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Assessing the Impact of Using Mobile Devices on School Students' Educational Outcomes: A Second-Order Meta-Analysis

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Abstract

Introduction. The use of mobile devices by children and adolescents is a common practice at the moment. Although mobile learning has some benefits, the results of the study on its effectiveness are contradictory. The study described in this paper is one of the first carried out to summarize the results of meta-analyses assessing the effects of using mobile devices by school children in the educational context. **Methods.** The study aimed to identify the effects of using mobile devices in learning based on second-order meta-analysis procedures. Twenty-nine meta-analyses conducted between 2014 and 2023 were analyzed, with minimal overlap between primary studies. A systematic search for sources and their assessment in accordance with the meta-review protocol, an analysis of coincidences in studies included in primary meta-analyses, an assessment of the presence of publication bias, and an analysis of the influence of categorical moderators were conducted. **Results.** The use of mobile devices by students has an average impact on their educational outcomes (g = 0.654 (95% CI: 0.578–0.73)). A significant result was found when assessing the heterogeneity of mean effect sizes ($\tau2$ = 0,042, Q = 277,255, p <0,001; I2 = 86,95%). The moderator analysis showed a significant impact of the type of educational outcome, subject area of study, type of publication and location of primary research. Conflicting results are found when mean effect sizes are analyzed across different levels of education. **Discussion.** The average effect size obtained during the analysis is characterized by a high degree of stability at different periods of digitalization of education. The use of mobile devices by school children can have a dual impact on their learning activities, depending on the inclusion of adults in this process. Problematic digital behavior is associated with worsened educational outcomes. The use of gadgets for educational purposes, on the contrary, helps to increase learning efficiency compared to its traditional forms. The meta-review provides further directions for research on the effects of the use of mobile devices by school children in their educational activities and can help develop digital culture education programs.

Keywords

mobile devices, second-order meta-analysis, meta-analysis, learning, school children, educational outcomes, mobile learning, digital behavior

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Introduction

The first decades of the 21st century were revolutionary for global educational institutions. Accelerating the pace of technological change requires rapid updating and qualitative transformation of information, the dynamic changes in the labor market associated with the transformation of the functionalities of occupations, and the digitalization of all aspects of modern life (Kamal et al., 2019; Nakano, 2022). These changes require education theorists and practitioners to discuss the main problems they solve, such as determining the ability of modern educational systems to prepare graduates to succeed in society (Zhao, 2020), analyzing real-life situations and seeking best methods of achieving their goals, and demonstrating citizenship and responsibility for their countries (Fu, 2020). Scientists recognize that the transformation of education to meet fundamental needs of changing society and the world as a whole is a key issue (Fadel, Bialik, & Trilling, 2018).

One solution to these challenges was digital transformation in education. The purpose of digital transformation of education is to integrate digital technologies into teaching practices, including personalization of education, in order to help students achieve the required educational outcomes (Uvarov, 2019). Mobile technology deserves special attention because its use in education has several advantages related to its increasing accessibility, adaptability, flexibility, and variety of functions (Yu et al., 2022). Already, more than 6 billion people around the world have smartphones, and this number will only increase in the future (Ericsson Mobility Visualizer, 2023). In addition, according to Mediascope CROSS WEB, in 2022, 96 % of Russian Internet users between the ages of 12 and 17 spend an average of about six hours on-line, and mobile devices are 94 % of Internet connections in the digital consumption structure (Borosdina, 2022). The increasing practice of using mobile devices (hereinafter MD) by school children opens up the possibility of using these tools for educational purposes. Research into the effectiveness of mobile learning began in the early 21st century (Keegan, 2000) and has been intensively ongoing for over twenty years. A large number of scientific data has been accumulated, but it is extremely contradictory. On the one hand, it has been shown that mobile technologies can improve school students' academic motivation (Kärchner et al., 2022), improve the quality of learning foreign languages (Chistova & Krotkova, 2018; Alfadil, 2020), natural sciences (Chang et al., 2020; Čevajka & Velmovská, 2022),; mathematics (Bimer and al., 2022); computer science (Novikov & Starichenko, 2020); and contribute to the formation of ideas on the potential of MD as an educational tool (Kapina, 2020; Sahin & Yilmaz, 2020). On the other hand, researchers emphasize the risks and negative effects of the use of mobile technologies by school children, expressed in problems such as self-control (Troll et al., 2020), the use of mobile phones for purposes that are not related to educational tasks and distractions while studying (Zhai et al., 2019; Yi et al., 2016), problems in the search and assessment of information (Bezgodova et al., 2020), threats to physical and mental health (Chau et al., 2022) and the growing digital inequalities (Jin et al., 2020). In some countries, the lack of consensus on such a sensitive issue led to restrictions on the use of gadgets in schools (Novikova et al. 2020). However, I. Sh. Mukhametsyanov notes that the non-alternative prohibition of the use of MD is the simplest solution to the problem of adapting schools and the pedagogical technologies they use to new digital realities (Mukhametsyanov, 2019). The author raises the question of the need to conduct in-depth research into the influence of MD on humans (Mukhametzyanov, 2019, p. 56).

In this respect, meta-analysis is an important area of research aimed at combining empirical studies and determining important patterns based on them (Kornilov & Kornilova, 2010). To date, a significant number of meta-analysis studies have been carried out to investigate the effects of MD in education. Most meta-analyses on mobile learning studies show positive effects ranging from 0.226 (Tamim et al., 2015) to 1.8 (Mihaylova et al., 2022). However, meta-analyses aimed at identifying the relationship between students' practices of using MD and their educational outcomes, on the contrary, demonstrate moderate negative effects ranging from -0.12 (Sunday et al., 2021) to -0.76 (Kärchner et al., 2022). It seems important to generalize the results of meta-analyses that have already been conducted on various aspects of the study of mobile technologies in education and on the use of gadgets by students. The generalization of the results will enable us to determine the general patterns of influence of mobile technologies in education on school students' educational outcomes and identify factors that can determine these patterns.

The tool used to summarize the results was a second-order meta-analysis or meta-review, addressing existing meta-analyses. Meta-review is a meta-analysis of statistically independent and methodologically comparable first-level meta-analyses aimed at investigating similar relationships between variables in different research contexts (Schmidt & Oh, 2013). First-order meta-analyses can reduce the influence of certain biases in empirical studies, but the potential for their influence remains. The remaining errors resulting from meta-analysis are usually called second-order biases. The elimination of the significance of this error is a task of the second-order meta-analysis, which in turn helps to reduce the heterogeneity of the overall result (Cooper & Koenka, 2012).

Purpose

This study aims to summarize the results of meta-analyses identifying the impact of the use of MD by school students on their educational outcomes.

Achieving this goal may enable us to answer some of the research questions related to education, including the following:

- What is the effectiveness of mobile learning compared to traditional teaching methods? How does it manifest itself at different levels of education?
- How can the effects of using MD for educational and extracurricular purposes be compared to school students' educational outcomes?
- Is there a difference in the effectiveness of mobile learning when studying different school subjects?
- Is there a relationship between the publication type and its results?

Methods

The study used the PRISMA statement (Preferred reporting items for systematic reviews and meta-analyses) (Moher et al., 2009; Liberati et al., 2009). Due to the limited scope of this article and in order to increase the transparency of research procedures, all meta-analysis data are published on the OSF portal (https://osf.io/tyz95/).

