ISSN: 1309 – 6575
Eğitimde ve Psikolojide Ölçme ve Değerlendirme Dergisi
Journal of Measurement and Evaluation in Education and Psychology
Research Article; 2023; 14(Special Issue); 287-298

The Effect of Using E-Portfolios on The Self-Regulation Skills of Students: A Meta-Analysis Study

Ceren MUTLUER*

Abstract

The change of self-regulation skills, one of the variables determining success in education, with measurement and evaluation techniques in the education process has been the subject of many studies. However, each research result leads to different results due to the planned situation and limitations. For this reason, e-portfolios used in the education process were examined with a meta-analysis study to evaluate whether they were effective on students' self-regulation skills from a more general point of view. The research is limited to published academic studies written in Turkish and English between 2000 and 2023. When the criteria determined in the research were examined, only 19 studies were found by these criteria. Theoretically, when the effect sizes in each study were examined, a meta-analysis was carried out with the random effects model. The analyzes of the research were made with the CMA version 3 program. As a result of the research, it was concluded that using e-portfolios greatly and significantly affect students' self-regulation skills.

Keywords: e-portfolio, self-regulation, meta-analysis, random effects model

Introduction

The expression 'academic achievement' is commonly used to refer to education quality within the education system. Many studies have reported that academic achievement used in determining the effectiveness of education is positively related to self-regulation strategies (Eom & Reiser, 2000; Pintrich & De Groot, 1990; Trainin & Swanson, 2005; Üredi & Üredi, 2005).

Performance for academic tasks is explained as academic achievement in the education process. Self-regulation skills play an active role in the process of determining the goals in the process of revealing the work done by the individual in academic tasks, the feedback in the process of reaching the goals, and the evaluation process in terms of concrete products. While describing the notion of self-regulation, Zimmerman (1986) defines it as comprehending students as active contributors to an academic task in terms of cognitive, motivational, affective, and behavioral aspects. Therefore, identifying which self-regulated learning strategies are important and which self-regulation strategies facilitate their use is essential to promote academic performance.

Dent & Koenka (2016) focused on determining the relationship between learning and academic achievement according to the self-regulation strategy in their meta-analysis study. In the meta-analysis study, when the overall effect calculated for metacognitive processes and cognitive strategies for self-regulation strategies was examined, it was seen that there was a significant and moderate effect. As an important variable affecting academic success, self-regulation skills are shaped by measurement and evaluation techniques. Measurement and evaluation processes, especially complementary measurement and evaluation techniques, focus on individuals' awareness of their characteristics. Personal choice and self-control are necessary for students to gain and develop self-regulation skills (Zimmerman, 1989).

Gözüyeşil & Tanrıseven (2017) examined the effectiveness of alternative measurement and evaluation techniques in their study. In their study, it was determined that alternative measurement and evaluation

* PhD, Bolu Abant İzzet Baysal University, Faculty of Education, Bolu-Turkiye, e-mail: cmutluer@yandex.com, ORCID ID: 0000-0002-3935-336X

To cite this article:
Mutluer, C. (2023). The effect of using e-portfolios on the self-regulation skills of students: A meta-analysis study. *Journal of Measurement and Evaluation in Education and Psychology, 14*(Special Issue), 287-298. https://doi.org/10.21031/epod.1267809

Received: 20.03.2023
Accepted: 20.06.2023

techniques increased academic achievement. In a detailed examination, the effect of portfolio applications on academic achievement was higher than other measurement and evaluation techniques.

In this process, it is appropriate to use performance-based measurement and evaluation tools. The use of portfolios is preferred to monitor the initial and developmental processes in self-regulation skills. Portfolio applications provide an authentic and meaningful collection of student work and allow students to accurately demonstrate their success or development (Ekbatani & Pierson, 2000).

