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A Meta-Analysis of Facebook-Assisted Learning Outcomes in Different Countries or Regions

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ABSTRACT

In this special pandemic time, many learners have been forced to stay at home receiving education through mobile learning applications and social media such as Facebook. It is thus meaningful to meta-analytically review the studies on Facebook-assisted learning outcomes in different countries or regions to provide constructive suggestions for improvements on mobile learning. Through a meta-analysis using Stata 14.0, this study concludes that the Facebook-assisted learning approach may improve learning interaction, learning performance, social presence, engagement, psycho-motor, and overall skills in different countries or regions, although there are still different results and even controversial issues. The controversies lie in different findings in Taiwan, Switzerland, and UK, where no significant results are revealed regarding the use of Facebook for educational purposes. Future research could examine the construction of a sustainable online learning model, the classic theory, gender differences, and other mobile applications.

KEYWORDS

Different Countries or Regions, Facebook, Learning Outcomes, Meta-Analysis

1. INTRODUCTION

During this special pandemic time, many learners have been forced to stay at home receiving education through mobile learning applications such as Facebook. Now, Facebook possesses 2.895 billion active users per month. The number of daily active Facebook users reaches 1.908 billion across the world.

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Facebook, as an online interactive platform, obtains 2.76 billion active users of Facebook-owned social media such as Instagram and WhatsApp everyday (Dean, 2022). Considering the popularity, it is thus meaningful to meta-analytically review the studies on Facebook-assisted learning outcomes in different regions to provide constructive suggestions for improvements on mobile learning.

Through collecting academic data, a Facebook platform could provide constructive suggestions for learning and teaching strategies. Facebook could collect data regarding users' preferences, dislikes, and mood to provide references for adjustment of learning and instruction strategies in Singapore (Liu, Choudhary, Zhang, & Magenenat-Thalmann, 2013). Teachers might choose proper instructive methods based on the collected data and learners may apply appropriate learning strategies for knowledge acquisition, based on the feedback from these immense data. However, it is not generally demonstrated that Facebook can exert a positive influence on teaching and learning in this way. Facebook may also exert a negative influence on learning and teaching. Facebook use gained increasing recognition in medical education (Teoh, 2021), and political knowledge acquisition (Kim, Lu, & Lee, 2021). However, little is known about whether the findings are generalizable across the world. To fill the research gap, it is necessary to meta-analytically examine whether this result is generalizable to other regions or countries so that instructors can determine whether or not to integrate Facebook with teaching strategies on the basis of collected data.

Facebook could satisfy users by facilitating text message delivery and improving knowledge gain (Joseph, Keller, Adams, & Ainsworth, 2015) in the USA. Although learners in Singapore were generally satisfied with Facebook integrated with the learning management system, the transferring files and discussion forms were limited and learners felt unsafe and uncomfortable for fear that their personal information might be disclosed (Wang, Woo, Quek, Yang, & Liu, 2012). This regional difference is worth further exploration and examination. Different regions may cause great differences in belief, learning strategies, and learning habits. The levels of popularity of Facebook may vary in different regions. Confronted with great convenience, Singaporeans may feel uneasy and thus take conservative measures to deal with the Facebook-assisted learning approach. However, there have been no plentiful studies reporting that users of Facebook in other countries or regions worry about the safety of personal information. To fill this research gap, it is worth exploring this in different countries or regions.

Facebook could also bring about negative results if excessively used. Addiction to Facebook could reduce self-efficacy levels especially for male learners in Taiwan. High levels of addiction to Facebook could reduce belief and could in turn negatively influence learning outcomes (Lin, 2018). Addiction may dampen learners' learning enthusiasm and exacerbate learning outcomes. The poor outcomes may most likely reduce their self-efficacy especially in Taiwan which is densely populated and where there is a fierce competition in the job market. It occurs in Taiwan that addiction to Facebook may be a way for learners to let out psychological pressure and gradually lose their self-efficacy. However, it is not proved in other countries or regions. How addiction exerts an influence on self-efficacy in other regions or whether Lin's (2018) findings are generalizable to other contexts awaits further research. To fill this research gap, this study aims to generalize the effect of Facebook use on educational outcomes across the world. Specifically, this study aims to identify the use of Facebook for educational purposes in different countries and regions in terms of various dimensions, e.g. learning interaction, learning performance, social presence, engagement, psycho-motor, and differences in learning outcomes.