Search strategy

International databases were used for the search of meta-analyses (EBSCO, Google Scholar, ProQuest Dissertations and Theses; ResearchGate; RSCI). The supplementary materials of the article provide keywords for meta-analysis search. The search for sources was also carried out by reviewing the sources cited in the retrieved publications.

Selection of studies, inclusion and exclusion criteria

According to the PRISMA statement, the selection of meta-analyses and their assessment were independently carried out by three researchers according to the following criteria:

1. Period of publication of meta-analyses – 2010-2023.
2. Publishing languages – English, Russian.

3. Meta-analyses should focus on the impact of school children's use of mobile technologies on their educational activities and educational outcomes.

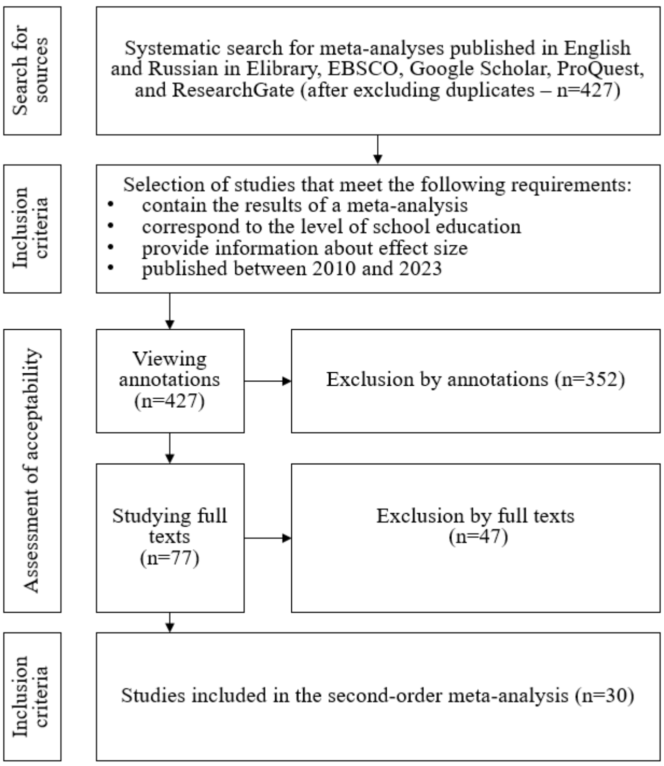
4. The results of meta-analyses should include statistics sufficient to calculate the effect size (for example, Cohen's d, Hedges's g, lower limit (LL), upper limit (UL), and standard error (SE), depending on this impact and variance values).

The degree of interobserver agreement was determined using Cohen's kappa interrater agreement coefficient (κ = 0.87–0.92). If there were differences of opinion between the researchers, they were resolved on the basis of consensus ratings.

The list of collected information included the year of publication, the number of studies included in the meta-analysis, the size of the total sample and country, the type and value of the effect size, standard error, the lower and upper limits of the confidence interval, the level of education, the type of educational outcomes, school subjects, the type of publication, the number of citations of a publication, and journal citation rates. If data were available, statistical parameters for different levels of education (primary, secondary, and high school) were included separately.

The initial search resulted in 427 sources (see Figure 1).

Figure 1
Flowchart of the process of searching, evaluating publications, including and excluding data



The review of the abstracts identified 352 studies that were not meta-analysis or that were not related to education. The remaining 77 documents were thoroughly examined. The criteria for the exclusion of publications were the text of the publication (neither English nor Russian – 2); not mobile, but other computer technologies – 19; the level of vocational or pre-school education – 8; specific samples of students (with disabilities) – 2; the absence of necessary statistical data and information on meta-analysis procedures – 11; the absence of correlations with educational outcomes – 5.

Finally, 30 meta-analysis publications were selected, including 36 effect sizes for different types of educational outcomes.

Analyzing agreements in studies included in primary meta-analyses

Second-order meta-analysis ideally involves generalization of meta-analyses based on non-overlapping samples of primary studies. In practice, however, this condition is extremely difficult to fulfil, and a general recommendation is to minimize the duplication of primary studies (Cooper & Koenka, 2012). The total number of primary studies overlapping in various meta-analysis was 161, with a total of 837 studies that became the primary basis for the second-order meta-analysis, which amounted to 19.24 %. The acceptable level of agreement between the main studies of the meta-analysis contained in the sample was assessed using covered area (CA) and corrected covered area (CCA) indices.

The CA index is calculated by the formula:

$$CA = \frac{N}{r*c} \qquad (1)$$

The CCA index is calculated by the formula:

$$CCA = \frac{N-r}{r*c-r} \qquad (2)$$

where N is the total number of primary studies included in the second-order meta-analysis (including duplication); r is the number of primary studies excluding duplication; and c is the number of meta-analyses included in the second-order meta-analysis (Hennessy et al, 2020).

According to D. Pieper and colleagues, CCA scores above 15 % are considered extremely high and characterize the lack of independence between the studies included in the meta-review, which reduces its quality (Pieper et al, 2014). The results of the index calculations showed a high degree of overlap between the primary studies included in the meta-analyses between (Sung et al., 2016) and (Sung et al., 2015), the index value was 35.40 %, as well as between (Sung et al., 2016) and (Yang, 2020) – 18.40 %. Therefore, the meta-analysis (Sung et al., 2016) was excluded from the sample.

Thus, we obtained a sample of 34 effect sizes based on various educational outcomes reported in 29 meta-analyses (see Table 1). The overall corrected covered area index was 1.31 %, indicating the independence of the included meta-analyses and close to zero duplication of their results.

Table 1
Studies included in the meta-review

Author	Year	N	Education level	Subjects	Type of educational outcomes	Publication type
Akçay et al., 2021	2021	22	Primary	Mathematics	Cognitive (grades, knowledge, outlook, etc.)	Article
Chen, 2022	2022	29	Primary, lower-secondary, upper-secondary, higher	Languages	Behavioral (skills, abilities, etc.)	Article
Chen et al., 2022	2020	63	Primary, lower-secondary, upper-secondary	Mixed	Cognitive	Theses
Cho et al., 2018	2018	20	Primary, lower-secondary, upper-secondary	Languages	Behavioral	Article
Feng et al., 2018	2018	34	Primary, lower-secondary, upper-secondary, higher	Mixed	No information available	Theses
Garzón et al., 2023	2023	62	All levels	Languages	No information available	Theses
Güler et al., 2022	2022	22	All levels	Mathematics	Cognitive	Article
Güzeller & Üstünel, 2016	2016	10	Primary, lower-secondary, upper-secondary, higher	Mixed	No information available	Article

Author	Year	N	Education level	Subjects	Type of educational outcomes	Publi-cation type
Kärchner et al., 2022	2022	58	Primary, lower-secondary, upper-secondary, higher	Mixed	Mixed	Article
Kates et al., 2018	2018	39	Primary, lower-secondary, upper-secondary, higher	No infor-mation available	Negative (grades, burnout, etc.)	Article
Lee et al., 2014	2014	44	No information available	Langua-ges	No information available	Theses
Lei et al., 2022	2022	41	Primary, lower-secondary, upper-secondary, higher	Natural sciences	Cognitive	Article
Li et al., 2023	2023	50	Lower-secondary, higher	No infor-mation available	Negative	Article
Liao et al., 2020	2020	81	No information available	Mixed	No information available	Article
Mihaylova et al., 2022	2022	23	Primary, lower-secondary, upper-secondary, higher	Langua-ges	Behavioral	Article
Petersen-Brown et al., 2019	2019	65	Pre-school, primary, lower-secondary, upper-secondary,	Mixed	Behavioral	Article

