untuk mengukur hubungan antara literasi digital terhadap kinerja akademik mahasiswa di tingkat universitas menggunakan tinjauan literatur sistematis dan meta-analisis dengan menerapkan Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) untuk menggabungkan hasil statistic dengan mempertimbangkan effect size yang dianalisis menggunakan Jeffreys's Amazing Statistics Program (JASP). Total sampel dalam penelitian ini sebanyak 4105 mahasiswa dalam 15 penelitian yang dianggap memenuhi syarat jurnal dari tahun 2011 hingga 2023. Hasil meta-analisis menunjukkan bahwa literasi digital menjadi prediktor terhadap kinerja akademik mahasiswa. Variabel literasi digital juga memiliki korelasi positif dan signifikan terhadap kinerja akademik mahasiswa pada tingkat sedang memiliki korelasi gabungan = 0.31 dengan CI 95% (0.184 hingga 0.444), hal tersebut menunjukkan semakin baik kemampuan literasi digital mahasiswa, semakin baik pula kinerja akademik mahasiswa tersebut. Uji heterogenitas menunjukkan hasil yang baik dan tidak terjadi bias publikasi.

ABSTRACT

Academic performance is an important focus for educational institutions, lecturers, students, and is also a main issue in research to determine the factors that can influence it. As the internet and information & communication technology develop, previous research has shown a correlation between digital literacy as a factor in students' digital skills that influence academic performance, but no research has focused on how much influence the r and size of the correlation between the two special variables have on students at the university level. This research aims to measure the relationship between digital literacy and student academic performance at the university level using a systematic literature review and meta-analysis by applying Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) to combine statistical results by considering the effect size which is analyzed using Jeffreys's Amazing Statistics Program (JASP). The total sample in this study was 4105 students in 15 studies which were considered eligible journal requirements from 2011 to 2023. The results of the meta-analysis show that digital literacy is a predictor of student academic performance. The digital literacy variable also has a positive and significant correlation to college academic performance at the moderate level, having a combined correlation = 0.31 with a 95% CI (0.184; 0.444), this shows that the better a student's digital literacy skills, the better the student's academic performance. The heterogeneity test showed good results and there was no publication bias.

1. INTRODUCTION

Technology development is accelerating in the era of globalization, especially with the presence of the Internet around the world. Technology and the Internet are present to help facilitate daily human activities. In the field of education, technology and the Internet are used to help the teaching and learning process. This development has entered the era of digital technology 4.0 and continues to develop towards the era of technology 5.0, which provides many benefits not only to increase economic growth and efficiency but also to expand educational opportunities that result in various online and blended learning methods.

The development of various kinds of learning methods, the main aim of which is to produce good academic performance of students. Academic performance is the final result individuals achieve as success during learning activities in an educational institution (Naomi & Nindyati, 2010) or in other words, Academic performance is a term to describe the success of learners during learning activities. Some previous studies called the term academic performance as learning achievement, learning success, assignment grades, and academic success (O'Connor & Paunonen, 2007; Tomas, Gutierrez, Georgieva, 2019; Lee et al., 2020). Academic performance is considered very important for institutions, lecturers and for students themselves and has even become the main focus of researchers to find the determining factors for students' academic success, especially in the digital era (Guney, 2009). The topic has become a worldwide concern regarding using information and communication technology (ICT), especially the Internet. This assumption is supported by survey data conducted by the Global Web Index (GWI) on the main reasons people in the world use the internet, where education is the main motivation for using the internet, with a total percentage of 41%. The reason people use the internet is as a necessity in the field of education and research. The survey results also show that education data remains an important motivator of internet use among teenagers and adults. The internet is used to find information related to "researching", "learning how to do something", and other things such as finding ways to solve technical problems in the field of education in both text and video descriptions (Kemp, 2022).