2. LITERATURE REVIEW

2.1 Theoretical Framework

Considering the established theories, we proposed a research model (Figure 1) that Facebook-assisted learning outcomes were made of learning interaction, learning performance, social presence,

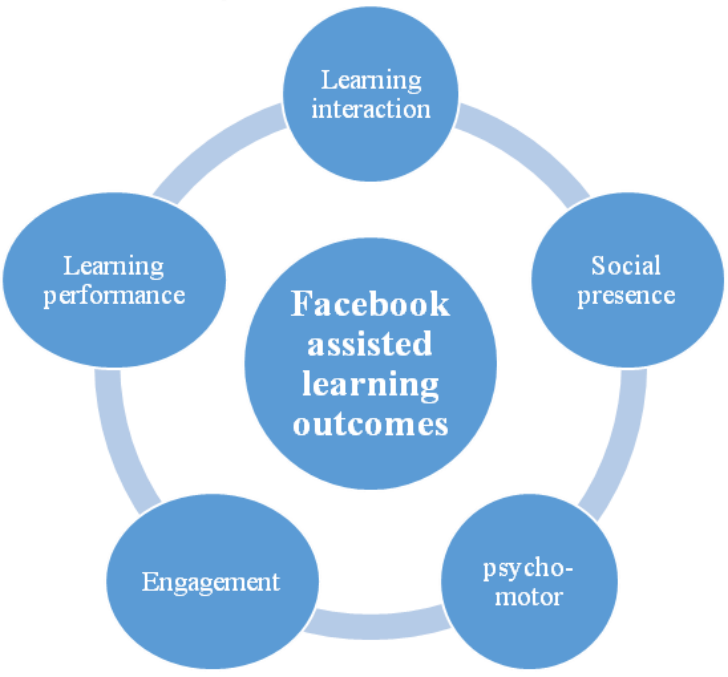
engagement, and psycho-motor. It was important to establish learning atmosphere and scaffold learning via learning interactions (Rovai, 2002), which could positively influence learning effectiveness (Offir, Lev, & Bezalel, 2008) and learner satisfaction with the academic experiences (Richardson & Swan, 2003). Learning interactions could also improve learning performance (Wei et al., 2012). Social presence exerted an important influence on both learning performance and satisfaction (Sung & Mayer, 2012). Educational technologies such as social media and platform could improve learners' engagement (Bowman & Akcaoglu, 2014), learning experience, satisfaction (Pratt & Hahn, 2015), and self-motivation (Lee et al., 2016).

The novelty of the framework lies in the model where an integrative analysis of the above-mentioned variables forms essential Facebook-assisted learning outcomes. Previous studies merely separately explored social media-assisted learning performance (Barrot, 2020), social presence and learning interaction (Gorozidis et al., 2020), engagement (Yu et al., 2022b), and psychological issues (Yu et al., 2023). Milošević et al (2015) formulated a model including adoption of Facebook, usefulness, perception of easy use, and social influence. Similarly, Sharma et al (2016) established a model influencing the adoption of Facebook for academic purposes including sharing of academic resources, perceived entertainment, social influence, and perceived usefulness. Previous studies have not synthetically examined the variables which are explored in the current study.

2.2 Learning Performance

A number of studies reported that Facebook could improve learning outcomes in different countries or regions due to its multiple functions. Facebook could improve pre-service teachers' learning outcomes by promoting their readiness, convenience, and communication in the USA (O'Bannon, Beard, & Britt, 2013). Facebook could significantly improve learning achievements and engagement of pre-service teachers in India (Saini & Abraham, 2019). Learners who used Facebook could outperform

Figure 1.
A model of Facebook-assisted learning outcomes



those who did not use it in the Philippines due to Facebook's numerous positive features such as interactivity, flexibility, accessibility, social easiness, and strong awareness (Barrot, 2020). Social media applications such as Facebook could effectively improve medical students' understanding of electrocardiogram courses and enhance their engagement in residential service in the USA (Liu, Zakaria, Vaidya, & Srivastava, 2017). Teachers' identity revelation could also influence learning effectiveness. In the USA, a highly disclosed teacher profile through Facebook could improve learners' motivation, cultivate a positive academic environment (Mazer, Murphy, & Simonds, 2007), increase the teacher credibility level (Mazer, Murphy, & Simonds, 2009), and thus improve learning outcomes. Similarly, in the UK, student-teacher relationship could improve if teachers revealed their identities in Facebook (Prescott, 2014). Courses with Facebook groups could improve peer relationships and create strong belonging sense among learners in Australia (Sheeran & Cummings, 2018).

Learning performance referred to the learning outcomes in the Facebook-assisted learning context, including students' perception of course sociability, ESL learners' writing performance, writing task achievement, knowledge, classroom discussion, the delivery of course content and resources, multimedia resources, educational experience, study assessment, quiz scores, affective learning, classroom climate, levels of trustworthiness, caring, pedagogical affordance, and organization of learning activities. Furthermore, the use of Facebook failed to improve learning outcomes although it could strongly enhance the learning awareness in Taiwan (Chang, Guo, & Lin, 2017).