As a reflection of technology in the educational process, the portfolio technique has also been moved to the electronic environment and names such as e-portfolio and web-based portfolios have been given. Electronic portfolios have also been promoted as the evolution of traditional portfolios. They have many advantages over paper-based portfolios. These are:

- Easier, even more immediate, access to students' work can be provided by a wider audience, including peers, teachers, parents, and others (Barrett, 2006)
- Increases information communication skills (van Wesel & Prop, 2009)
- Fewer cultural barriers (Wanchid & Charoensuk, 2015)
- Allows two-way communication (without time and place restrictions) (Barrett, 2006)
- Faster feedback is received (Wanchid & Charoensuk, 2015).
- Increases a greater sense of potential and a high sense of pride and achievement regarding the permanence of the content (Campbell & Schmidt, 2005).
- Allows individuals to develop self-regulation skills with the support of technology.
- Prevents the manual storage of portfolio materials.

Due to these advantages, e-portfolio is used as one of the measurement and evaluation techniques of the education process. There are electronic portfolios as a technology-assisted formative assessment. The e-portfolios ensure ease of access, data storage opportunities, time-saving, contribution to teaching, and continuous monitoring of teacher performances. It assists in the collection, update, and management of data. It is a guide in terms of the effectiveness of the evaluation process (Polat & Köse, 2013). Apart from being an evaluation tool, it has been decided that an e-portfolio encourages students to learn, increases their motivation, changes their attitudes and perceptions positively, and increases their success in the process (Barış & Tosun, 2013; Chou, 2012; Demirli, 2007; Demirli & Gürol, 2010; Gülbahar & Köse, 2006).

Many benefits can be mentioned when a literature review is done on the educational inputs, processes, and outputs of e-portfolios. Primarily, the tasks are received in feedback as they are shared with teachers and friends. In addition, E-portfolios support students' individual development by shaping learning materials (Kinash et al., 2012). Among other benefits, e-portfolios encourage students to develop their skills using multimedia components and to reveal all individuals' learning achievements and expectations. In the process of creating an e-portfolio, students are provided with the opportunity to reflect on their learning levels, teachers provide feedback and guidance, the continuity of students' development is ensured, participation in collaborative activities is ensured, and socialization, encouragement, and motivation are provided (Demirli & Gürol, 2010; Ghosh, 2003; Lorenzo & Ittelson, 2005). E-portfolios assessment include the features of self-reflection, self-review, self-monitoring, and self-improvement (Bartlett & Sherry, 2006).

In their study, e-portfolios' benefits are listed under five headings by Jenson & Treuer (2014). These five topics are collection, self-regulation, reflection, integration, and collaboration. Jenson & Treuer (2014) explained these concepts as follows, taking into account the skills of the 21st century.

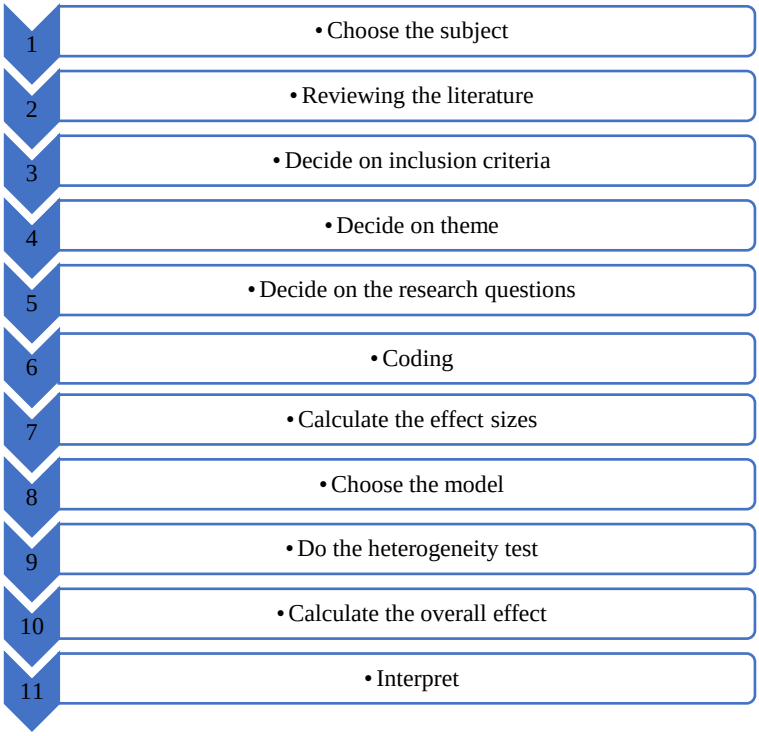
- *Collecting:* Relevant artifacts that demonstrate learning outcomes.
- *Self-Regulating:* Being aware of behavior, students can control and exercise that control for learning.