Considering the importance of using the Internet, which is the main thing in the field of education, especially for students, in this case, students as Internet users in the learning process to produce good academic performance, it is necessary to have control from within individuals as students. Students are expected to use the Internet properly and wisely as a learning support tool so that their learning becomes effective and produces good academic performance. The use of ICT and the internet in learning to improve good academic performance requires students to have the proficiency and skills to use digital technology in the learning process or digital literacy in lecture activities. Digital literacy is considered one of the indicators in education and culture to create a critical and creative way of thinking for students (Silalahi, 2022; Tang & Chaw, 2016). Digital literacy is the ability of individuals to find content, think critically, choose what is good and right, and then share it with others (Sukmawati et al., 2019). According to Ng (2012), digital literacy is an individual's ability, awareness, and attitude to use digital tools and facilities properly to identify, access, manage, integrate, evaluate, analyze, and combine digital resources, build innovation both in products or concepts and communicate with others.

The importance of digital literacy variables to improve academic performance is supported by the research results of several previous studies that prove digital literacy is considered an important indicator in education which is currently accompanied by the development of ICT, especially the internet (Banik & Kumar, 2019; Abbas, Hussain & Rasool, 2019; Aboderin & Govender, 2022; Limniou et al, 2021; Munawaroh, Fitriati, Febriantina, 2022; Khan, Sarwar, Chen, & Khan, 2022). Previous studies found that students with digital literacy and active use of ICT have high academic performance (Avci & Ergun, 2019; Khan, Sarwar, Chen, & Khan, 2022). Other studies show that the relationship between computer and internet literacy is important in improving students' academic performance (Flierl, Bonem, Maybee, & Fundator, 2018).

Although there has been previous research published regarding digital literacy and academic performance (Lei, Xiong, Chiu, Zhang Cai, 2021; Yustika & Iswati, 2020), there has been no research that specifically examines the meta-analysis of the relationship between the two in level college. Meta-analysis plays a role in finding the true r by considering the effect size (Schmidt & Hunter, 2015). Several previous meta-analyses regarding academic performance focused on the issue of learning motivation strategies (Muryono, Ildil & Rangka, 2021), or academic flow (Fatimah, Eva & Farida, 2021), or self-efficacy mediated by emotional intelligence (Hutasuhut & Sari, 2021). Therefore, this meta-analysis was carried out to fill the gaps left by previous meta-analyses, especially those that focused on digital literacy on college academic performance. The purpose of this meta-analysis is to measure the effect size of the correlation between digital literacy and academic performance. In the Meta-analysis research, it will also be seen how the correlation exists after considering the effect size and various existing variances, as well as ascertaining the strength of the correlation, heterogeneity, whether the score distribution is symmetrical or not, and publication bias.

This research uses a meta-analysis technique to summarise the findings of previous studies by combining, reviewing, and summarising digital literacy variables and academic performance specifically on a sample of students at the university level. The aim is to focus on looking at the relationship between the two variables only in the student sample because the use of ICT, especially the internet, has long been widely used by students as a basic resource for learning and preparing themselves when entering the workforce in the future.

2. METHOD

Protocol design

This research uses the Systematic Literature Review (SLR) method to identify, study, evaluate and interpret all research that is in accordance with the research theme. This meta-analysis study was conducted to determine the true r and effect size of various studies regarding the correlation of digital literacy and academic performance in college students. results found research from 2011 to 2023 that was relevant to the research topic. The study selection was carried out through several stages, namely identification, screening, and eligibility. Study selection was carried out using PRISMA or Preferred Reporting Items for Systematic Reviews 2020 (Page et al., 2021).

Search strategy

The research strategy was carried out using several processes, namely identifying problems using the keywords digital literacy and academic performance with search efforts were made based on two major sources, namely the Google Scholar register, and from databases such as Elsevier, SAGE, EBSCO, Taylor and Francis, and Jstor. The keywords used are "digital literacy", "ICT literacy", "academic performance" and "academic achievement". The literature found and eligible for use ranged from 2011 to 2023. Selecting journals that can be accessed in full text and in accordance with the inclusion and axclusion criteria.