2.3 Social Presence and Learning Interaction

Learning interaction was defined as the academic activities where Facebook users communicate with peers, teachers, learning materials and other related learning objects in the context of Facebook-assisted learning (Akcaoglu & Lee, 2018). In this study, learning interactions included peer learning interaction, instructor learning interaction, dialogue, integration, communication between classmates, communication between teacher and the students, communication of announcements about courses, classes, or school, the creation of academic groups, group work, course-related information exchange, resource sharing, social support from friends and family, and the student-lecturer relationship.

Social presence was operationally defined as the sense of getting together with other Facebook users or the mutual sense with each other when both users in Facebook-assisted learning (Biocca et al., 2003). The definition of social presence included the conception of copresence proposed by Biocca et al. (2003). This study, therefore, combined social presence with copresence and considered them an inseparable entity. In this study, social presence included peer copresence, instructor copresence, cognitive presence, teaching presence, and sense of belonging.

Numerous studies reported that Facebook could enhance the sense of presence and interactions. Facebook could improve social presence, enhance sociability of learners, and promote interactions between peers, instructors, and learning materials in the USA (Akcaoglu & Lee, 2018). Physical Education Teacher Collaborative Network assisted with Facebook proved a positive and innovative approach to enhance interactions and teacher training outcomes in Greece (Gorozidis et al., 2020). Assisted with Facebook, learners in Taiwan could interact with their peers and instructors, improve English learning outcomes, foster positive learning attitudes, and enhance their learning motivation (Wang, Lin, Tsai, & Chuang, 2017). Facebook could improve communication between instructors and students, provide rich learning resources, and improve learning experiences, but could not facilitate the formation of learning groups in Switzerland (Chen, 2018). Facebook users, especially females, could have more positive feelings of instructor presence, social presence, cognitive presence, and overall academic experience than those using Moodle as a learning platform in the UK (Kazanidis, Pellas, Fotaris, & Tsinakos, 2018).

2.4 Engagement

In this study, engagement referred to the activity where learners or teachers cognitively, psychologically, emotionally, or behaviourally participated in Facebook-assisted learning or teaching. Measurements of

engagement included frequency of Facebook use, daily Facebook application, cognitive engagement, psychological engagement, and behavioural engagement. As an important dimension, engagement was closely related to learning outcomes.

Although numerous studies reported positive results regarding the use of Facebook, negative findings were also revealed. The frequent use of Facebook could decrease knowledge gain especially for those with less political enthusiasm in the Netherlands (Boukes, 2019). The learning management system might be a better platform to act as a facilitator of online discussion and completion of assignment in the USA despite that Facebook could foster student engagement and encourage them to participate in peer communication (Camus et al., 2016). Surprisingly, it was found that use of social media such as Facebook did not greatly facilitate efficiency and improve convenience in learners' life. The non-users seemed to be well connected with the society and ready to access the Internet although they seemed less interested in learning activities compared with users in the USA (Tufekci, 2008).

2.5 Psycho-Motor

In this study, psycho-motor referred to the cognitive strategy guiding learners to participate, understand, encode, remember, and think (Larkin, 1980) and the motor skills motivating learners and teachers to engage in Facebook-assisted learning and teaching activities (Gagné, 1984). Psycho-motor included a number of variables, e.g. self-efficacy, autonomy, satisfaction, competence satisfaction, relatedness satisfaction, autonomous motivation, training satisfaction, teacher self-efficacy, outcome expectations, and self-regulation, etc. As a newly proposed and integrated factor, psycho-motor was considered an influencing element of Facebook-assisted learning outcomes.

2.6 A Statement of Research Questions

Based on the literature reviewed, this study aims to bridge the literature gap by meta-analytically examining Facebook-assisted learning outcomes in terms of learning interaction, learning performance, social presence, engagement, and psycho-motor, as well as the differences in learning outcomes in different countries or regions, compared with non-Facebook-assisted learning approaches. We collected corresponding data including the number of participants (N=8071 for the treatment groups, N=6056 for the control groups), means, and standard deviations. The included studies were also coded in terms of learning outcomes and different countries or regions.

3. METHODS

3.1 Data Availability Statement

The data used in this study are available to anyone who wants to have access and the data are submitted together with the manuscript in the system. The data sourced from Web of Science, Cochrane Databases of Systematic Review, Taylor & Francis, Springer Nature, Elsevier, Educational Research Complete, and the Centre for Review and Dissemination and the Joanne Briggs Institute.

3.2 Protocol and Registration

This meta-analysis is carried out in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021). There is no review protocol but this study has been approved by the author's affiliated ethical and academic committees.

3.3 Eligibility Criteria

Researchers designed the eligibility criteria based on the PRISMA protocol (Page et al., 2021). The randomized controlled studies were considered eligible and included if (1) their participants were divided into Facebook-assisted learning and non-Facebook-assisted learning groups; (2) they designed Facebook or non-Facebook-assisted learning or instructional approaches and compared

their differences; (3) they included learning outcomes in different countries or regions; (4) they were written in the English language; (5) they could provide full-texts and enough data needed for the meta-analysis.