Author	Year	N	Education level	Subjects	Type of educational outcomes	Publication type
Romadiah et al., 2022	2022	15	Primary, lower-secondary, upper-secondary	No information available	No information available	Article
Shi & Kopcha, 2022	2022	34	Primary, lower-secondary, upper-secondary	Natural sciences	No information available	Article
Sunday et al., 2021	2021	44	Higher	Mixed	Negative	Article
Sung et al., 2015	2015	44	All levels	Languages	Cognitive	Article
Sung et al., 2017	2017	48	All levels	Mixed	Mixed	Article
Talan, 2020	2020	104	Primary, lower-secondary, upper-secondary, higher	Mixed	No information available	Article
Talan et al., 2020	2020	154	All levels	Mixed	Cognitive	Article
Tamim et al., 2015	2015	27	Primary, lower-secondary	Mixed	No information available	Research report
Tingir et al., 2017	2017	14	Primary, lower-secondary, upper-secondary	Mixed	No information available	Article
Ulum, 2022	2022	27	Primary, lower-secondary	Mixed	No information available	Article
Wang et al., 2023	2023	78	Primary, lower-secondary	Mixed	Mixed	Article
Yang et al., 2020	2020	38	No information available	Mixed	Mixed	Article
Zheng et al., 2018	2018	34	Primary, lower-secondary, upper-secondary, higher	Mixed	Cognitive	Article

Note*. N is the number of primary studies included in the meta-analysis.*

Statistical data processing

The average effect sizes reported in each meta-analysis were analyzed, maintaining the method used to calculate it. Most of the meta-analysis included in the sample of this meta-review was based on the estimates of the effect size using Hedges's g, while the other studies used Cohen's d and correlation coefficient r. All effect size measures were converted to Hedges's g statistics (Borenstein et al., 2021). Standard errors were obtained from both the texts of the meta-analyses and independently calculated from the available confidence interval data. The study used a random effect model because it has greater generalization capacity (Borenstein et al., 2021). To evaluate heterogeneity, coefficients τ^2 and Q statistics were used, whose significance indicates inconsistencies in meta-analysis results. I^2, measured as a percentage, was also used. The I^2 values above 75 % indicate a high degree of heterogeneity in the results of the first-order meta-analyses.

To assess the presence of publication bias, we used graphical analysis of the funnel plot, the Egger test, and Rosenthal's fail-safe N. The latter is based on the idea of creating a "virtual sample" of data, which allows us to calculate the number of studies with an insignificant result that could reduce the overall significance level of the effect measures in the meta-analysis to an insignificant level (Kornilov & Kornilova, 2010).

The role of mediating variables (moderators) has also been assessed, including educational levels, types of educational outcomes, school subjects, types of publication, number of citations of a publication, and journal citation rates. The Q coefficient was used to assess to what extent the effect sizes differed depending on moderators.

To perform statistical calculations, the programs Jamovi ver 2.4.8 and Comprehensive Meta-Analysis (CMA) 4.0 were used.

Results

Based on the selection and evaluation of the first-order meta-analysis, the study included 29 publications with a total sample of 454,824 students of various educational levels (pre-school, school, and higher education). Effect sizes in the sample ranged from 0.226 to 1.08. Overall, the confidence intervals for effect sizes showed that the null hypothesis was rejected in all cases (see Figure 2). The average effect size was 0.654 (95 % CI: 0.578–0.73). This value is within the range of 0.5 to 0.8, which is considered an average effect size. The analyzed meta-analyses were characterized by a high level of heterogeneity (τ^2 = 0,042, Q = 277,255 at df = 27 and p <0,001; I^2 = 86,95%), which allows us to reject the null hypothesis of equality of the c in the meta-analysis sample.

Estimates of publication bias based on graphical analysis (see Figure 3) indicate a rather symmetric funnel plot of effect sizes. Analysis using Egger's test (t = -1.085, p = 0.36) indicated that there was insufficient statistical evidence to detect publication selection bias. Moreover, Rosenthal's fail-safe N showed that 21.989 studies would need to be added to confirm that the effect size was not significant. Thus, it can be concluded that publication bias has not been established.

Figure 2
Effect sizes and confidence intervals in the meta-analyses reviewed

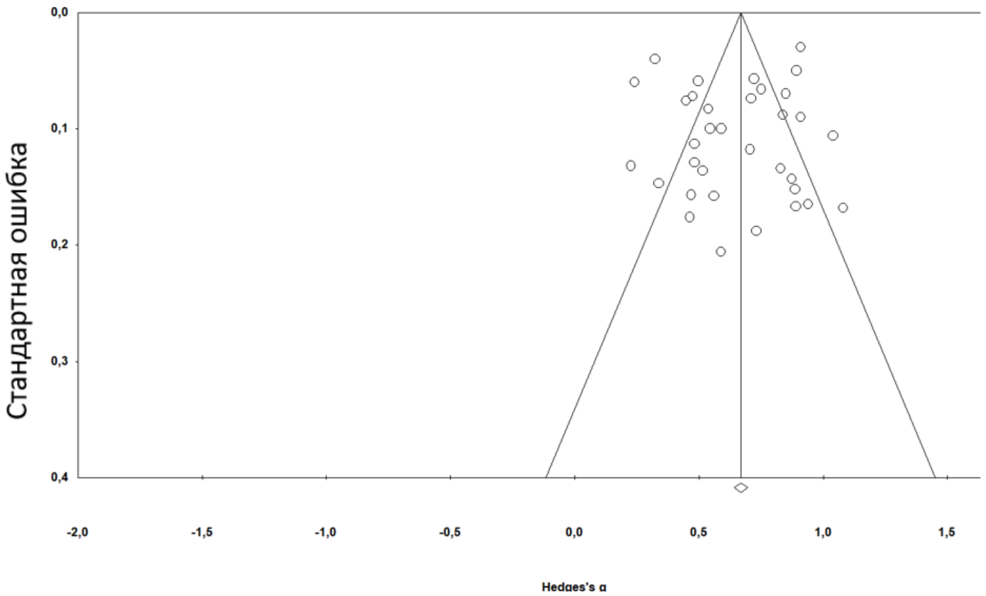
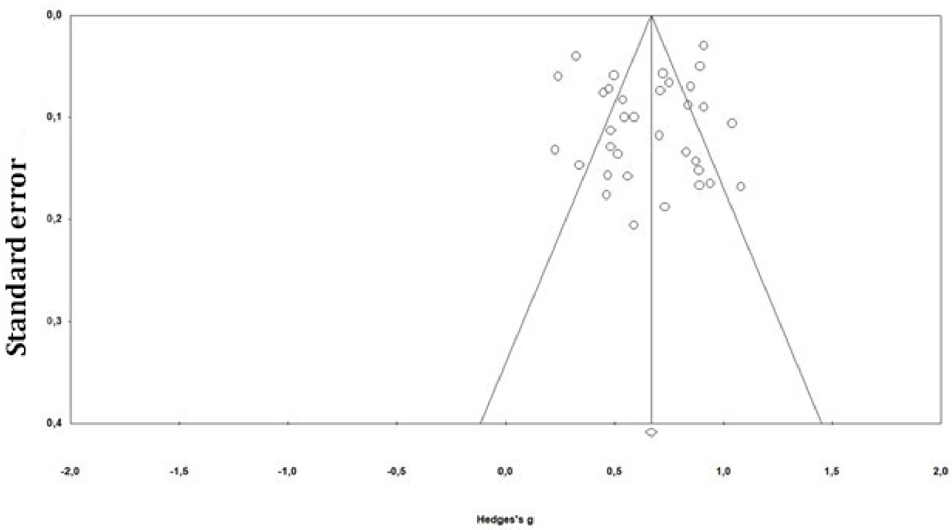


Figure 3
Funnel plot of effect sizes in meta-analyses reviewed



The next stage of the study analyzed changes in average effect sizes influenced by various characteristics of meta-analyses. Table 2 shows the results of a comparative analysis of moderators in which significant differences were identified.