- *Reflecting:* Contextualizing the meaning and significance of learning, consistent with established goals and values.
- *Integrating:* Synthesizing and transferring learning to any number of situations.
- *Collaborating:* Participating in the community to build knowledge and skills based on existing knowledge.

As one of the benefits mentioned above, the e-portfolio application has a great place in acquiring and developing self-regulation skills. Many studies in the literature use e-portfolios in the input, process, and process-oriented evaluation phase of learning environments. However, considering the differences in the number of study groups, their aim at different times, and the different target audiences, studies have yet to be decided to examine the effect of e-portfolios on self-regulation skills with a holistic perspective. Therefore, this study aims to examine the effect of using electronic portfolio (e-portfolio) in the literature between 2010-2023 on self-regulation skills in learning processes from a holistic perspective. In this study, a meta-analysis study was planned over the studies conducted in the literature between the years 2000-2023 using the variables specified in the purpose of this study.

The meta-analysis is one of the first proposals to test the statistical significance of combined results (Hedges, 1992). Furthermore, a meta-analysis was felt to consider the research results holistically and form a common opinion (Mutluer, 2022). According to Borenstein et al. (2010), meta-analysis studies are studies that can be more generalized as a result of integrating the results of studies with the same or related purpose and reach results that many studies have confirmed. There are eleven sequential steps to conducting a quality meta-analysis (Borenstein et al., 2010; Field & Gillett, 2010; Şen & Yıldırım, 2020):

Figure 1
The Steps of the Meta-Analysis Procedure



The meta-analysis stages was interpreted in Figure 1. The overall effect of the meta-analysis should be interpreted in line with the specified stages.

Methods

The statistical process used to reach a more general result than the results of studies conducted for similar purposes at different times is possible with meta-analysis. According to Glass (1976), *meta-analysis* is the statistical analysis of many analyses emerging from individual studies to integrate the findings. The effects of e-portfolios on the self-regulation skills of individuals have been examined with meta-analysis and the steps to be followed in the process are included. This section includes the criteria determined for the meta-analysis, the studies included in the meta-analysis, the process of dealing with publication bias, and the data analysis.