The randomized controlled studies were considered ineligible and excluded if (1) they were written in a language other than English; (2) they could not provide enough data or full-texts; (3) they focused on the technology of Facebook itself rather than the use of Facebook in education; (4) their research was not rigidly designed or did not adopt correct quantitative research methods.

3.4 Data Sources and Search Strategy

To detect and prevent the duplicates of this study, we searched numerous databases such as Web of Science, Cochrane Databases of Systematic Review, Taylor & Francis, Springer Nature, Elsevier, Educational Research Complete, and the Centre for Review and Dissemination and the Joanne Briggs Institute. We searched the databases based on their specific syntactic rules using various terms such as Facebook, learning outcome, country, region, control group, and experimental/treatment group. To include comprehensive literature, we searched both published studies written in English within all years. We also cooperated with an experienced librarian to obtain literature from their inception until November 2020.

Four phases were adopted to select and include the studies according to the PRISMA flowchart (Figure 2). The first phase aimed to exclude the duplicates from a comprehensive scope of databases. In the second phase, two independent researchers removed the irrelevant studies by screening the titles and abstracts. The third phase aimed to assess the eligibility using the eligibility criteria. In the fourth phase, the two independent reviewers finally decided the included studies via discussion and collaboration. In case they could not reach an agreement on any inclusion or exclusion, a third qualified reviewer would join and make a final decision.

3.5 Quality Assessment

We assessed the individual trial using the University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003). The framework evaluates the study in terms of each section of the article, i.e. introduction, methods, data collection and analysis (quantitative and qualitative methods), ethics, the results/findings, and the conclusions. There are specific requirements for each section. For instance, the conclusion section should be able to fully answer the questions "Are the implications for further research acknowledged? Are areas for further research identified? Are further recommendations made for practice that comes from the results/discussion?" Kappa statistic was used to assess the inter-raters' agreement between two or more reviewers.

3.6 Data Extraction

Both reviewers extracted the related data from the included studies based on the standardized data extraction form (Higgins & Green, 2011). The extracted information from eligible studies included authors, publication years, means, standard deviations, numbers of participants of both control and treatment groups, educational levels of participants, regions or countries of the study, and learning outcomes. The learning outcomes consisted of learning interaction, learning performance, social presence, engagement, and psycho-motor. In case the information was not enough for the meta-analysis, we would contact the corresponding authors. Both reviewers collaborated in the process of data extraction. If they held different opinions, they would try to discuss. They would consult a third expert for the final decision in case they could not persuade each other.

3.7 Statistical Analysis

The statistical tool, Stata 14.0, was used to analyze the extracted data from the included studies. Z-statistics were used to analyze the overall effect of the Facebook and non-Facebook-assisted approaches. Cohen's *d* (Cohen, Manion, & Morrison, 2007), i.e. standardized mean difference (SMD),

was used to measure the effect size of the Facebook treatment. If 0.1 † d † 0.2, the effect size would be considered very small; if 0.2 † d † 0.5, the effect size would be considered small; if 0.5 † d † 0.8, the effect size would be considered medium; if 0.8 † d † 1.2, the effect size would be considered large; if 1.2 † d † 2.0, the effect size would be considered very large; if d ‡ 2.0, the effect size would be considered huge (Sawilowsky, 2009). SMD was calculated as the difference in the mean outcome between control and treatment groups divided by the standard deviation of the outcome among participants across both groups (Sedgwick & Marston, 2013).

We determined whether to use a random-effect or fixed-effect model to conduct the meta-analysis based on heterogeneity tests. Heterogeneity generally referred to the heterogeneity of included studies in meta-analysis. It described the differences and diversity of measurement results among participants, treatments and a series of studies, or the variation of internal authenticity among those studies. The statistical heterogeneity was also used to describe the variation degree of effect quantity in a series of studies, and also indicated the differences between studies except for the foreseeable chance. Q and I^2 statistics were used to detect both the existence and the degree of heterogeneity, and the graphical method was used to find the abnormal reasons (one or several studies) causing heterogeneity. If 0%†I^2†40%, the heterogeneity would be considered unimportant; if 30%† I^2 †60%, the heterogeneity would be considered moderate; if 50%† I^2 †90%, the heterogeneity would be considered substantial; if 75%† I^2 †100%, the heterogeneity would be considered considerable (Higgins & Green, 2011). In a meta-analysis, heterogeneity exists naturally. If the heterogeneity was small ($I^2 < 50\%$), the fixed effect model was more reliable; if the heterogeneity was large ($I^2 > 50\%$), the random effect model was recommended. A random-effect model was used to conduct the meta-analysis. A sensitivity analysis, which was carried out, aimed to identify the heterogeneous study and to enhance the homogeneity (Higgins & Green, 2011).