Table 2
Results of the analysis of effect size mediation by categorical moderators

	k	g	Lower limit 95 % CI	Upper limit 95 % CI	Q	p
Type of educational outcome					15.77	0.008
No information available	12	0.75	0.64	0.87		
Cognitive	9	0.55	0.48	0.61		
Affective	3	0.48	0.35	0.61		
Behavioral	5	0.76	0.58	0.94		
Mixed	1	0.52	0.25	0.78		
Negative	4	0.58	0.20	0.95		
Subject area					11.31	0.023
No information available	5	0.58	0.24	0.92		
Mixed	17	0.63	0.53	0.73		
Languages	8	0.75	0.62	0.88		
Natural science	2	0.88	0.55	1.20		
Humanities	2	0.48	0.35	0.60		
Location					32.01	<0.001
No information available	16	0.76	0.68	0.84		
Multicultural	17	0.54	0.43	0.66		
Monocultural	1	0.91	0.85	0.97		
Publication type					10.43	0.01
Research article	30	0.66	0.56	0.75		
Theses	3	0.74	0.49	1.00		
Research report	1	0.23	0.08	0.37		

***Note**. k – number of first-order meta-analyses, g – average effect size, CI – confidence interval; Q - weighted sum of squared differences between the observed effect size and the weighted average effect size, p - significance level.*

There were no significant differences in the average effect sizes, depending on the year of publication, the number of primary studies included in the meta-analysis, the level of education, or the publication rating (CiteScore). However, the effects varied considerably in the meta-analysis of different educational outcomes. The largest average effect size was found in the educational outcomes associated with the development of skills and abilities, while the smallest one was found in the study of the impact of the use of MD on students' motivation, participation, and satisfaction. We should note that meta-analyses characterized by the negative effects of the use of MD in learning reveal comparable results to the effects of the use of mobile learning.

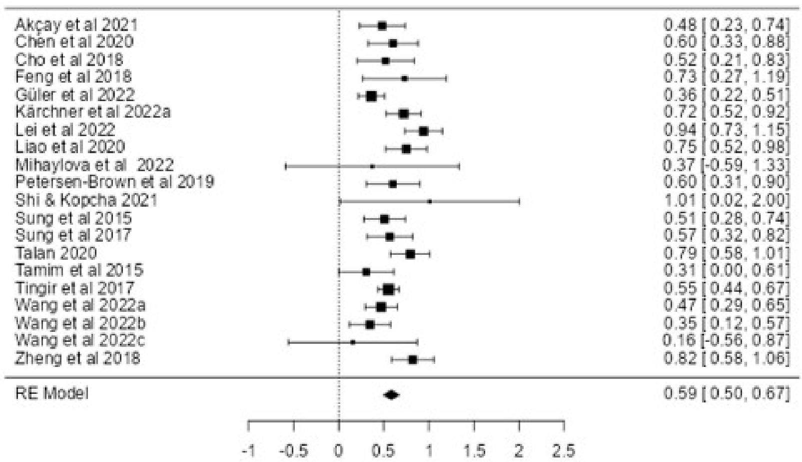
Significant differences were found in the average effect sizes depending on the subject area. Thus, the largest effect sizes were found when studying languages and natural sciences, while for the humanities the smallest average effect size was noted.

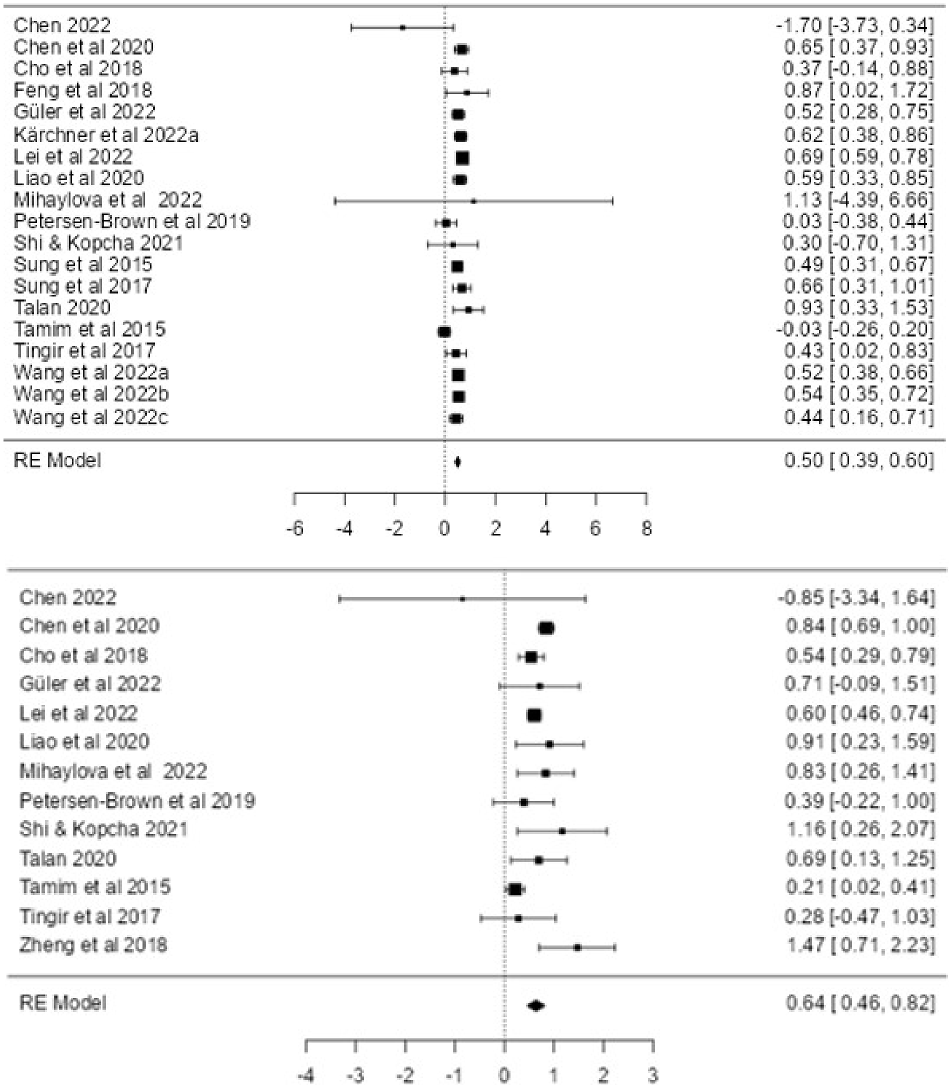
We should note that, although most formal publication parameters did not reveal significant differences in the average effect sizes, the type of publication became an important factor in mediating the results. Thus, the smallest effect size was reported in the research report, while the largest ones were found in conference proceedings. The smallest average effect sizes could also be found in meta-analyses, including primary research conducted in different countries and cultures.

