Journal of Theoretical Educational Science, 16(1), 199-217, January 2023
Kuramsal Eğitimbilim Dergisi, 16(1), 199-217, Ocak 2023
[Online]: http://dergipark.org.tr/akukeg
DOI number: http://doi.org/10.30831/akukeg.1134207

A Meta-Analysis Study on Data Literacy Education for School Administrators and Teachers

Okul Yöneticisi ve Öğretmenlerin Veri Okuryazarlığı Eğitimi Üzerine Bir Meta-Analiz Çalışması

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Received: 22 June 2022 **Research Article** **Accepted:** 29 December 2022

ABSTRACT: This meta-analysis study aimed to examine the effect of data literacy education, which affects databased decision processes, on data use knowledge and skills of school administrators and teachers. Therefore, theses on data literacy education for school administrators and teachers and relevant studies in peer-reviewed journals were examined through several databases. The study was conducted using the Comprehensive Meta-Analysis (CMA) software, using a total of eight studies published between 2006-2021. The results revealed that the selected studies were heterogeneous. Therefore, a random effects model was applied in the study. The overall effect size value of data literacy education was calculated as 2.16 according to Cohen d, suggesting that data literacy education makes a positive contribution to data use knowledge and skills of school administrators and teachers. The subgroup analyses conducted to determine the source of heterogeneity in results have shown that data literacy education did not differ by the type or the country of publications but varied by the type of participants, where studies conducted with mixed participants had high effect values.

Keywords: Data literacy, professional development, school administrator, teacher, meta-analysis.

ÖZ: Bu araştırmanın amacı, veriye dayalı karar süreçlerini etkileyen veri okuryazarlığı eğitiminin okul yöneticileri ve öğretmenlerin veri kullanımı bilgi ve becerileri üzerindeki etkisine ilişkin araştırmaları sentezlemektir. Bu amaçla okul yöneticileri ve öğretmenlere verilen veri okuryazarlığı eğitimini inceleyen tez çalışmaları ile hakemli dergilerde yayınlanmış makaleler veri tabanları aracılığıyla incelenmiştir. Comprehensive Meta-Analiz (CMA) yazılımı ile gerçekleştirilen araştırmanın analizlerine 2006-2021 yılları arasında yayınlanan 8 çalışma dahil edilmiştir. Bulgular, seçilen çalışmaların heterojen olduğunu ortaya koymuştur ve buna göre rastgele etkiler modeli uygulanmıştır. Araştırmada veri okuryazarlığı eğitiminin genel etki büyüklüğü değeri Cohen d'ye göre 2.16 olarak hesaplanmıştır. Bu sonuç okul yöneticisi ve öğretmenlere verilen veri okuryazarlığı eğitiminin yüksek düzeyde olumlu katkı yaptığını göstermektedir. Bulgulardaki heterojenliğin kaynağını belirlemek için yapılan alt grup analizleri; veri okuryazarlığı eğitiminin yayın türüne ve çalışmanın yapıldığı ülkeye göre farklılaşmadığını, yalnızca katılımcı türüne göre farklılaştığını, karma katılımcılarla yapılan çalışmaların etki değerinin yüksek olduğunu göstermiştir.

Anahtar kelimeler: Veri okuryazarlığı, mesleki gelişim, okul yöneticisi, öğretmen, meta-analiz.

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Citation Information
Doğan, E. (2023). A meta-analysis study on data literacy education for school administrators and teachers. *Kuramsal Eğitimbilim Dergisi [Journal of Theoretical Educational Science], 16*(1), 199-217.