Sensitivity analysis and publication bias were conducted to improve the reliability of the meta-analysis. We found the basis of heterogeneity through sensitivity analysis to eliminate its impact in case the degree of heterogeneity was high. Both the Begg's (Begg & Mazumdar, 1994) and Egger's tests (Egger, Smith, Schneider, & Minder, 1997) were used to test publication biases.

4. RESULTS

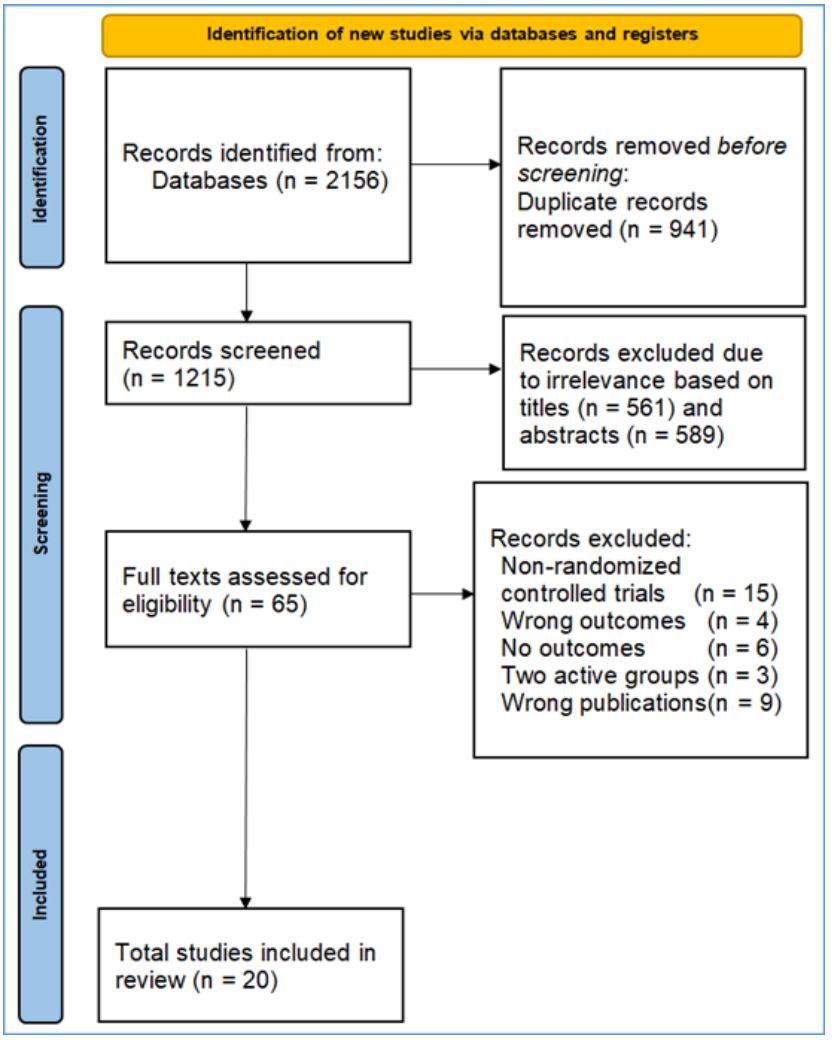
4.1 Study Selection

As shown in Figure 2, we firstly obtained 2156 results from numerous online databases, i.e. Web of Science, Taylor & Francis, Springer Nature, Elsevier, and Educational Research Complete. We then screened 1215 results after removing 941 results due to duplication. Two reviewers examined the titles and abstracts and excluded 561 results due to irrelevant titles and 589 results due to irrelevant abstracts. We then downloaded 65 full-text articles for eligibility assessment. We removed the articles that did not adopt randomized controlled methods (n = 15). Four articles were excluded due to wrong results. Six articles were removed due to unclear outcomes. Three articles were removed because there were two active groups in the design. Nine articles were excluded due to improper population. Finally, we determined and included 20 randomized controlled trials for the meta-analysis.

4.2 Characteristics of Studies

Characteristics of the included studies are pooled in Table 1. Participants in the included studies came from different countries or regions, e.g. USA, UK, India, Australia, Singapore, the Philippines, Taiwan, Switzerland, and Greece. Educational levels of participants were of many sources, including university students (both undergraduates and postgraduates), university teachers, and social workers. Learning outcomes were measured through learning interaction, learning performance, social presence, engagement, and psycho-motor. We also pooled sample sizes for both control and treatment groups, as well as authors and publication years (see Table 1).