Inclusion criteria

The basic criteria used in this meta-analysis are (1) quantitative studies, (2) involving digital literacy as the independent variable and academic performance as the dependent variable, (3) the studies selected for processing used a sample of students at the university rather than at other learning levels such as elementary school, junior high school and high school, (4) journals published from 2011 to 2023, and (5) using English in the text

Exclusion criteria

Several criteria were not included in the research search for this meta-analysis. Some of these criteria are (1) letters to editors, and (2) undergraduate and master thesis studies. The additional considerations used are statistical results that do not generate r , t , F , or R^2 scores, or studies using Chi-Square are not used in the literature source of this meta-analysis.

Data collection and analysis

The literature search was carried out using a variety of keywords from source databases and registers. The studies found were then selected independently. The inclusion criteria that have been set previously are used to sort out which literature sources are eligible, and which are not, including considerations for statistical findings.

Data extraction

Data from the literature sources found were then extracted based on pre-determined criteria. Extraction is also done independently.

Statistical analysis

The study passed the initial selection and was selected and then analyzed and searched for the correlation coefficient and the number of participants. Statistical findings in the form of scores in the form of F , d , t or R^2 are then converted into r scores. The next step is to calculate the effect size (z), variance (Vz) and standard error (SEz) where the results are then processed using Jeffreys's Amazing Statistics Program (JASP). The main things to do are to find the calculation of heterogeneity test, summary effect size, forest plot, funnel plot, Egger's test, and fail-safe N test.

Population and Sample

The population in this research is international journals that have been published related to digital literacy and academic performance. The total population in this study was 30 with samples taken of 15 studies from

14 relevant literature based on inclusion and exclusion criteria. The number of student samples in the selected journals was 4105 college students.

3. RESULT AND DISCUSSION

Result

An early-stage search for this meta-analysis found 30 studies. After removing duplicates and considering inclusion and exclusion criteria, there are 15 studies from 14 literatures that are considered eligible. PRISMA flow as a literature screening process in this meta-analysis research can be seen in [Figure 1](#). The total number of participants was 4105 people.