ISSN: 1308-1659

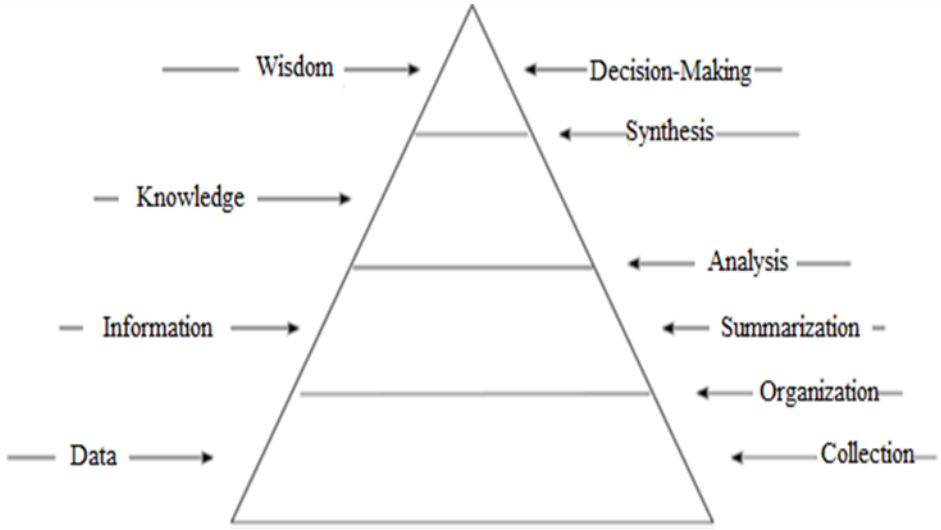
School improvement studies emphasize the use of data by school administrators and teachers in meeting expectations and achieving educational reforms (Van Geel et al., 2016; Van Kuijk et al., 2016). Several studies suggest that the use of data in schools supports educational decisions and improves educator attitudes towards students (Feldman & Tung, 2001; Symonds, 2003). Killion and Bellamy (2000, p. 27) argue that without analyzing and discussing the data, it will not be possible for schools to identify and solve problems, define appropriate interventions to solve these problems or know how to proceed to achieve their goals. They also emphasize the significance of data use skills in school administrators and teachers. Studies emphasize strong professional development in data literacy to analyze and use data appropriately (Coburn & Turner, 2011; Kerr et al., 2006; Marsh et al., 2006).

The No Child Left Behind Act (NCLB), which came into force in the United States (USA) in 2001, has increased accountability based on learning outcomes in education. Databased decision making, which came to the fore through this act, later went beyond accountability and has developed as a process (Childress, 2009). Databased decision-making requires asking various questions about the data, making inferences based on the data, and analyzing and interpreting the data to make instructional decisions (Gummer & Mandinach, 2015). Data literacy is defined as the ability to understand and use data to make effective and correct decisions (Mandinach & Gummer, 2013, p. 30), and is also considered to be competent in the knowledge and skills required for databased decision-making (Schildkamp & Lai, 2013). Competence is the ability to take satisfying actions by integrating knowledge, skills, and attitudes (Vanhoof et al., 2011, p. 143). There are also different definitions of data literacy in the literature. It is defined as the capacity to understand how to generate, interpret and use data by Athanases et al. (2012, p. 6). According to Williams and Coles (2007, p. 188), it refers to the strategies and skills required to identify information needs and find, evaluate, synthesize, organize, present, and communicate information. It is also described as a specific skill set and knowledge base to transform data into actionable knowledge by Mandinach and Gummer (2013, p. 30). These knowledge and skill sets are part of a gradual, cyclical system (Earl & Katz, 2002).

Data first turns into information and then into knowledge. Three cognitive skills are required for each level: “collecting” and “organizing” at the data level, “analyzing” and “summarizing” at the information level, and “synthesizing” and “prioritizing” at the knowledge level (Mandinach et al., p. 8). This suggests that data does not have a meaning in itself as it becomes knowledge depending on the competence of individuals who interpret it. Mandinach and Gummer (2016) describe data-driven decision-making as a cyclical inquiry process with five primary phases: identifying problems, using data, transforming data into information, transforming information into a decision, and evaluating outcomes. Figure 1 shows the transformation of data into information and data-driven decision-making processes.

Figure 1

Knowledge Spectrum



Note. (Barutçugil, 2002, p. 60).

School administrators and teachers collect data such as student achievement, classroom observation, and parent survey data (Schildkamp & Lai, 2013). In education, data literacy shows the ability of educators to collect and analyze data from various sources and transform it into instructive knowledge, and strategies or practices, accelerating school improvement (Gummer & Mandinach, 2015, p. 2). Data literacy is a prerequisite for transforming data into valuable and usable information (Keuning et al., 2017). Data literacy can help school administrators and teachers to follow a systematic and consistent process instead of an intuitive, messy and undocumented process (Gambell, 2004). Data literacy plays a significant role for school administrators and teachers in making databased decisions by predicting and designing proper school improvement and student learning (Doğan, 2021). Furthermore/Moreover, data literacy enables educators to make data-driven decisions about teaching goals, methods, and time allocation, to target better teaching to students, and ultimately to achieve higher levels of school success (Means et al., 2009). Indeed, Vanhoof et al. (2011) found that educators with data literacy have a significant impact on school improvement.