Figure 2.
The PRISMA flowchart



4.3 Tests for Publication Bias

As shown in Figure 3, x-axis indicates the analysis results, i.e. standard errors of standardized mean differences, while the y-axis indicates the precision, i.e. the standardized mean differences. The middle line indicates the overall-effect, with two lines indicating pseudo 95% confidence limits scattering along both sides. One dot indicates an individual study. If the dots are symmetrically distributed along both sides of the overall-effect line, there will be no presence of publication bias. However, the asymmetrical distribution indicates the presence of publication bias. We cannot judge the publication bias based on Figure 3, since it is hard to directly determine whether the distribution is symmetrical or not with naked eyes. Therefore, we further conducted both Begg's and Egger's tests to determine the publication bias. Begg's test indicates the presence of publication bias (Kendall's Score (P-Q) = 1196, Std. Dev. of Score = 325.81, z = 3.67, p<.01), and Egger's test also indicates the presence of publication bias (t = 2.07, p = 0.041). It is, therefore, necessary to include more reliable and comprehensive studies in the future research.

Table 1.
Characteristics of included studies

N	Author/year	Sample size		Outcome	Educational level	Country/ region
		Treatment	Control			
1	Akcaoglu & Lee, 2018	38.00	38.00	learning interaction	University students	USA
2	Barrot, 2020	48.00	41.00	learning performance	University students	The Philippines
3	Camus et al., 2016	24.00	28.00	Engagement	University students	USA
4	Chang et al., 2017	70.00	90.00	learning performance	University students	Taiwan
5	Chen, 2018	67.00	67.00	Engagement	University students	Switzerland
6	Gorozidis et al., 2020	63.00	63.00	Psycho-motor	University teachers	Greece
7	Joseph et al., 2015	14.00	14.00	learning interaction	Social workers	USA
8	Kazanidis et al., 2018	40.00	10.00	learning interaction	University students	UK
9	Lin, 2018	398.00	292.00	Psycho-motor	University students	Taiwan
10	Liu et al., 2013	12.00	12.00	learning interaction	Social workers	Singapore
11	Liu et al., 2017	11.00	11.00	learning performance	University students	USA
12	Mazer et al., 2007	45.00	44.00	learning performance	University students	USA
13	Mazer et al., 2009	126.00	125.00	learning performance	University students	USA
14	O'Bannon et al., 2013	77.00	77.00	learning performance	University teachers	USA
15	Prescott, 2014	80.00	92.00	learning interaction	University students	UK
16	Saini & Abraham, 2019	31.00	31.00	Engagement	University teachers	India
17	Sheeran & Cummings, 2018	163.00	104.00	social presence	University	Australia
18	Tufekci, 2008	443.00	86.00	learning interaction	University	USA
19	Wang et al., 2012	14.00	14.00	learning performance	University	Singapore
20	Wang et al., 2017	40.00	40.00	Psycho-motor	University	Taiwan

4.4 A Sensitivity Analysis

To identify whether the estimates of effect sizes of the included studies were stable or not, we conducted a sensitivity analysis using the influence analysis program in Stata 14.0. The result (Figure 4) indicates that the meta-analysis estimates are stable since the estimates exist between the lower 95% CI limit and the Upper 95% CI limit given a named study is omitted. This partially complements the presence of publication bias.

4.5 Meta-Analysis Results for Facebook Users' Learning Outcomes

To determine whether to adopt a fixed or random-effect model, we measured the heterogeneity of effect sizes in learning outcomes. As shown in Table 2, the effect sizes are generally heterogeneous. Specifically, effect sizes in studies are heterogeneous on learning interaction ($Q = 481.76$, $df = 21$, $I^2 = 95.6\%$, $z = 1.40$, $p = 0.162$), learning performance ($Q = 139.12$, $df = 26$, $I^2 = 81.3\%$, $z = 11.34$, $p < 0.01$), social presence ($Q = 247.5$, $df = 9$, $I^2 = 78.6\%$, $z = 5.44$, $p < 0.01$), engagement ($Q = 208.22$, $df = 9$, $I^2 = 95.7\%$, $z = 1.21$, $p = 0.227$), psycho-motor ($Q = 261.10$, $df = 23$, $I^2 = 91.2\%$, $z = 4.00$, $p < 0.01$), and overall skills ($Q = 1205.63$, $df = 92$, $I^2 = 92.4\%$, $z = 10.21$, $p < 0.01$).