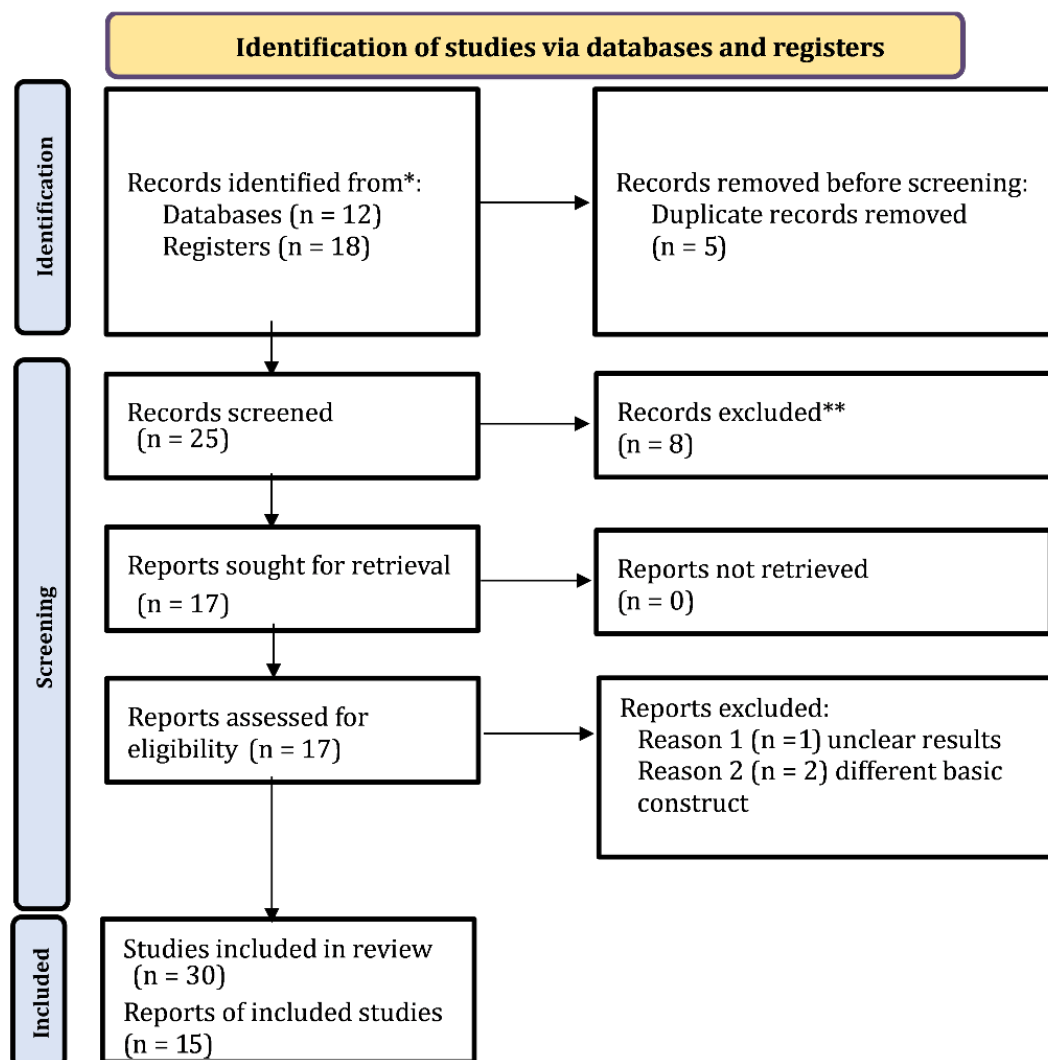


Figure 1. PRISMA for Depicting the Screening Process

From the results of 15 studies that were processed according to the inclusion criteria in the study, demographic data were obtained in [Table 1](#), which shows that the source of the scale used for the digital literacy variable and the source of measurement used for the academic performance variable varied. Almost all studies used tests or study scores to measure academic performance. This is due to the development of variable constructs in various research settings. The national setting of this research comes from several countries, namely Bangladesh, India, Indonesia, Nigeria, Pakistan, South Africa, Sri Lanka, Turkey, the United Kingdom, and the United States. Some studies present data on the scales used to measure digital literacy, and some do not. This serves as supporting data and is not used in the meta-analysis calculations, so this is acceptable.

Table 1. Characteristics of the Studies Used for the Meta-Analysis

No	Study	Year	Sampel Size	Digital Literacy Scale	Academic Performance	National Setting
1	Abbas, Hussain & Rasool (2019)	2019	800	Abbas, Hussain & Rasool (2019)	GPA_ Last_ Exam	Pakistan
2	Barlow-Jones & Westhuizen (2011)	2011	171	A structured non-anonymous questionnaire	English Test Score	South Africa
3	Limniou, Varga-Atkins, Hands & Elshamaa (2021): Studi 1	2021	133	The Digital Literacy Scale by Ng (2012)	GPA	United Kingdom
4	Limniou, Varga-Atkins, Hands & Elshamaa (2021): Studi 2	2021	170	The Digital Literacy Scale by Ng (2012)	GPA	United Kingdom
5	Munawaroh, Fitriati, Febriantina (2022)	2022	188	Kim et al. (2019)	Value of the Mid-Semester Examination	Indonesia
6	Naz, Raheem, Khan & Muhammad (2022)	2022	120	-	GPA	Pakistan
7	Sari (2022)	2022	95	Makarim & Sari, 2021	GPA	Indonesia
8	Thamrin, Aditia & Hutasuhut	2023	358	Rodriguez-de-Dios et al. (2016)	Nayak (2018)	Indonesia
9	Aboderin & Govender (2022)	2022	1025	-	GPA	South Africa
10	Azizi (2014)	2014	254	The IC Scale created by the scholar	GPA	India
11	Falode O. C., Gambari A. I., Alabi, T. O. & Falode, M. E.	2017	100	Questionnaire on Students' ICT Exposure and Access (QSIEA)	Educational Technology Academic Scores (ETAS) - > GPA	Nigeria
12	Flierl, Bonem, Maybee, & Fundator	2018	3152	AACU (2019)	Course Grade	United States
13	Nanayakkara, Peiris, Ranathunga, & Muthuthanmy (2020)	2020	126	ICT literacy by administering theory and practical based examination conducted by the ICT Centre, Wayamba University of Sri Lanka	Continuous Assessment Test (CAT) marks	Sri Lanka
14	Avci & Ergun (2019)	2019	65	Information Literacy Scale by Aldemir (2004)	Total Score Semester	Turki
15	Banik & Kumar (2019)	2019	325	Information literacy skill index	GPA	Banglade sh