We were also interested in data on the effect sizes of MD use in primary, secondary, and high schools (Figure 4). The evidence was found to be inconsistent. At the primary school level, the confidence intervals of the effect sizes of two meta-analyses cross the zero line, at the secondary school level - six meta-analyses, at the high school level - four meta-analyses.

Figure 4

Effect sizes and confidence intervals by school education levels





***Note**. a – primary school, b – secondary school, c – high school.*

The effect sizes by educational levels are the largest in upper-secondary school (g = 0.64 with 95 % CI 0.46–0.82), medium in primary school (g = 0.59 with 95 % CI 0.50 –0.67), while in lower-secondary school they are the smallest (g = 0.50 with 95 % CI 0.39–0.60).

Discussion

In conducting this meta-review, data from 29 meta-analyses were studied, with the aim of identifying the effects of the use of mobile devices on student educational activities. We found a predominant medium effect size in the constructive use of MD (mobile learning) and in the destructive forms of its use (dependence on MD, problematic MD use, etc.). At the same time, the average effect size practically retains its value at different stages of digital education, bringing the results of this study closer to the meta-analysis data by N. O. Gordeeva, based on a sample of Russian studies, and also revealing an average effect size (Gordeeva, 2018).

The scale and representativeness of the meta-analysis studies included in the meta-review enabled us to validate such a conclusion. We can argue that the use of MD by students may increase or inhibit their learning activities, depending on the degree of involvement of adults in managing students' digital behavior. Thus, V. I. Panov and colleagues understand digital behavior as a system of actions associated with the use of the digital environment (Panov et al., 2021). According to R. Barr, the creation of a harmonious family media environment by adults and its shared use with children already in childhood can contribute to their cognitive and emotional development, while the use of the digital environment to distract children or to participate in them uncontrollably becomes an obstacle to the social and emotional development of children (Barr, 2019). Furthermore, adult digital behavior itself becomes an important factor in children's mental development. Firstly, it serves as a model for the development of a child's digital behavior and, secondly, it may become an obstacle to the creation of a harmonious relationship between parents and children (Liu & Wu, 2023). Thus, researchers introduce the concept of "technoference" as a condition of either a parent or a child in which the use of technology interrupts interpersonal interactions and, in any case, has a negative impact on the child's emotions and memory (McDaniel & Radesky, 2018). At the same time, adults' attitudes towards MD play an important role in understanding the form of use of MD by school children (Spasskaya & Proekt, 2023; Wang, Lwin, Cayabyab, Hou & You, 2023). Therefore, there is a growing need to form constructive strategies for managing digital behavior of children.

The results of the meta-review showed differences in the degree of effectiveness of the use of MD in the study of various school subjects. Therefore, the greatest effectiveness is found in the study of natural sciences and languages, whereas in the study of the humanities, a weaker effect of the use of MD is observed. Mobile technologies significantly improve the teaching process of natural sciences by creating more accessible scientific experiment visualizations and using fundamentally new teaching methods by teachers (Mutambara & Bayaga 2021). The latter is particularly important for the application of MD to teaching, as confirmed by a meta-review by B. Öztürk and colleagues, who showed the important role of applied pedagogical technology in the use of problem-based learning supported by technology (Öztürk et al., 2022). Mobile learning can provide learners with access to resources, tools and collaboration opportunities, thereby developing research abilities, creativity, reflexion, critical thinking, and analysis (Afikah et al., 2022). The advantages of using MD for language learning (both native and foreign languages) have long been one of the most discussed issues in mobile language learning research

(Okumuş Dağdeler, 2023). The success of this field is also linked to the introduction of several effective applications for learning foreign languages (Lingualeo, Duolingo, Puzzle English, etc.). Research shows that the use of MD contributes to personalized learning and student autonomy, vocabulary development, reading skills, and speaking practice (Okumuş Dağdeler, 2023). At the same time, the field of humanities studies is less covered by mobile learning.

Another important result of the meta-review was the inconsistency of data in the meta-analyses of the impact of using MD by students in primary, lower-secondary and upper-secondary schools. The adolescence period is considered to be the most difficult period to implement mobile learning, as school students must adapt to new learning models and, on the one hand, adapt to the increase in academic workload and, on the other, to deal with the crisis of adolescence (Malkova & Naumova, 2012). It is noteworthy that in adolescence the range of digital activities of school children expands considerably and becomes more diverse (Soldatova et al., 2022). Adolescents show a reduced academic motivation, which can become a stronger input variable than the use of MD, which in turn often becomes a factor that distracts from educational activities (Avdeeva & Kornilova, 2022). At the same time, in secondary school, academic motivation increases, among other things, because school students with the lowest academic motivation leave school (Goshin et al., 2019), while in primary school, the use of MD takes place to a greater extent under adult supervision.

Finally, publishing characteristics become important factors that determine the effect sizes of meta-analyses. We found the largest effect size in a meta-analysis that reported a relationship between MD addiction and academic burnout among Chinese students (Li et al., 2023), while meta-analyses summarizing the results of primary studies conducted in different countries and cultures report smaller effect sizes. This result may indicate the importance of cultural factors in the research of strategies to use MD in the educational environment. In addition, the largest effect sizes are reported in conference proceedings and the smallest ones – in research reports. This result is related to one of the general limitations of meta-analysis as a methodology, as the insignificant research results are more frequently published in the so-called "archive box" and less often in scientific journals (van Aert et al., 2019; Kornilov & Kornilova, 2010).

Conclusion

The purpose of this meta-review was to summarize the results of meta-analyses aimed at identifying the impact of the use of MD by school children on their educational outcomes. According to results obtained in our study, the use of MD by school students has a moderate impact on their educational outcomes. Compared to traditional teaching methods, mobile learning technologies can be more effective in developing school children's skills, increasing their level of knowledge and academic performance, developing motivation for learning and participation in it. At the same time, in cases of deviations in school children's digital behavior, the quality of their educational activities is at risk of deteriorating, resulting in a reduced academic motivation and education performance and an increase in academic burnout. The results raised questions about the development and implementation of a systematic approach to the targeted formation of digital behavior among children. The main components of such a system should be the subjects of the education process (students, teachers and parents), the educational environment and its possibilities, the technology and teaching methods used, the MDs themselves and their functionalities.

The contradictory conclusions found in summarizing the results of the meta-analysis included in the meta-review indicate the need to take into account a number of factors influencing the success of the use of MD in the educational process. Further research is required to investigate the use of MD by students in educational activities at different age levels, with different strategies of digital activity and mediation by adults, and in different cultures.

Some limitations of this meta-review must be noted, relating to the heterogeneity of generalized effect sizes and the apparent lack of information on a wide range of factors determining its variation. The difficulty of finding meta-analysis in the so-called "grey" literature indicates that there is a clear lack of application of meta-analysis approaches in unpublished studies (reports, dissertations, etc.). This meta-review did not take into account the characteristics of educational models and technologies used in mobile learning, MD types, and the gender-related aspects of the use of MD by students. Although meta-analysis does not provide a final answer to the question of the effectiveness of MD use in the educational process, it highlights promising areas of research on digital behavior among school children and the development of psychological and educational programs for the formation of digital culture in young generations.