Data Literacy Education for School Administrators and Teachers

Wayman (2005, p.301) states that "the transformation of these data and summary statistics into practical, serviceable information is more difficult and requires proper training and professional development," emphasizing the need to develop educators' capacity to use data effectively and appropriately. Otherwise, educators can resist change (Cowie & Cooper, 2017). Although studies emphasize the significance of having data literacy for educators, Mandinach (2012) has argued that there is a lack of formal and informal mechanisms by which educators can acquire the necessary data literacy knowledge and skills. Some studies have found that educators without data literacy have lower self-confidence and demand/require data literacy education to overcome this deficiency (DeLuca & Bellara, 2013; Means et al., 2009; Wayman & Jimerson, 2013). Mason (2003) has reported that teachers request/require data literacy

education to ask better questions and interpret and use responses. Doğan (2021) examined the data literacy levels and databased decision-making skills of school administrators in Turkey and stated that even school administrators with postgraduate education did not have data use skills, felt inadequate about data literacy, and wanted to have practice-oriented data literacy education. Likewise, some studies have reported a lack of data literacy training among educators. (Jacobs et al., 2009; Mandinach & Gummer, 2013). Cowie and Cooper (2017) have found that data literacy education lacks the depth and real-life applications of knowledge and skills related to data literacy. Verbiest et al. (2014) have revealed that school administrators suggested in-service data literacy education and data practices based on training activities and practices to solve problems they would encounter in their professional lives. For this reason, school administrators and teachers need theoretical knowledge to acquire data literacy skills and trainers who clearly model and discuss data processes and mindsets. Ebbeler et al. (2016) emphasized the importance of cooperation with universities in data literacy education, suggesting that stronger links with higher education institutions should be established for professional development in order to strengthen educators' professional capacity and expertise.

Some studies focus on the results of this data literacy education. Uiterwijk-Luijk et al. (2017) determined that school principals with data literacy education had higher self-efficacy and built a culture of data use by creating a research and inquiry environment at school. Edwards et al. (1997) found that data literacy education encourages teachers to make databased decisions and make data-driven changes in teaching. Park (2008) has revealed that a lack of data literacy education affects student achievement and educator beliefs and attitudes, lowering self-efficacy and increasing anxiety. Data literacy is a key component of databased decision-making and is a necessary step for student success and school improvement. Data literacy is also particularly important for educators in school improvement and learning/teaching/education. There is only one meta-analysis study by Gesel et al. (2020) on the effect of professional development of databased decision-making on 'teachers' knowledge, skills, and self-efficacy. In addition, Filderman et al. (2021) conducted a meta-analysis study to measure the efficacy of education given to K-12 teachers for improving their skills in reading and understanding data to make the right decisions in curriculum-based measurement. However, there is no meta-analysis study on data literacy education for school administrators and teachers. This meta-analysis study is significant as it provides educators and researchers a holistic view of data literacy education. This study can provide a framework for data literacy education for school administrators and teachers. In this context, this study aims to answer the following question:

What are the effects of data literacy education given to school administrators and teachers in terms of professional development? Does this effect differ by publication type, research country, and type of participant?

Method

This section includes the research model, study group, data collection process, and data analysis.

Research Model

This study used the meta-analysis method, one of the systematic synthesis methods, to evaluate the effects of data literacy education given to school administrators and teachers. A meta-analysis is the synthesis and interpretation of quantitative results of independent individual studies on the same subject, combining them in a consistent and coherent manner and using various statistical techniques (Cumming, 2012). A meta-analysis has the capacity to reach comprehensive data as a result of systematic literature review and to statistically analyze the results of studies on the researched subject by testing their accuracy (Hunter & Schmidt, 1990).

Data Collection

This study utilized several databases, including Web of Science (WoS), Education Resources Information Center (ERIC), JSTOR, Sage Journal, Scopus, Springer Link, Taylor & Francis Online, Google Scholar, EBSCO Open Dissertations, ProQuest Dissertation, to find proper studies. In this regard, it used several keywords, including "data literacy," "professional development," "teacher," "principal," "school leader," "school administrator." The data were collected in April 2021, including studies published between 2006 and 2021. The following criteria were considered to determine the studies to be included in the study:

• The research should be a master's thesis, doctoral thesis, or article published in peer-reviewed scientific journals and should be written in English.