Table 2 presents the results of the Q statistic for the heterogeneity test. The meta-analysis was carried out by considering the college students sample, showing that the 15 studies were heterogeneous ($Q = 196.209$; $p < .001$). Thus the random effect model is more suitable to be used to estimate the mean effect size of the 15 studies analyzed. The results of the analysis also show that there is potential to investigate moderator variables that influence the relationship between digital literacy and college students academic performance.

Tabel 2. Fixed and Random Effects

	Q	df	p
Omnibus test of Model Coefficients	22.398	1	< .001
Test of Residual Heterogeneity	196.209	14	< .001

Note. p -values are approximate.

Note. The model was estimated using Restricted ML method.

Random effect showed a significant positive correlation between digital literacy and academic performance college students ($z = 4.733$; $p < .001$; 95% CI [0.184; 0.444]). The relationship between digital literacy with academic performance college students is $r = 0.314$. These results have scores that are classified as moderate (Cohen, 1988). Detailed explanation is shown in Table 3.

Tabel 3. Coefficients Score for Participant

	Estimate	Standard Error	z	p	95% Confidence Interval	
					Lower	Upper
College students	0.314	0.066	4.733	< .001	0.184	0.444

Note. Wald test.

The study effect sizes in these meta-analyses varied. Most studies showed an effect size with strong significance with scores ranging from $z = 0.01$ with 95% CI (-0.01; 0.12) to $z = 0.87$ with 95% CI (0.73; 1.02). Meanwhile, the summary effect size is $z = 0.31$ with 95% CI (0.18; 0.44). The results are more clearly seen in Figure 2.