Note. Sources marked with asterisks (*) indicate the studies included in the meta-review.

References

Afikah, A., Astuti, S. R. D., Suyanta, S., Jumadi, J., & Rohaeti, E. (2022). Mobile Learning in Science Education to Improve Higher-Order Thinking Skills (HOTS) and Communication Skills: A Systematic Review. *International Journal of Advanced Computer Science and Applications*, *13*(7). https://doi.org/10.14569/IJACSA.2022.0130782

Akçay, A. O., Karahan, E., & Bozan, M. A. (2021). The Effect of Using Technology in Primary School Math Teaching on Students' Academic Achievement: A Meta-Analysis Study. *FIRE: Forum for International Research in Education*, *7*(2), 1–21. https://doi.org/10.32865/fire202172231 *

Alfadil, M. (2020). Effectiveness of virtual reality game in foreign language vocabulary acquisition. *Computers & Education*, 153, 103893. https://doi.org/10.1016/j.compedu.2020.103893

Avdeeva, E. A., & Kornilova, O. A. (2022). Influence of digital environment on the cognitive functions of schoolchildren and students. *Cardiovascular Therapy and Prevention, 21*(S3), 3331. https://doi.org/10.15829/1728-8800-2022-3331 (in Russ.)

Barr, R. (2019). Growing up in the digital age: Early learning and family media ecology. *Current Directions in Psychological Science*, *28*(4), 341–346. https://doi.org/10.1177/0963721419838245 PMID:31423053

Bezgodova, S., Miklyaeva, A., & Nikolaeva, E. (2020). Computer vs smartphone: How do pupils complete educational tasks that involve searching for information on the internet. In *SEUR Workshop Proceedings*, 2630, 52–62.

Biber, S. K., Biber, M., & Erbay, H. N. (2022). Teachers' perceptions on technology-assisted mathematics teaching and the interactive activities. *Education and Information Technologies*, *27*(5), 6913–6945. https://doi.org/10.1007/s10639-022-10898-9

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2021). *Introduction to meta-analysis.* John Wiley & Sons.

Borozdina, N. (2022). *Mediascope CROSS WEB. Internet audience in 2022.* https://mediascope.net/upload/iblock/3d8/qrlhud7t7dxyzw1rhtzxg3rwk8deg7uk/2022_%D0%98%D0%9D%D0%A2%D0%95%D0%A0%D0%9D%D0%95%D0%A2.pdf (in Russ.)

Čevajka, J., & Velmovská, K. (2022). The use of mobile technologies in teaching from the perspective of the Slovak physics teachers. In Cieśla, P. (Ed.) *Active Science Education*. (pp. 7–19). University of the National Education Commission. https://doi.org/10.24917/9788380848139.1

Chang, C. J., Liu, C. C., Wen, C. T., Tseng, L. W., Chang, H. Y., Chang, M. H., Chiang, S. H. F., Hwang, F. K., & Yang, C. W. (2020). The impact of light-weight inquiry with computer simulations on science learning in classrooms. *Computers & Education*, 146, 103770. https://doi.org/10.1016/j.compedu.2019.103770

Chau, K., Bhattacherjee, A., Senapati, A., Guillemin, F., & Chau, N. (2022). Association between screen time and cumulating school, behavior, and mental health difficulties in early adolescents: A population-based study. *Psychiatry Research*, https://doi.org/10.1016/j.psychres.2022.114467

Chen, M. L. (2022). The Impact of Mobile Learning on the Effectiveness of English Teaching and Learning – A Meta-Analysis. *IEEE Access*, 10, 38324–38334. https://doi.org/10.1109/ACCESS.2022.3165017 *

Chen, Z., Chen, W., Jia, J., & An, H. (2020). The effects of using mobile devices on language learning: A meta-analysis. *Educational Technology Research and Development*, 68. https://doi.org/10.1007/s11423-020-09801-5 *

Chistova, Yu. S., & Krotkova, I. N. (2018). Mobile apps as a resource for motivating schoolchildren when learning English. *Scientific Search*, (3), 16–19. (in Russ.).

Cho, K., Lee, S., Joo, M. H., & Becker, B. J. (2018). The effects of using mobile devices on student achievement in language learning: A meta-analysis. *Education Sciences, 8*(3), 105. https://doi.org/10.3390/educsci8030105 *

Cooper, H., & Koenka, A.C. (2012) The overview of reviews: unique challenges and opportunities when research syntheses are the principal elements of new integrative scholarship.

American Psychologist, 67(6), 446-462. https://doi.org/10.1037/a0027119

Ericsson Mobility Visualizer – Mobility Report. (2023, February 23). Telefonaktiebolaget LM Ericsson. https://d110erj175o600.cloudfront.net/wp-content/uploads/2022/11/29180338/Ericsson-Mobility-Report-November-2022.pdf

Fadel, C., Bialik, M., & Trilling, B. (2018). *Four-dimensional education: The competencies learners need to succeed*. Tochka. (in Russ.).

Feng, Y., Liao, Y., & Ren, Y. (2018). Effects of M-Learning on Students' Learning Outcome: A Meta-analysis. In L. Deng, W. W. K. Ma, & C. W. R. Fong (Eds.), *New Media for Educational Change* (pp. 115–123). Springer. https://doi.org/10.1007/978-981-10-8896-4_10 *

Garzón, J., Lampropoulos, G., & Burgos, D. (2023). Effects of Mobile Learning in English Language Learning: A Meta-Analysis and Research Synthesis. *Electronics*, *12*(7), 1595. https://doi.org/10.3390/electronics12071595

Gordeeva, N. O. (2018). The use of mobile technologies in education: A meta-analysis of Russian studies. *Modern problems of science and education* (digital scientific journal). https://science-education.ru/ru/article/view?id=27704 (in Russ.)

Goshin, M. E., Grigor'iev, D. S., & Mertsalova, T. A. (2019). Types of parental involvement in education and academic performance of schoolchildren. *Voprosy Psikhologii*, 2, 29–44. (in Russ.).

Güler, M., Bütüner, S. Ö., Danişman, Ş., & Gürsoy, K. (2022). A meta-analysis of the impact of mobile learning on mathematics achievement. *Education and Information Technologies*, 27, 1725–1745. https://doi.org/10.1007/s10639-021-10640-x *

Güzeller, C. O., & Üstünel, F. (2016). Effects of Mobile Learning on Academic Achievement: A Meta Analysis. *Journal of Social Sciences/Sosyal Bilimler Dergisi*, *8*(23), 528–561. *

Hennessy, E. A., & Johnson, B. T. (2020). Examining overlap of included studies in meta-reviews: Guidance for using the corrected covered area index. *Research synthesis methods*, *11*(1), 134–145. https://doi.org/10.1002/jrsm.1390

Jin, W., & Sabio, C. J. (2018). Potential use of mobile devices in selected public senior high schools in the city of Manila Philippines. *International Journal of Learning, Teaching and Educational Research*, *17*(4), 102–114. https://doi.org/10.26803/ijlter.17.4.7

Kapina, A. A. (2020). Modern solutions to the problem of managing distance learning using mobile applications. *Pedagogical Bulletin*, 15, 24–26. (in Russ.).