Data Sources and Search Strategies

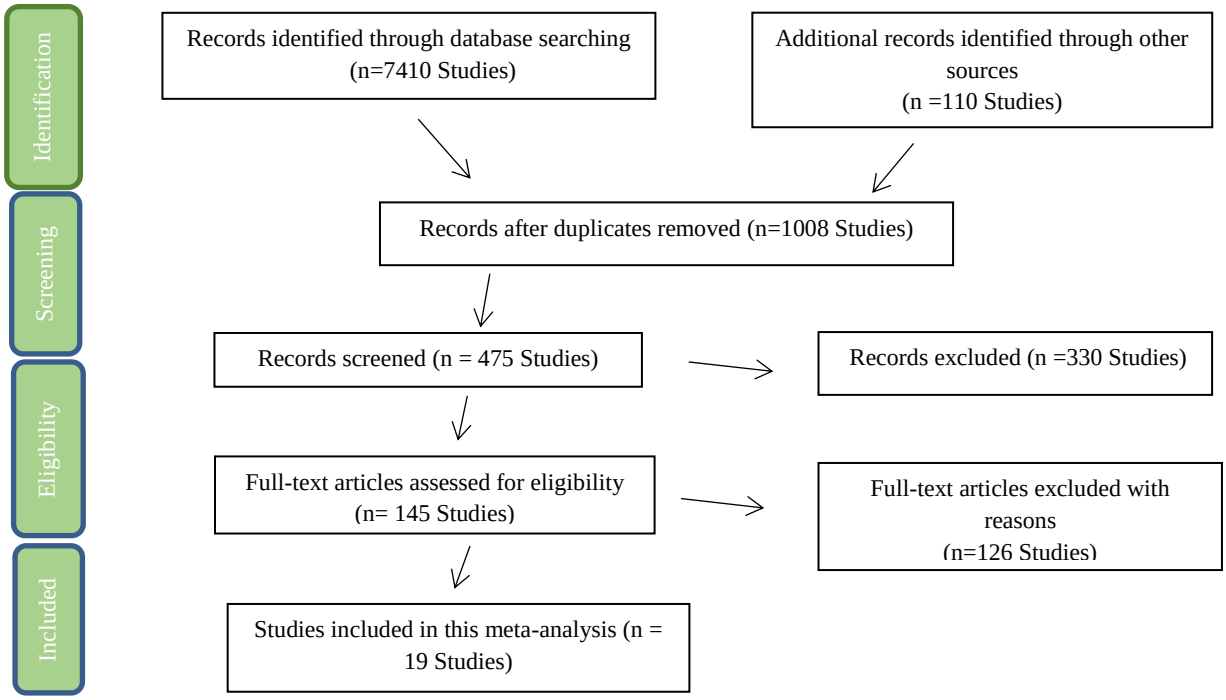
Both published articles and theses were reviewed to obtain a wide range of available resources for meta-analysis. The electronic search consisted of databases including JSTOR, ERIC, ScienceDirect, Wiley Online Library, SAGE Journals, ProQuest Dissertations, YÖK (Council of Higher Education) National Thesis Center, Web of Science, and Google Scholar. The primary search terms were 'electronic portfolio', 'e-portfolio', 'digital portfolio', 'online portfolio', 'web-based portfolio', 'self-regulation', 'self-regulation skills', 'self-regulation strategies', 'self-organizing', and 'self-reflective'. Considering these keywords, among the studies conducted between 2000-2023, 'e-portfolios affect the self-regulation skills'. The following criteria were used to select the studies included in the meta-analysis study:

- To be examined the effect of e-portfolio on self-regulation,
- To be published as Master's, doctoral thesis or article,
- To be written only in English and Turkish,
- To be decided the valid studies which were used an experimental design,
- To be included sufficient information (sample size, mean, standard deviation) in studies to calculate the effect size. In the figure below, which studies were selected according to the criteria determined for the meta-analysis are summarized in stages.

Publications were sorted by taking into account the criteria in the meta-analysis process. In the Prisma model in Figure 2, the number of publications in the meta-analysis process and the elimination process according to the criteria are given.

Figure 2

The Flowchart Shows the Selection of Included Studies (PRISMA)



When the literature was examined, the data extraction process started with 7410 studies in which the keyword was mentioned and continued by reducing it to 19 studies. 19 studies were selected by the criteria specified in the study. Information about the studies selected for the research is given in Table 1.