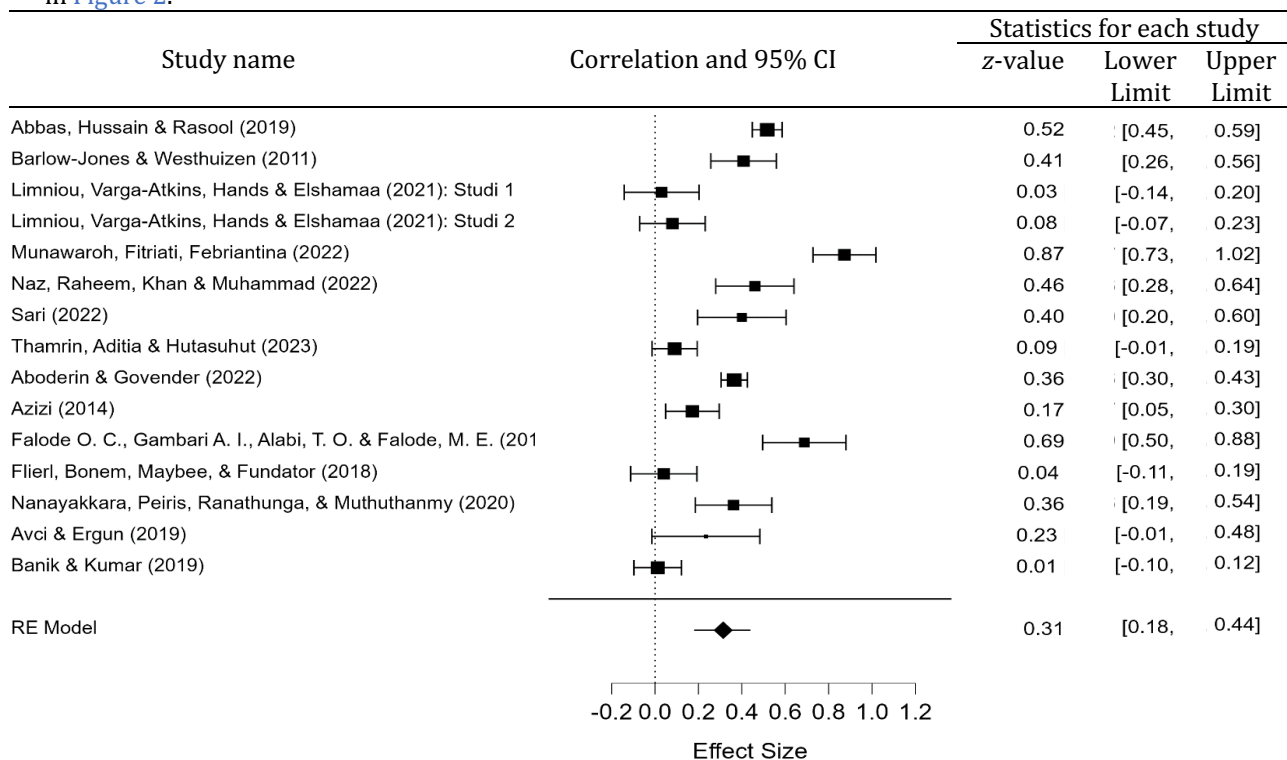


Figure 2. Forest plot for the random-effects model

This study also looked at findings related to evaluating publication bias. The first is to look at the funnel plot, as shown in Figure 3, to consider whether the distribution of scores is symmetrical or asymmetrical. Publication bias was not found when the distribution of scores in the funnel plot was symmetrical. However, the distribution of scores in the funnel plot sometimes cannot be justified as symmetry or asymmetry, so another technique is needed to determine the evaluation of publication bias, namely Egger's test method. Table 4 shows the results of the Egger's test. It was found that the z value =

0.255 ($p > 0.05$). It means that the distribution of scores in the meta-analysis of samples related to the relationship between digital literacy and academic performance is symmetrical.

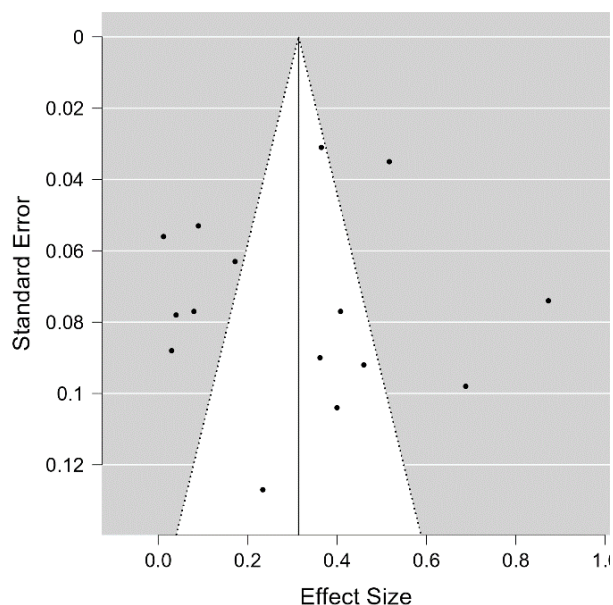


Figure 3. Funnel Plots

Table 4. Regression test for Funnel plot asymmetry ("Egger's test")

	z	p
College students	0.255	0.799

Another way to identify publication bias is through the Fail-safe N or Number Fail-Safe (Nfs). Nfs is defined as the minimum number of studies with insignificant results so that the meta-analysis results in the study are also said to be insignificant. If the Nfs condition is less than $5k + 10$ (k is the number of original studies identified from the beginning before screening), there is a high probability of publication bias (Rothstein et al., 2005). In Table 5, the score obtained from the participants, in this case students, is 1897 ($p < 0.01$), which is greater than $5(30) + 10 = 160$. It means that there is no publication bias in the meta-analysis study related to the relationship between digital literacy and academic performance in the student sample. The funnel plot results, Fail-safe N or Nfs from Rosenthal's formula, did not show significant publication bias.