Figure 3.
A funnel plot of publication bias

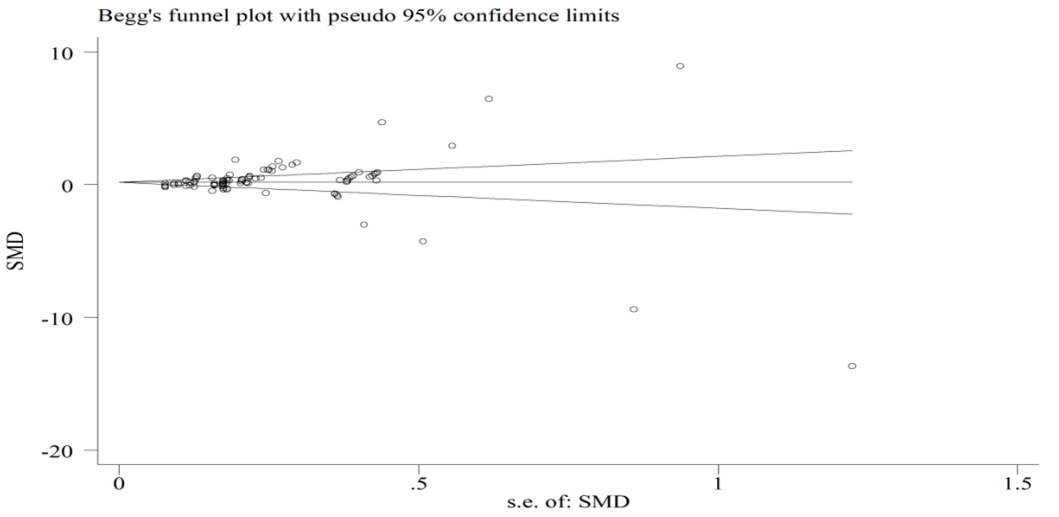
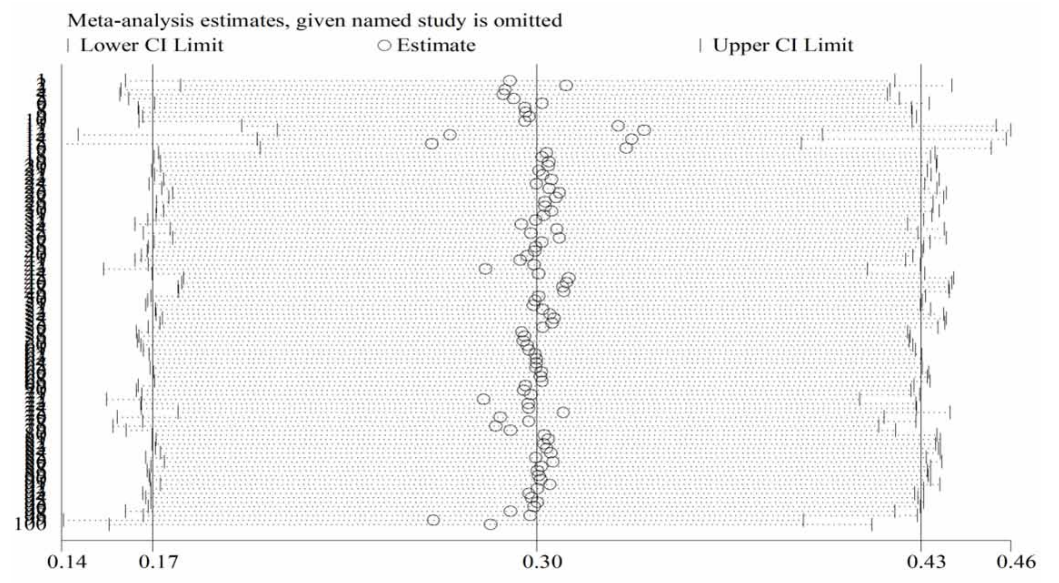


Figure 4.
A plot of sensitivity analysis



Therefore, we adopted a random-effect model to analyze the meta-analysis results. It shows in Table 2 that the Facebook-assisted group significantly outperformed the control group in terms of learning performance (d = 0.460, 95%CI = 0.380, 0.539), social presence (d = 0.322, 95%CI = 0.206, 0.438), psycho-motor (d = 0.116, 95%CI = 0.059, 0.173), and overall skills (d = 0.184, 95%CI = 0.148, 0.219). However, no significant differences were found in learning interaction (d = 0.065, 95%CI = -0.026, 0.156) and engagement (d = 0.052, 95%CI = -0.032, 0.135).

Table 2.
Meta-analysis results for Facebook-assisted learning outcomes

Learning outcomes	SMD	95% CI		%weight	Heterogeneity statistic	df	p	I^2(%)	z	p
Learning interaction	0.065	-0.026	0.156	15.06	481.76	21	<.01	95.6%	1.40	0.162
Learning performance	0.460	0.380	0.539	19.66	139.12	26	<.01	81.3%	11.34	<.01
Social presence	0.322	0.206	0.438	9.23	42.08	9	<.01	78.6%	5.44	<.01
Engagement	0.052	-0.032	0.135	17.67	208.22	9	<.01	95.7%	1.21	0.227
Psycho-motor	0.116	0.059	0.173	38.38	261.10	23	<.01	91.2%	4.00	<.01
Overall	0.184	0.148	0.219	100.00	1205.63	92	<.01	92.4%	10.21	<.01