Table 1

Descriptive Explanations for All Included Studies in This Study

Study	Year	Author(s)	Publication Type	Effect Size
1	2007	Cooney	Thesis (Doctoral)	0,569
2	2010	Meyer and others	Article	-0,03
3	2010	Koç	Thesis (Doctoral)	0,9
4	2013	Cheng & Chau	Article	0,497
5	2013	Abrami & others	Article	0,652
6	2013	Alexiou & Paraskeva	Article	0,839
7	2014	Alexiou & Paraskeva	Article	6,322
8	2015	Tseng & Lin	Article	0,512
9	2015	Nguyen & Ikeda	Article	0,006
10	2016	Liang & others	Article	1,638
11	2017	Sasai	Article	3,411
12	2018	Chang *et al.*	Article	0,780
13	2019	Karami *et al.*	Article	0,553
14	2019	Corta	Article	-3,396
15	2019	Alexiou & Paraskeva	Article	1,863
16	2020	Akgün & Şahin Kölemen	Article	0,539
17	2021	Alhitty & Shathawi	Thesis(Master)	1,801
18	2021	Türkkaynağı	Article	0,214
19	2022	Lysenko *et al.*	Article	0,116

The table gives the year, publication type, author information, and effect sizes of 19 studies. When the research was examined, it was found that two studies (%10.5) in 2020, 2012, 2015, 2018, 2019, and 2021 years were related to the subject title. In addition, three of the studies are dissertations. Of these theses, only the work completed by Türkkaynağı in 2021 is a master's thesis. Finally, while only three of these studies were written in Turkish, the remaining 16 studies were written in English.

Publication Bias in the Meta-Analysis Process

Conducting meta-analysis with only studies supporting a certain hypothesis in the research process causes publication bias. Therefore, publication bias should be determined in studies that meet the criteria. In this study, Funnel-Plot, Classic Fail-Safe N analysis, and Egger regression estimation coefficient were used for investigating publication bias. The results of these methods were evaluated together and it was decided whether there was a publication bias or not.

Analysis of Data

Firstly, the effect sizes were calculated. For this research, Comprehensive Meta-Analysis (CMA)-Version 3 program was used to calculate both effect sizes and overall effects in the process.

While investigating the effect of e-portfolios on students' self-regulation skills within the scope of the research, the comparison between pre-test and post-test scores was considered. Therefore, the following

equation of sample score means differences will be used for the difference between pre-test and post-test scores.

$$D= \overline{X}_1-\overline{X}_2 \quad (1)$$
$$D= \overline{X}_{Diff}$$

The second equation below was used to calculate the variance for both measurements in the study.

$$V_D=\frac{n_1- n_2}{n_1 n_2} S^2_{pooled} \quad (2)$$

In this context, the effect size can be calculated.

$$SE_D=\sqrt{V_D} \quad (3)$$

The Cohen D effect size was then converted to Hedge's g effect size. Hedge's effect size formula will be used to calculate the effect size in the research. In addition, the coefficient developed by Hedges (1982) will be used to calculate individual effect size values:

$$\text{Hedges' } g = (M_1 - M_2) / SD_{pooled} \quad (4)$$

Choosing the appropriate model to determine the overall effect size is important when performing meta-analyses (Srinivasjois, 2021). Where there is no heterogeneity between studies and there is a valid reason to assume that the true effect is constant, it is appropriate to use the fixed effects model (Harrer *et al.*, 2022). However, in cases where the studies will be generalized to a universe with different effects and characteristics, the random effects model should be used based on the assumption that the actual effect may vary from study to study (Hanji, 2017). Therefore, before the analysis, it was decided by the researchers to calculate the overall effect size using the random effects model. In addition, heterogeneity analysis was performed to determine the variability between the effect sizes of the primary studies included in the meta-analysis.