Kärchner, H., Trautner, M., Willeke, S., & Schwinger, M. (2022). How handheld use is connected to learning-related factors and academic achievement: Meta-analysis and research synthesis. *Computers and Education Open*, 3, 100116. https://doi.org/10.1016/j.caeo.2022.100116 *

Kates, A. W., Wu, H., & Coryn, C. L. S. (2018). The effects of mobile phone use on academic performance: A meta-analysis. *Computers & Education*, 127, 107–112. https://doi.org/10.1016/j.compedu.2018.08.012 *

Keegan, D. (2000). From Distance Learning To E-learning To Mobile Learning. *Open Education Research*, 5, 211–217.

Kornilov, S. A., & Kornilova, T. V. (2010). Meta-analytic studies in psychology. *Psychological Journal, 31*(6), 5–17. (in Russ.).

Lee, Y. S., Sung, Y. T., Chang, K. E., Liu, T. C., & Chen, W. C. (2014). A meta-analysis of the effects of learning languages with mobile devices. In *New Horizons in Web Based Learning: ICWL 2014 International Workshops, SPeL, PRASAE, IWMPL, OBIE, and KMEL, FET, Tallinn, Estonia, August 14-17, 2014, Revised Selected Papers 13* (pp. 106–113). Springer International Publishing. https://doi.org/10.1007/978-3-319-13296-9_12 *

Lei, H., Chiu, M. M., Wang, D., Wang, C., & Xie, T. (2022). Effects of Game-Based Learning on Students' Achievement in Science: A Meta-Analysis. *Journal of Educational Computing Research*, *60*(6), 1373–1398. https://doi.org/10.1177/07356331211064543 *

Li, S., Xu, M., Zhang, Y., & Wang, X. (2023). The more academic burnout students got, the more problematic mobile phone use they suffered? A meta-analysis of mainland Chinese adolescents and young adults. *Frontiers in Psychology*, 13, 1084424. https://doi.org/10.3389/fpsyg.2022.1084424 *

Liao, Y., Chen, C.-H., & Yang, Y.-C. (2020). A meta-analysis of the effects of mobile learning on students' academic achievement in Taiwan. *Contemporary Educational Research Quarterly*, 28, 67–102. https://doi.org/10.6151/CERQ.202009_28(3).0003 *

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals of internal medicine*, *151*(4), W-65. https://doi.org/10.7326/0003-4819-151-4-200908180-00136

Liu, Q., & Wu, J. (2023). What children learn in a digital home: the complex influence of parental mediation and smartphone interference. *Education and Information Technologies*, 1–19. https://doi.org/10.1007/s10639-023-12071-2

Malkova, E. E., & Naumova, A. A. (2012). Adolescence as a clinical and psychological phenomenon in science and culture. *Medical psychology in Russia,* (6), 17–17. (in Russ.).

McDaniel, B. T., & Radesky, J. S. (2018). Technoference: Longitudinal associations between parent technology use, parenting stress, and child behavior problems. *Pediatric research*, *84*(2), 210–218. https://doi.org/10.1038/s41390-018-0052-6

Mihaylova, M., Gorin, S., Reber, T. P., & Rothen, N. (2022). A Meta-Analysis on Mobile-Assisted Language Learning Applications: Benefits and Risks. *Psychologica Belgica*, *62*(1), 252. https://doi.org/10.5334/pb.1146 *

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Medicine*, *6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mukhametzyanov, I. Sh. (2019). Smartphone at school: "To be or not to be, that is the question." *Informatics in school, 7*(150), 52–56. https://doi.org/10.32517/2221-1993-2019-18-7-52-56 (in Russ.)

Mustafa Kamal, N. N., Mohd Adnan, A. H., Yusof, A. A., Ahmad, M. K., & Mohd Kamal, M. A. (2019, January). Immersive interactive educational experiences–adopting Education 5.0, Industry 4.0 learning technologies for Malaysian Universities. In *Proceedings of the International Invention, Innovative & Creative (InIIC) Conference, Series* (pp. 190–196).

Mutambara, D., & Bayaga, A. (2021). Determinants of mobile learning acceptance for STEM education in rural areas. *Computers & Education*, 160, 104010. https://doi.org/10.1016/j.compedu.2020.104010

Nakano, M. (2022). Artificial intelligence and robotic process automation for accounting and auditing in society 5.0. *Journal of Social Science*, 89, 51–61. https://doi.org/10.34577/00005073

Novikov, M. Yu., & Starichenko, B. E. (2020). Construction of the school informatics course based on mobile and cloud technologies. *Informatics in school, 1*(154), 40–54. https://doi.org/10.32517/2221-1993-2020-19-1-40-54 (in Russ.)

Novikova, I. I., Zubtsovskaya, N. A., Romanenko, S. P., Kondrashchenko, & A. I., Lobkis, M. A. (2020). Effects of mobile phones on children's and adolescents' health. *The Science of the Person: Humanitarian Researches,* 2, 95–103. https://doi.org/10.17238/issn1998-5320.2020.14.2.16 (in Russ.)

Okumuş Dağdeler, K. (2023). A systematic review of Mobile-Assisted Vocabulary Learning research. *Smart Learning Environments*, *10*(1), 19. https://doi.org/10.1186/s40561-023-00235-z

Öztürk, B., Kaya, M., & Demir, M. (2022) Does inquiry-based learning model improve learning outcomes? A second-order meta-analysis. *Journal of Pedagogical Research*, *6*(4), 201–216. https://doi.org/10.33902/JPR.202217481

Panov, V. I., Borisenko, N. A., Mironova, K. V., & Shishkova, S. V. (2021). Behavior of adolescents in the digital educational environment: Definition of concepts and formulation of the problem. *Izvestiya of Saratov University. New Series. Series: Educational Acmeology. Developmental Psychology, 3*(39), 188–196. https://doi.org/10.18500/2304-9790-2021-10-3-188-196 (in Russ.)

Petersen-Brown, S. M., Henze, E. E., Klingbeil, D. A., Reynolds, J. L., Weber, R. C., & Codding, R. S. (2019). The use of touch devices for enhancing academic achievement: A meta-analysis. *Psychology in the Schools*, *56*(7), 1187–1206. https://doi.org/10.1002/pits.22225 *

Pieper, D., Antoine, S.-L., Mathes, T., Neugebauer, E. A. M., & Eikermann, M. (2014). Systematic review finds overlapping reviews were not mentioned in every other overview. *Journal of Clinical Epidemiology*, *67*(4), 368–375. https://doi.org/10.1016/j.jclinepi.2013.11.00

Romadiah, H., Dayurni, P., & Fajari, L. E. W. (2022). Meta-Analysis Study: The Effect of Android-Based Learning Media on Student Learning Outcomes. *International Journal of Asian Education*, *3*(4), 253–263. https://doi.org/10.46966/ijae.v3i4.300 *

Sahin, D., & Yilmaz, R. M. (2020). The effect of augmented reality technology on middle school students' achievements and attitudes towards science education. *Computers & Education*, 144, 103710. https://doi.org/10.1016/j.compedu.2019.103710

Schmidt, F. L., & Oh, I. S. (2013). Methods for second-order meta-analysis and illustrative applications. *Organizational Behavior and Human Decision Processes*, *121*(2), 204–218. https://doi.org/10.1016/j.obhdp.2013.03.002

Selwyn, N., Hillman, T., Eynon, R., Ferreira, G., Knox, J., Macgilchrist, F., & Sancho-Gil, J. M. (2020). What's next for Ed-Tech? Critical hopes and concerns for the 2020s. *Learning, Media and Technology, 45*(1), 1–6. https://doi.org/10.1080/17439884.2020.1694945

Shi, L., & Kopcha, T. J. (2022). Moderator effects of mobile users' pedagogical role on science learning: A meta-analysis. *British Journal of Educational Technology*, *53*(6), 1605–1625. https://doi.org/10.1111/bjet.13210 *

Soldatova, G. U., Rasskazova, E. I., Vishneva, A. E., Teslavskaya, O. I., & Chigarkova, S. V. (2022). *Born digital: Family context and cognitive development*. Akropol. (in Russ.).