• The research should include applications for data literacy education.

• The research should be conducted using school administrators and teachers.

• The research should be an experimental study with a pretest-posttest.

• The research should be conducted between 2006-2021.

• The research should include the validity and reliability information of the measurement tool used.

• The research should include statistical information required to calculate the effect size (arithmetic mean, standard deviation or t-test, "F" test analysis results, and pretest-posttest correlations).

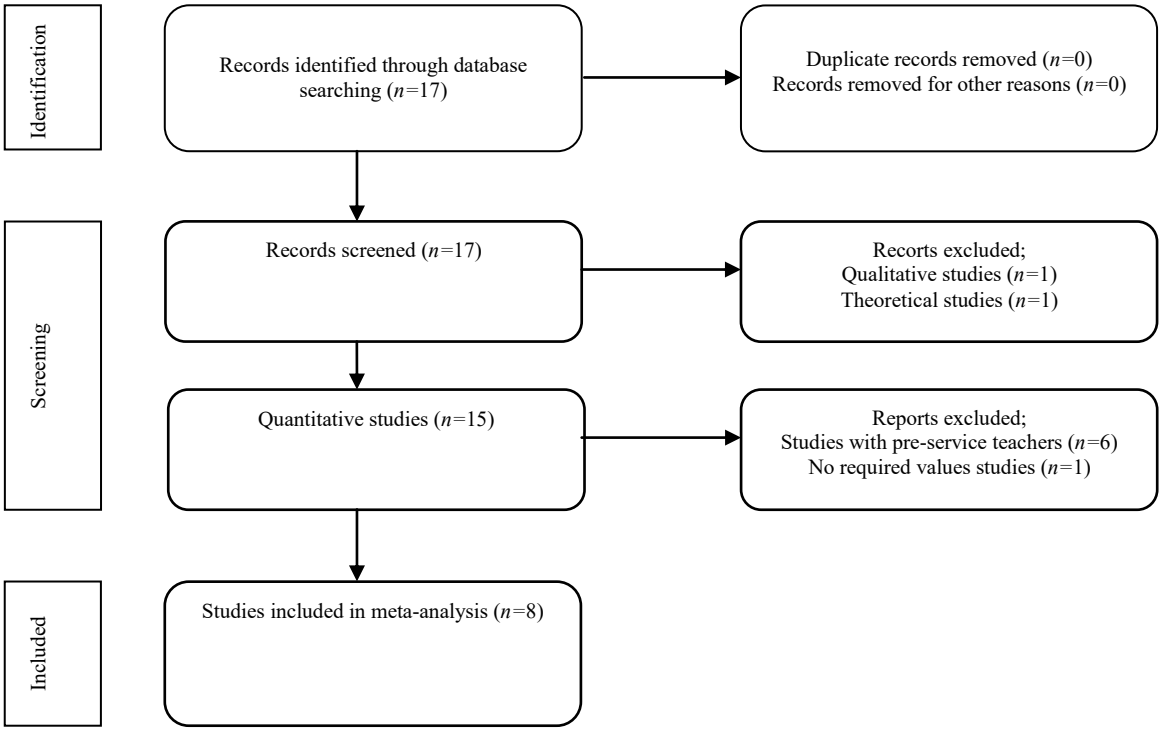
• The research should include the sample sizes of study groups.

The studies were examined using the above criteria, and those that did not meet the inclusion criteria were excluded from the meta-analysis study. Among them, qualitative (LaPointe-McEwan et al.,2017) and theoretical studies (Mandinach & Gummer, 2013), those conducted with prospective teachers (Carey et al., 2018; Piro et al., 2014; Piro & Hutchinson, 2014; Reeves & Chiang, 2019; Reeves & Honig, 2015; Rogers, 2015), and those that did not include arithmetic mean, standard deviation, t-test, F-test analysis results and pretest-posttest total score correlations or necessary values to calculate these variables (Niemeyer, 2012) were excluded from the meta-analysis study. As a result, a total of eight (8) studies were included in the meta-analysis study. The

flow chart showing the process of including the resources accessed through the literature review in the meta-analysis is shown in Figure 2.

Figure 2

Flow Chart



Coding of Studies

First of all, the studies were coded to deal with and compare the studies on data literacy education. Coding allows the researcher to access relevant information easily and quickly. For coding, several characteristics were determined to cover all studies and reveal their differences, including (*i*) type of publication, (*ii*) country, and (*iii*) type of participant.