Table 5. File Drawer Analysis for Rosenthal's Formula

	Fail-safe N	Target Significance	Observed Significance
Rosenthal	1897	0.05	< .001

Discussion

This meta-analysis study found that digital literacy and students' academic performance have values in the moderate category, so digital literacy is a good antecedent and can be considered to improve students' academic performance. These findings are in line with previous studies which show that digital literacy, ICT literacy, or information literacy is an important and significant factor that students must have in carrying out learning in order to produce good performance (Abbas, Hussain & Rasool, 2019; Flierl, Bonem, Maybee, & Fundator, 2018; Banik & Kumar, 2019; Limniou, Varga-Atkins, Hands, & Elshamaa, 2021; Naz, Raheem & Muhammad, 2022). This can happen because, with good digital literacy, students become creative and have critical thinking skills. The digital literacy variable is considered to be an influential factor as seen from the effect size measurement results in Table 2 and Figure 2.

In line with the results of meta-analysis in research which states the level of relationship between digital literacy variables as a predictor of student academic performance, there is a brief review study conducted by Yustika and Iswati (2020) regarding digital literacy in formal education using online learning methods, the results show that the level of literacy is high. Student digital literacy has a positive impact on

high performance or academic achievement of students, digital literacy skills of students that are relevant to student achievement or academic performance are technical abilities such as operating communication and information technology during the learning process, the ability to search, read and rewrite information found via the internet as a reference sources for assignments.

In addition, the digital literacy variable includes various abilities that are relevant to achieving good student academic performance. Students' digital literacy assessment abilities or dimensions can be further explained from various opinions and frameworks, one of the digital literacy framework concepts developed by Ng (2012) which assumes digital literacy has three dimensions of literacy ability, namely technical dimensions such as understanding and mastering the operational use of information and communication technology (ICT), cognitive dimensions related to the individual's ability to think critically in searching, evaluating and reusing information search results through search engines, and socio-emotional dimensions include how individuals or social interactions through cyberspace with responsibility in communicating, and paying attention to and applying ethics. These dimensions are applied by students during their learning in college and everyday life (Silalahi, 2022). The framework is proven by the results of other studies, which show that there are several factors of students' digital literacy abilities that play a role in improving academic performance, namely a) understanding of digital literacy, b) searching for information through digital tools, c) digital literacy in evaluating information critically, online interaction, and online, d) managing and communicating information, e) collaboration and sharing digital content (Abbas, Hussain & Rasool, 2019; Barlow-Jones, & Westhuizen, 2011; Flierl, Bonem, Maybee, & Fundator, 2018; Limniou, Varga-Atkins, Hands, & Elshamaa, 2021; Naz, Raheem & Muhammad, 2022; Nanayakkara, Peiris, Ranathunga, & Muthuthanmy, 2020). The study from Ukwoma and Iwundu (2016) explains that digital literacy affects students' academic performance to a better level. Digital literacy increases knowledge in literature searches, increases communication levels, and identifies various sources of information. In line with the results of this meta-analysis research, a study conducted by Sari (2022) showed that digital literacy abilities such as basic internet skills, searching and obtaining information, information sources used, and the ability to use information effectively have a significant relationship with academic performance because these skills are implied in the learning process.

Although the results of the meta-analysis in this study show that the relationship between digital literacy and student academic performance is in the moderate category, several studies explain the weak relationship, namely no relationship and insignificant. A study by Falode, Gambari, Alabi, Omotayo, and Falode (2017) revealed no relationship between students' information and communication technology (ICT) background and academic performance. In addition, there is no significant relationship between students' access to ICT learning facilities and academic achievement in Education technology. Another study conducted by Azizi (2014) showed that the information-seeking component was significantly and negatively correlated with student achievement. Besides, no significant correlation exists between the number of internet competencies of general computer knowledge, general computer skills, communication and collaboration, general use of web pages, and information management with student achievement. The research findings are supported by a study conducted by Darlis and Sari (2020), showing that student characteristics and digital literacy provide insignificant influence on student performance in blended learning.