Spasskaya, E. B., & Proekt, Yu. L. (2023). Mobile devices of students in the school learning environment through lens of teacher assessment. *Perspectives on Science and Education, 3*(63), 603–618. https://doi.org/10.32744/pse.2023.3.36 (in Russ.)

Sunday, O. J., Adesope, O. O., & Maarhuis, P. L. (2021). The effects of smartphone addiction on learning: A meta-analysis. *Computers in Human Behavior Reports*, 4, 100114. https://doi.org/10.1016/j.chbr.2021.100114 *

Sung, Y.-T., Chang, K.-E., & Yang, J.-M. (2015). How effective are mobile devices for language learning? A meta-analysis. *Educational Research Review*, *16*(1), 68–84. https://doi.org/10.1016/j.edurev.2015.09.001 *

Sung, Y.-T., Chang, K.-E., & Liu, T.-C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, 94, 252–275. https://doi.org/10.1016/j.compedu.2015.11.008

Sung, Y.-T., Yang, J.-M., & Lee, H.-Y. (2017). The Effects of Mobile-Computer-Supported Collaborative Learning: Meta-Analysis and Critical Synthesis. *Review of Educational Research*, *87*(4), 768–805. https://doi.org/10.3102/0034654317704307 *

Talan, T. (2020). The Effect of Mobile Learning on Learning Performance: A Meta-Analysis Study. *Educational Sciences: Theory & Practice*, *20*(1), 1. https://doi.org/10.12738/jestp.2020.1.006 *

Talan, T., Y. Doğan, & Batdı V. (2020). Efficiency of Digital and Non-Digital Educational Games: A Comparative Meta-Analysis and a Meta-Thematic Analysis. *Journal of Research on Technology in Education*, *52*(4), 474–514. https://doi.org/10.1080/15391523.2020.1743798 *

Tamim, R. M., Borokhovski, E., Pickup, D., Bernard, R. M., & El Saadi, L. (2015). *Tablets for teaching and learning: A systematic review and meta-analysis*. Commonwealth of Learning. Retrieved from: https://oasis.col.org/server/api/core/bitstreams/678099a2-4d78-4fc3-a6b8-3f9e81f51c7e/content *

Tingir, S., Cavlazoglu, B., Caliskan, O., Koklu, O., & Intepe-Tingir, S. (2017). Effects of mobile devices on K–12 students' achievement: A meta-analysis. *Journal of Computer Assisted Learning*, *33*(4), 355–369. https://doi.org/10.1111/jcal.12184 *

Troll, E. S., Friese, M., & Loschelder, D. D. (2020). How students' self-control and smartphone-use explain their academic performance. *Computers in Human Behavior*, 117, 106624. https://doi.org/10.1016/j.chb.2020.106624

Ulum, H. (2022). The effects of online education on academic success: A meta-analysis study. *Education and Information Technologies*, *27*(1), 429–450. https://doi.org/10.1007/s10639-021-10740-8 *

Uvarov, A. Yu. (2019). The model of the digital school and the digital transformation of education. *Researcher*, (1–2), 22–37. (in Russ.).

Van Aert, R. C., Wicherts, J. M., & Van Assen, M. A. (2019). Publication bias examined in meta-analyses from psychology and medicine: A meta-meta-analysis. *PloS one, 14*(4), e0215052. https://doi.org/10.1371/journal.pone.0215052

Wang, J., Tigelaar, D. E. H., Zhou, T., & Admiraal, W. (2023). The effects of mobile technology usage on cognitive, affective, and behavioural learning outcomes in primary and secondary education: A systematic review with meta-analysis. *Journal of Computer Assisted Learning*, *39*(2), 301–328. https://doi.org/10.1111/jcal.12759 *

Wang, M., Lwin, M. O., Cayabyab, Y. M. T. M., Hou, G., & You, Z. (2023). A Meta-Analysis of Factors Predicting Parental Mediation of Children's Media Use Based on Studies Published Between 1992–2019. *Journal of Child and Family Studies*, *32*(5), 1249–1260. https://doi.org/10.1007/s10826-022-02459-y

Xu, Y., & Fang, F. (2022). Internationalization of teacher education and the nation state: rethinking nationalization in Singapore: by Rita Z. Nazeer-Ikeda, London, Routledge, 2020, 262 pp., ISBN 978-0-367-22704-3. *Asia Pacific Journal of Education*, *0*(0), 1–3. https://doi.org/10.1080/02188791.2022.2151740

Yang, J.-M., Sung, Y.-T., & Chang, K.-E. (2020). Use of Meta-Analysis to Uncover the Critical Issues of Mobile Inquiry-Based Learning. *Journal of Educational Computing Research*, *58*(4), 715–746. https://doi.org/10.1177/0735633119879366 *

Yi, Y. J., You, S., & Bae, B. J. (2016). The influence of smartphones on academic performance: The development of the technology-to-performance chain model. *Library Hi Tech*, *34*(3), 480–499. https://doi.org/10.1108/lht-04-2016-0038

Yu, D., Yan, Z., & He, X. (2022). Capturing knowledge trajectories of mobile learning research: A main path analysis. *Education and Information Technologies*, *27*(5), 7257–7280. https://doi.org/10.1007/s10639-021-10869-6

Zhai, X., Zhang, M., Li, M., & Zhang, X. (2019). Understanding the relationship between levels of mobile technology use in high school physics classrooms and the learning outcome. *British Journal of Educational Technology*, *50*(2), 750–766. https://doi.org/10.1111/bjet.12700

Zhao, K. (2020). Educating for wholeness, but beyond competences: Challenges to key-competences-based education in China. *ECNU Review of Education*, *3*(3), 470–487. https://doi.org/10.1177/2096531120935463

Zheng, L., Li, X., Tian, L., & Cui, P. (2018). The effectiveness of integrating mobile devices with inquiry-based learning on students' learning achievements: A meta-analysis. *International Journal of Mobile Learning and Organisation*, *12*(1), 77–95. https://doi.org/10.1504/IJMLO.2018.089238 *

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Author Contribution

Yuliya L'vovna Proekt developed the research strategy and research protocol, analyzed and interpreted the results, and prepared the text of the manuscript.

Elena Borisovna Spasskaya analyzed the relevant literature, selected and evaluated meta-analyses, summarized the results of the study, and suggested the prospects of the study.

Nina Olegovna Ivanushkina analyzed the relevant literature, selected and evaluated meta-analyses, performed mathematical and statistical analysis of data.

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Conflict of Interest Information

The authors have no conflicts of interest to declare.