Data Analysis

The Comprehensive Meta-Analysis (CMA) software was used to calculate the effect size of the data obtained in the meta-analysis study. Effect size is considered to be the basis of meta-analysis and is explained as the frequency of occurrence of a phenomenon in the community (Cohen, 1988). Standardized mean differences are considered while calculating effect sizes. Studies included in a meta-analysis may consist of the results obtained from different statistics for the problem in question. This requires standardizing the results before the data are combined. Standardized mean difference refers to the extent of the intervention effect according to the variability observed in each study (Borenstein et al., 2013). Meta-analysis studies use fixed and random effects models to calculate the effect sizes by analyzing the data. The fixed effects model assumes that each study included in the analysis has a true effect size. All differences in the effects observed in this model are due to sampling error (Borenstein et al., 2013). The random effects model assumes that the actual effect may differ by study (Ellis, 2010). The diversity is expected to be reasonable in this model to interpret the

results accurately and reliably (Çarkungöz & Ediz, 2009). It should be tested whether the effect sizes are heterogeneously distributed for deciding between these two models. If the effect sizes do not show a heterogeneous distribution, using the fixed effect model is recommended, or vice versa (Ellis, 2010). A *p-value* for the heterogeneity test greater than .05 indicates a homogeneous distribution, indicating that the fixed effects model can be used. If this value is below .05, the random effects model should be used (Borenstein et al., 2009).

In this meta-analysis study, the effect size was also taken as the index of the difference between the experimental and control groups. The formats in which the means, standard deviation values, sample sizes, or test statistics values (such as *p-value*, *t value*) of experimental and control groups can be entered through the interface provided by the CMA program were selected in the calculation of effect sizes. In addition, the variables of publication type, country, and participant type were determined as moderators in the study. A confidence level of 95% was accepted in all calculations regarding effect sizes. For interpreting the significance of effect sizes, Cohen d ≤ .20 was considered as an insignificant effect, .20 ≤ Cohen d ≤ .50 as a small effect, .50 ≤ Cohen d ≤ .80 as a medium effect, and Cohen d ≥ .80 as a large effect (Cohen, 1988).

Validity and Reliability

For a meta-analysis study to be valid and reliable, data collection and analysis, effect model, sample size, and publication bias criteria should be followed in the meta-analysis process, and the studies included in the meta-analysis should be examined by at least two experts (Açıkel, 2009). To ensure the reliability of coding, two researchers conducted independent coding and analysis processes for the data and then came together to provide the necessary consensus on non-overlapping coding. In terms of internal validity, research diversity affects meta-analysis results (Başol & Johanson, 2009). The validity of each study in this meta-analysis was examined, and those with inappropriate variables or methods were excluded from the sample. In meta-analysis studies, heterogeneity test contributes to external validity (Wolf, 1988). In this meta-analysis study, heterogeneity tests and publication bias were also examined. For this reason, funnel plots were examined with the trim-and-fill method proposed by Duval and Tweedie (2000) in order to examine the relevance of the effect size obtained.

In order to increase reliability in the research process, the steps of adding and removing articles, calculating the effect size value, and interpreting the analysis results were always tried to be provided by the two researchers conducting the process separately and comparing their findings. It was observed that there was a complete agreement between the two researchers in these steps. In addition to the Q statistic, the I2 value was examined to determine the homogeneity/heterogeneity during the analysis of the data. An I2 value of 25 indicates low heterogeneity, 50 indicates moderate heterogeneity, and 75 and above indicates high heterogeneity (Higgins & Thompson, 2002).

Publication Bias

The hypothesis that all studies on a specific subject are unpublished is based on publication bias. In particular, as studies that find low or no relationship between

research variables are not deemed worthy of publication, they negatively affect the total effect size value in meta-analysis studies, and the related value rises biasedly. This is also caused by missing data and can also negatively affect the total effect level in some cases (Borenstein et al., 2009). The presence of publication bias in meta-analyses can be examined using some statistical methods. This meta-analysis study examined the probability of publication bias using Orwin's Fail-Safe N analysis, Duval and Tweedie's Trim and Fill method, Egger's regression test, and Kendall's Tau Coefficient.