Academic or non-academic internet use can positively or negatively influence student learning. The study's results showed a low relationship between digital literacy and academic performance, no relationship, and insignificance of these variables. This is because even if students have an ICT background and access to ICT learning facilities, the priority of resources is only used for purposes that are not in accordance with the academic achievement and performance process, such as spending valuable learning time on the Internet to do useless activities, namely playing games, chatting with friends outside the context of learning, and looking for entertainment that is not related to academic learning. Based on the results of this study that digital literacy has an important role in determining students' academic performance, efforts are needed to advance digital literacy in higher education by focusing on integrating digital literacy into various courses (Azizi, 2014; Avci & Ergun, 2019; Flierl, Bonem, Maybee, & Fundator, 2018; Nanayakkara, Peiris, Ranathunga, & Muthuthanmy, 2020).

This meta-analysis study emphasizes depicting and describing the results of calculating the correlation between digital literacy variables and academic performance, so that the research results can be used as a scientific reference regarding the relationship between variables for further research. Besides that, this meta-analysis study also provides information about the measurement tools used in research on the digital literacy and academic performance variables. The aim is to facilitate future researchers in determining the right measuring instrument in accordance with the objectives of the study. Most previous studies used measuring instruments on student academic performance variables at the university level, namely Grade Point Average (GPA). In Indonesia, the Grade Point Average (GPA) is the achievement of

national education goals, so it is one of the parameters used to measure the effectiveness of the education institution system (Alimi et al., 2012). The measuring instruments used in digital literacy variables vary such as measuring instruments in a study conducted by Abbas, Hussain, & Rasool (2019), who compiled their own measuring instruments that digital literacy was measured by several factors, namely understanding skills, information search, evaluation skills, management and communication, collaboration and sharing, and knowing the obstacles in digital literacy learning. Limniou, Varga-Atkins, Hands, & Elshamaa (2021) used The Digital Literacy Scale tool developed by Ng (2012). This scale is a framework that produces three dimensions: Technical, Cognitive, and Social Emotional.

4. CONCLUSION

The results of this meta-analysis study concluded that digital literacy is considered to be one of the variables that influences academic performance along with the development of the use of information and communication technology (ICT) in the education sector. This meta-analysis study found that digital literacy and students' academic performance have values in the moderate category, so digital literacy is a good antecedent and can be considered to improve students' academic performance, in other words that students with a good level of digital literacy or information and communication technology (ICT) literacy have better academic performance.

In addition, there are two implications that can be presented from this meta-analysis, namely practical implications for students and theoretical implications as a contribution to the field of psychology. The practical implications of the findings of this meta-analysis are that students can know and consider the aspects that become an assessment of digital literacy skills or the ability to use information and communication technology (ICT) which can affect academic performance, these abilities including the ability to identify, search, evaluate, apply, and recognize. In addition, students and universities can understand and master the use of ICT, which includes technical, cognitive, and social-emotional aspects, which help students to carry out their daily activities in the fields of education, research, communication with others and independent learning, as an effort to improve academic performance output according to the application of their university standards and help overcome the challenges faced in the online learning environment.

The theoretical implication of this meta-analysis study is that digital literacy can be considered as one of the internal antecedents in order to result in academic performance, especially in university students, for further research in the era of technological development 4.0 towards 5.0. Another suggestion is to consider other internal variables that can improve students' academic performance, such as digital information literacy, learning style, self-efficacy, independent learning such as self-regulated learning, and self-directed learning. This is important before other researchers ascertain whether external factors such as ease of computer use, perceived social support, and online risks faced in learning have a supporting role in improving university students' academic performance.

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