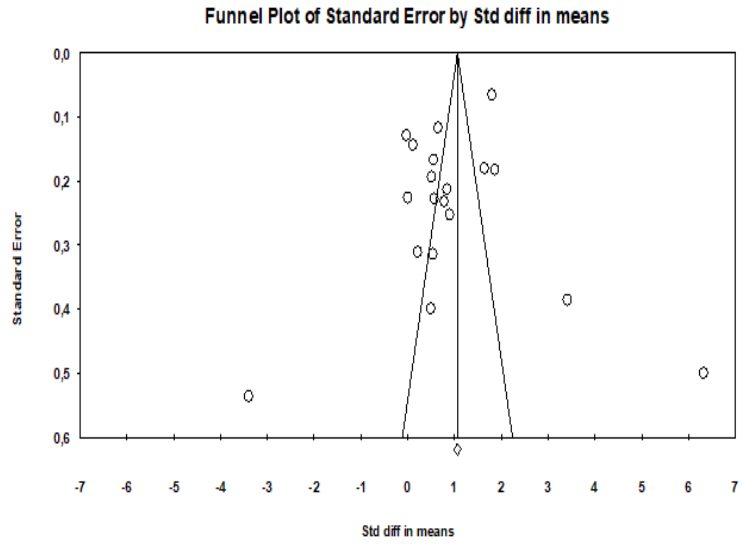
Results

Result of Publication Bias

Including studies that defend and confirm only one hypothesis in the research process causes publication bias. For this reason, the process should be started by examining whether the meta-analysis has publication bias.

In this study, Funnel-Plot, Classic Fail-Safe N analysis, Egger regression estimation coefficient were used to investigate publication bias. With Funnel Plot, the distribution of the effect sizes on the funnel plot is presented. The distributions of the effect sizes of all studies on the Funnel plot are given in Figure 2 below.

Figure 3
The Effect Size Distributions on the Funnel Plot



When the Funnel plot above is examined, it is seen that the distribution around the funnel plot cone is homogeneous, although there is no perfectly symmetrical distribution. This distribution of the effect sizes of the funnel plot indicates the absence of publication bias (Rothstein *et al.*, 2005; Sterne *et al.*, 2011).

As the other analysis bias method, Classical Fail-Safe N value was examined. The overall effect will change significantly if more than 2135 studies are added to the research. Since the number of these studies is quite high, it has been proven again that there is no publication bias. As the last bias analysis, Egger's regression test was used. The regression intercept was insignificant (intercept = -2,664, p = .309). Therefore, the hypothesis was accepted to show that the regression constant did not deviate from zero significantly.

Testing for heterogeneity

Although heterogeneity is a process that needs to be analyzed statistically, it is a process that needs to be decided based on the actual literature. It is not a correct approach to determine a model based on only statistical results. To treat the heterogeneity situation hypothetically, it should be decided whether the effect in the universe differs according to the situations in the study.

According to Borenstein *et al.* (2021), a fixed effects model was proposed if the real effect is unique in the universe and has a constant feature in all studies. In this case, homogeneity is achieved. According to the fixed effects model, each study's effect on the universe is the same as the real effect. Furthermore, it is stated that a single source of error in the fixed effects model is sampling error. As an alternative to the assumptions of the fixed effects model, the fact that the effect in the studies is not equal to the general effect in the universe is explained with the random effects model. The effect in the universe may not be the same in all studies and there may be different subgroups. In this case, different effect sizes are mentioned. The actual effect varies from study to study. For example, the fact that a drug has different effects at different age levels causes different effect sizes to be calculated in the research results. In this model, it is desired to estimate the mean of the distribution of effects. It is not correct to accept a single effect size in the random effects model. According to this model, there are multiple effects in the universe.

It is incorrect to test for heterogeneity in research and choose a model in this context. However, if it is known that there is more than one effect size in the study and the distribution of these effects is theoretically supported, the random effects model is recommended. In this study, the random effects

model was chosen because it was theoretically explained that the effect in the universe was different in all studies. Although the literature-supported model was chosen in the process, the heterogeneity tests in the research process are given in the Table 2 below as second evidence.