Figure 2

Funnel Chart

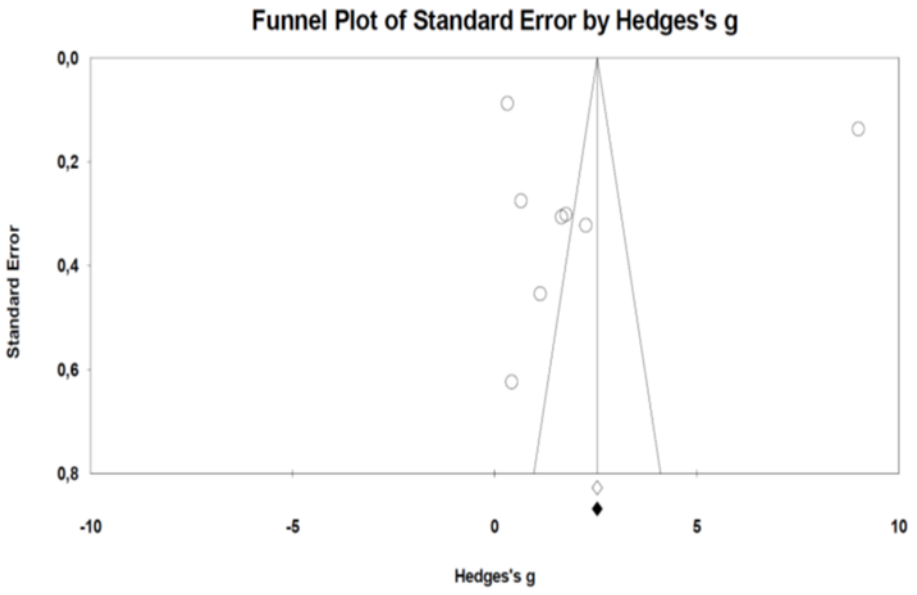


Table 1

Publication Bias Results

The Number of Included Studies	Classic Fail-Safe N number	Duwal's and Tweedy's Trim and Fill Method		Egger's Test	Kendall's Tau Coefficient
		Trimmed Study	SOF Observed (filled)		
8	2022.0000	0	2.15	.47	.50

As seen in Table 1, Egger's regression coefficient is greater than .05, Kendall's Tau two-tailed p values are greater than .05, and the number of studies to be added in order for the meta-analysis to be invalid according to Classic Fail-Safe N analysis is high. The results of Duval and Tweedie's cut-and-add method lack a corrected number of publications. All these results suggest no publication bias in the meta-analysis study on data literacy education of school administrators and teachers. In addition, the funnel chart shows that the scattering is close to a symmetrical shape.

Results

This section presents the list, overall effect sizes, heterogeneity tests, and publication bias results regarding the studies included in the meta-analysis. Table 2 shows the studies included in the meta-analysis.

Table 2

Descriptive Data on the Studies Included in the Meta-Analysis

Author	Type of Publication	Country	Participant
Abrams et al., 2021	Article	USA	Teacher
Bettesworth, 2006	Doctoral Thesis	USA	School administrators
Ebbeler et al., 2016	Article	Netherlands	Teacher
Green et al., 2016	Article	USA	Teacher
Jimenez et al., 2012	Article	USA	Teacher
Kippers et al., 2018	Article	Netherlands	Teacher
Rotondi, 2017	Master's thesis	USA	Teacher
Vangeel et al., 2017	Article	Netherlands	Mixed

The studies in the meta-analysis were mostly articles published in the United States and used teachers as participants. Table 3 presents the meta-analysis results using fixed and random effects models.

Table 3

Effect Sizes and Heterogeneity Test

Model	k	ES	Z	SE	%95 CI	df	Q	p	I^2
Fixed Effects Models	8	2.53	38.758	0.065	[2.409; 2.666]	7	3930.326	0.000	99.761
Random Effects Models	8	2.16	1.371	1.575	[-0.928;5.247]				

Note. k = number of studies; ES = effect size; SE= Standard Error, 95% CI = 95% confidence interval; Q = total heterogeneity of the weighted mean effect sizes; I2 = degree of inconsistency in the observed relationship across studies*p> .05

Firstly, the heterogeneity of the meta-analysis was examined using both Q and p values in Table 3. Considering the $\chi 2$ significance table, the studies included in the meta-analysis were found to be heterogeneous, as the Q value for organizational citizenship was large for 3930.326 df=7 (14.067, p <.05). The I^2 value, a complement to the Q statistic, also reveals a clearer result regarding heterogeneity (Petticrew & Roberts, 2006). If I^2 is 25%, it shows low heterogeneity, 50% moderate, and 75% high heterogeneity (Cooper et al., 2009). The I^2 value was % 99.761, suggesting a high heterogeneity. In addition, a significant p-value (p<.05) also supports this result.

Therefore, the "random effects model" was used in the meta-analysis. Accordingly, the effect size was calculated as 2.16, indicating a positive large relationship between the variables. In other words, data literacy education has a high effect on the data use knowledge and skills of school administrators and teachers. Table 4 presents the results of subgroup analyses obtained in the random effects model of the studies included in the meta-analysis by considering the type of publication, research country, and type of participant.

Table 4

Subgroup Analyzes for The Random Effects Model

	Moderator	*k*	*d*	SE	%95 CI	*df*	.05 Confidence Level $\chi 2$	Q	*p*
Type of Publication	MA	1	42	.62	[-.79; 1.64]	2	5.991	4.017	0.13
	PhD	1	1.77	.30	[1.17; 2.36]				
	Article	6	2.50	1.93	[-1.27; 6.29]				
	Total	8	1.53	.26	[1.00; 2.06]				
Country	USA	4	1.50	.34	[.82; 2.17]	2	3.841	0.31	0.57
	Netherlands	4	2.94	2.56	[-2.08; 7.96]				
	Total	8	1.52	.34	[.85; 2.19]				
Type of Participant	Teacher	6	1.08	.12	[.38; 1.78]	2	5.991	783.518	0.00
	School Administrator	1	1.77	.09	[1.17; 2.36]				
	Mixed	1	9.00	.01	[8.73; 9.27]				
	Total	8	7.03	.11	[6.801; 7.265]				

Note. k=number of studies, d=Cohen's d, SE= Standard Error, CI= Confidence Interval, Q=heterogeneity among the studies

For the variable of the type of publication, the heterogeneity value (Q=4.017, p > .05) is smaller than the chi-square critical value, indicating no significant difference between the sub-groups. Similarly, for the variable of country, the heterogeneity value (Q= 0.31, p > .05) is smaller than the chi-square critical value, indicating no significant difference between the sub-groups. For the variable of the type of participant, the heterogeneity value (Q=735.518, p < .05) is greater than the chi-square critical value, indicating a significant difference between the sub-groups. In this regard, the value of the mixed group consisting of school administrators and teachers is large.

Conclusion, Discussion, and Recommendations

There is a growing worldwide interest in using data to improve education (Van Geel et al., 2016). Several studies reveal the benefits of using data in education, such as increasing student success (Bernhardt, 2009), facilitating educational practices (Wayman et al., 2012), creating a fairer learning environment by closing success gap, revealing students' strengths and weaknesses (Dunn et al., 2013), and enhancing effective accountability (Schildkamp & Kuiper, 2010). Strengthening the data literacy

knowledge and skills of school administrators and teachers in educational institutions will support educators improving and changing their practices to achieve better results (McNaughton et al., 2012). The most widespread problem cited in the data literacy literature is educators' lack of knowledge and skills to analyze and use data appropriately (Mandinach & Gummer, 2013; Mertler, 2004).

This meta-analysis study aimed to reveal the effects of data literacy education on data use knowledge and skills of school administrators and teachers, using pretest-posttest results from a total of eight studies that experimentally examined the effect of data literacy education given within the scope of professional development until April 2021. Studies on the subject have been done more recently in the USA and the Netherlands. In this meta-analysis, the overall effect size value of data literacy education was calculated as 2.16. In other words, data literacy education given to school administrators and teachers provides a high level of positive contribution to their data use knowledge and skills. Similarly, Ezzani (2009) conducted a study using observations, interviews, and document analysis and found that school administrators who received data literacy training increased their data usage skills and created a data usage culture.

Several correlational studies found a positive high relationship between data literacy and data use, which also supports the results of this meta-analysis study (Dejear, 2016; Luo et al., 2015; McCray, 2014). In addition, studies on databased decision-making emphasize the significance of data literacy knowledge and skills of school administrators (Datnow et al., 2007; Mandinach et al., 2006), suggesting data literacy as an important predictor of instructional leadership (Albrect et al., 2014). Data literacy has a significant impact on the evaluation and interpretation of school performance feedback systems (Vanhoof et al., 2011).