Table 2

Overall Effect Size and Confidence Intervals for Heterogeneity by Random Effect Model

Number of the Studies	Overall Effect Size	df	Q	Se	I^2	Tau square (τ^2)	Effect size and %95 confidence	
							Lower limit	Upper Limit
19	0,925	18	559,201	0,233	96,781	0,955	0,469	1,381

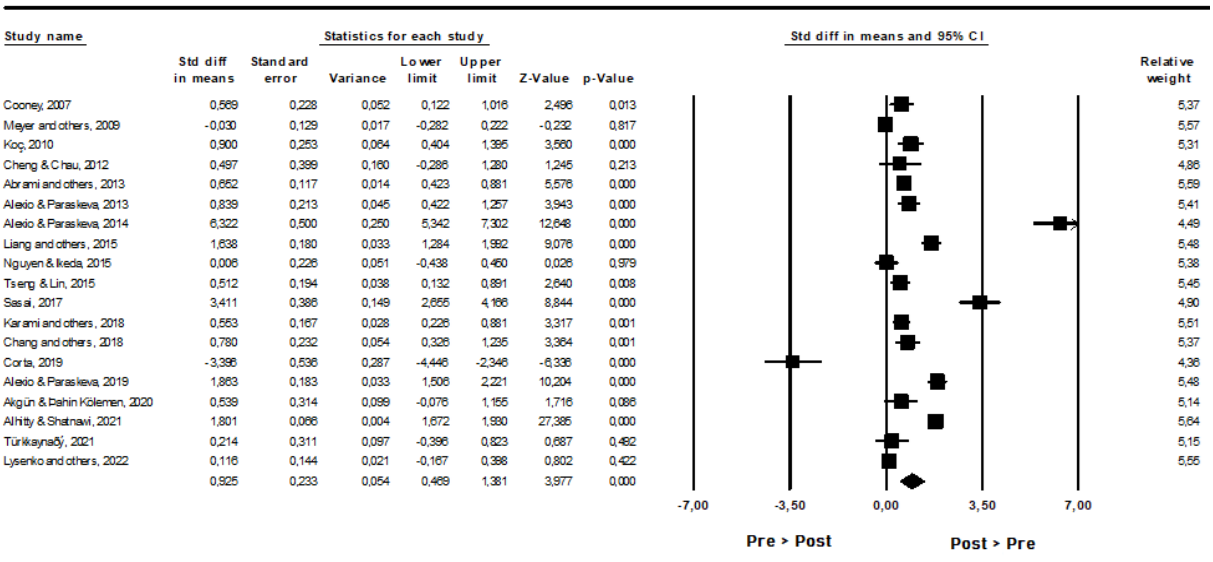
Although it has been stated that the effect in the studies differs in theory, the results are supported by looking at the statistical heterogeneity test for model selection. According to the heterogeneity table, the general effect is mentioned first. The forest-plot table also interprets the overall effect obtained from all effects. Interpreting the Q statistic alone is impractical. A value of Q-df > 0 was obtained. This proves the heterogeneity. Unfortunately, the number of studies (Borenstein *et al.*,2010; Borenstein *et al.*, 2021) affects the Q value. The value of τ^2 is calculated by faulting Q. But independent of the Q value, the heterogeneity value is unaffected by the number of studies. It also allows estimation on the effect size scale (Borenstein *et al.*, 2021; Hedges & Vevea, 1998). The examined τ^2 supports heterogeneity. The I^2 value is interpreted as the explained variance. 96.781% of the observed distribution of the self-regulation variable is explained through the effectiveness of the e-portfolio application considered for the research. According to the random effects model, the effect sizes vary between 0.469 and 1.382. The above heterogeneity analysis results, which are given as a second proof of the theoretically decided random effects model, also argue that the model selection is appropriate.

Result of the meta-analysis

All the effect sizes discussed within the scope of the research were analyzed over the CMA-Version 3 program and the distribution of the effect sizes was given in the forest plot below. The overall effect size was obtained from 19 studies selected in accordance with the criteria in the study.

Figure 4

Forest Plot For All Included Studies



While the 0 point in the forest plot above shows that e-portfolios do not affect self-regulation, it is stated that the effect sizes on the left are significantly higher than the pre-test results of the post-test results and there are effect sizes of the studies showing that the e-portfolio application does not work. The effect sizes of the studies conducted by Meyer *et al.* (2010) and Corta (2019) are included in this section. The part to the right of the reference point summarizes that the post-test results show a significant change from the pre-test results. For the effect sizes on the right, it is seen that e-portfolios have significant and positive effects on self-regulation. Although the effect sizes of Nguyen & Ikeda (2015) were very close to 0 in their study, the effect sizes of 17 of 19 studies were in this area.