A meta-synthesis study on data literacy revealed that data literacy has many aspects and is applied according to its purpose, action, and context (Khan et al., 2018). Education faculty students stated that the data literacy training they received reduced the reality shock they encountered in using data for accountability in the in-service period (Mandinach & Gummer, 2013). In addition, researchers have reported that data literacy education has a positive effect on student outcomes (Dejear, 2016; Jung et al., 2018; Stecker et al., 2005). It was stated that school administrators and teachers who receive data literacy education improve their ability to change educational practices (Harris, 2011), and data literacy education increases self-efficacy in teachers and other educators (Rogers, 2015). However, Means et al. (2009) have argued that although data literacy education is considered potentially the most important strategy in developing data literacy skills, educators' own beliefs about data use are effective in developing their data literacy skills. Instructional changes or improvements will occur, provided that data literacy education affects both beliefs and pedagogies of school administrators and teachers (Young & Kim, 2010). In addition, for data literacy education to be successful, mentoring and feedback should be provided to trainees (Athanases et al., 2012), the education should be sustainable (Mandinach & Gummer, 2013), and a systematic approach should be adopted to integrate it into training practices (Mandinach & Gummer, 2016). As this meta-analysis did not directly measure data literacy attitudes and beliefs of school administrators and teachers, this can be considered a limitation.

The subgroup analyses conducted to determine where the heterogeneity of results originates have shown that data literacy education does not differ by type of publication and research country but varies by type of participant and that the studies conducted with only teachers and only school administrators have close effect values to each other, while those conducted with mixed participants have high effect values. There may be alternative features of the study set that contribute to these differences between studies. It is also possible that this set of studies fell short of detecting sources of heterogeneity, even if it was a crucial factor (Borenstein et al., 2009). Studies highlight the development of human capital for the professional development of teachers and school administrators as the most necessary and important investment in educational institutions (Darling-Hammond & Orphanos, 2006). In general, the literature on professional development advocates the significance of collaboration during education (Desimone, 2009; Yoon et al., 2007). This is not surprising, as learning is theorized as a social effort through active participation in a community of practice (Vygotsky, 1978). Collaborative training should be provided to educators rather than individual experiences in data use (Wayman, 2005). Means et al. (2011) have observed that collaboration can also be important for encouraging the use of data in practice; thus, teachers interpret data more accurately, clarify problems, ask follow-up questions, solve problems, and correct mistakes. Green et al. (2016) found that collaborative training is effective only if it is given to school administrators and teachers together with a school-based team approach in order to create a data culture at school. Similarly, Faber and Visscher (2014) conducted a meta-analysis study about the effects of data use on student achievement through digital student monitoring systems and showed that data use would be effective when applied by school-wide school administrators and teachers and simultaneously aiming to improve education for all students. These results are consistent with those of our meta-analysis study. However, the relevant literature generally emphasizes the central role of school principals in creating a culture of data use at school, supporting and encouraging teachers as role models in data use (Farley-Ripple & Buttram, 2014; Lange et al., 2012; Levin & Datnow, 2012; Wayman et al., 2012).

This study has some limitations. First, all theses and articles in the relevant literature were scanned to reduce publication bias in the research, using publication bias statistics and funnel graphic visuals. Despite this, some studies may still be overlooked. Second, there are no standardized measures of knowledge and skills in school administrators and teachers; therefore, the study included proximal measurements and subjective rating scales. Third, there was a notable heterogeneity in the data set, commonly observed in meta-analyses (Higgins et al., 2013). Moderator analyses in the study were also limited, as there were few studies involving the relevant variable. The subject can be assessed again using different moderator analyses in future studies. Finally, there was no indication of how education turned into practice. There is a need for further studies on the long-term effects of education on practice.

Based on all these results, it can be suggested that data literacy education given to school administrators and teachers should be expanded in all countries and at all education levels. The facilitation of data access technology over time promises a bright future for the development of schools, as data literacy education strengthens the potential of integrating different and innovative approaches in teaching processes. There

is a need for empirical studies that will reflect the applications of data literacy knowledge and skills to use existing technological processes. Researchers are recommended to make a meta-analysis of correlational studies about the relationship between data literacy and different variables. In addition, comprehensive studies can be conducted on how a collaborative data usage culture is supported for school improvement, focusing on the factors affecting data literacy in educators.

Author Bios

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Sources marked with an asterisk (*) indicate studies included in the meta-analysis.

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