It is thought that choosing studies that have effect sizes were higher than the reference point, that the independent variable causes the same effect in terms of the dependent variable. It will also cause publication bias. In this research, the inclusion of studies that are very close to the reference point, and studies that e-portfolios have no effect on self-regulation and have an effect are the strengths of the study.

As considered in the heterogeneity decision part of the study, there wasn't only one effect size was in the studies. This decision was supported by the literature and estimation was made according to the random effects model. As a result of the analysis, the overall effect of e-portfolios used in the education process on self-regulation is 0,925. When this value is compared with the effect size criterion values (Wide effect = 0,75 ≤ Effect size ≤1,10) suggested by Thalheimer & Cook (2002), it is seen that it has a very large effect.

The overall effect value shows that the independent variable in the study has a significant effect on the dependent variable. And this effect size indicates that the e-portfolio application has a very large effect (Hedge's g = 0.925) on the self-regulation variable, which is determined as the dependent variable.

Discussion and Conclusion

There are many studies in which e-portfolio, one of the complementary measurement and evaluation techniques, is discussed. Among these studies, the focus was on studies conducted to examine the effectiveness of e-portfolios on self-regulation skills. Some of these studies reported that e-portfolio did not affect self-regulation, while others reported that it had positive effects. In line with the results of these studies carried out for the same purpose, the quantitative ratio of positive-negative or ineffective results will not give an accurate result. Therefore, Meta-analysis was used to reconsider the statistical results obtained from studies conducted under the same purpose and to interpret the overall effect. When examined with the criteria given in the method section for the research, 19 studies were found between the years 2000-2023 by these criteria. The meta-analysis conducted with 19 studies resulted in an overall effect size of +0.925. When this overall effect value is compared with the effect size scale, it is seen that it has a very large effect.

The fact that the e-portfolio application has been found to be significantly effective, like many variables that may affect self-regulation skills, is in line with the result of the study conducted by Railean (2008). Railean (2008) explains this situation provided and activities suggested to help the learning develop meta-cognitive abilities. These are awareness and regulation of cognition (which includes planning, monitoring, and self-evaluation of learning). Romero et al. (2019) remarked that, especially in higher education, individuals adapt to online tasks regarding 21st-century skills and being active in self-assessment and evaluation will increase the effect on self-regulation skills at a positive level.

Van der Gulden et al. (2020) examined the effects of e-portfolios on the components of the concept of self-regulation in their studies. In line with the results of their research, the researchers positively affected the concepts of self-assessment, reflection, feedback, goal setting, planning, and monitoring. levels were found to be affected. Each of these concepts represents the basic characteristics of self-regulation skills. The result obtained is consistent with the study of Van der Gulden et al. (2020).

Unfortunately, researchers only want to report their publications if the treatment, stated in studies based on a strategy, method or a technique trial, does not make a difference in post-tests. This study tested publication bias with very few studies stating that e-portfolios were ineffective on self-regulation skills. The study can be renewed with a larger sample number by changing the criteria and adding the remaining studies to the drawer. Especially in this age where education and training activities in the online environment gain meaning as one of the 21st century skills, the positive or negative effects of new measurement and evaluation techniques on the education process can be a new research topic.

Declarations

Ethical Approval: Secondary data were used in this study. Therefore, ethical approval is not required.
Author Contribution: Since there is only one author in this publication, the single author has 100% contribution in conceptualization, research, methodology, data curation, supervision, writing – review, editing, original draft, formal analysis and visualization.
Funding: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Consent to Participate: All authors have given their consent to participate in submitting this manuscript to this journal.

Consent to Publish: Written consent was sought from each author to publish the manuscript.

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