4.6 Meta-Analysis Results for Different Regions or Countries

We also firstly determined whether there is any heterogeneity of effect sizes in different countries or regions. Effect sizes were found heterogeneous in the USA (Table 3) ($Q = 763.47$, $df = 25$, $I^2 = 96.7\%$, $z = 9.37$, $p < 0.01$), Taiwan ($Q = 194.89$, $df = 10$, $I^2 = 94.9\%$, $z = 1.95$, $p = 0.051$), Greece ($Q = 19.18$, $df = 5$, $I^2 = 73.9\%$, $z = 3.94$, $p < 0.01$), the UK ($Q = 42.06$, $df = 8$, $I^2 = 81\%$, $z = 0.86$, $p = 0.390$), India ($Q = 11.44$, $df = 3$, $I^2 = 73.8\%$, $z = 8.54$, $p < 0.01$), and overall regions across the world ($Q = 1205.63$, $df = 92$, $I^2 = 92.4\%$, $z = 10.21$, $p < 0.01$).

Considering that meta-analysis results from most of the regions are heterogeneous, we adopted a random-effect model to analyze the effect sizes. The results (Table 3) reveal that the Facebook-assisted learning group significantly outperform the control group in the USA ($d = 0.423$, 95%CI = 0.335, 0.511), the Philippines ($d = 0.519$, 95%CI = 0.329, 0.709), Greece ($d = 0.290$, 95%CI = 0.146, 0.435), Singapore ($d = 0.574$, 95%CI = 0.324, 0.823), India ($d = 1.129$, 95%CI = 0.870, 1.389), Australia ($d = 0.090$, 95%CI = 0.024, 0.156), and overall regions ($d = 0.184$, 95%CI = 0.148, 0.219). However, we did not find any significant differences between the treatment and control groups regarding the use of Facebook in Taiwan ($d = 0.073$, 95%CI = -0.000, 0.146), Switzerland ($d = 0.020$, 95%CI = -0.078, 0.118), and the UK ($d = 0.060$, 95%CI = -0.078, 0.199). We, therefore, arrive at the conclusion that in most countries or regions, Facebook-assisted learners

Table 3.
Meta-analysis results for different countries/regions

Region	SMD	95% CI		%weight	Heterogeneity statistic	df	p	I^2(%)	z	p
USA	0.423	0.335	0.511	15.88	763.47	25	<.01	96.7	9.37	<.01
The Philippines	0.519	0.329	0.709	3.44	4.35	4	0.358	8.5	5.36	<.01
Taiwan	0.073	-0.000	0.146	23.19	194.89	10	<.01	94.9	1.95	0.051
Switzerland	0.020	-0.078	0.118	12.93	16.86	11	0.112	34.8	0.40	0.689
Greece	0.290	0.146	0.435	5.93	19.18	5	0.002	73.9	3.94	<.01
UK	0.060	-0.078	0.199	6.52	42.06	8	<.01	81.0	0.86	0.390
Singapore	0.574	0.324	0.823	2.00	2.93	9	0.967	0.0	4.51	<.01
India	1.129	0.870	1.389	1.85	11.44	3	0.01	73.8	8.54	<.01
Australia	0.090	0.024	0.156	28.26	17.51	9	0.041	48.6	2.66	0.008
Overall	0.184	0.148	0.219	100.00	1205.63	92	<.01	92.4	10.21	<.01

significantly outperformed those without the assistance of Facebook, but in some countries or regions no significant differences were revealed.

5. DISCUSSION

This study revealed that use of Facebook could improve learning performance, social presence, psychomotor, and overall skills, although it could not improve learning interactions and learning engagement. Eight studies were included to determine the differences in learning interactions between the treatment and control groups. The educational levels of participants were of many kinds, including undergraduates, postgraduates, and social workers. Regions or countries involved in learning interactions included the USA, Switzerland, the UK, and Singapore. The evidence thus seems convincing and thought-provoking.

There are numerous rationales for the non-significant effect of Facebook use on learning interactions. The frequent use of Facebook might reduce the quality of time users spent learning. When users focused on their electronic devices instead of their peers, they would soon hang out without Facebook users and learning interactions would be decreased. One of the bad habits many Facebook users had cultivated was that they liked to write vague messages on Facebook to stimulate others' curiosity and draw their attention. However, the excessively vague messages would possibly make peers fed up and finally they stayed away from mutual interactions. Eventually, Facebook could not improve learning interactions in many countries and regions.

The use of Facebook could greatly improve learning outcomes in most countries and regions, although it could not do so in Taiwan, Switzerland, and the UK. There was merely one study conducted in Switzerland (Chen, 2018) included in this meta-analysis, which might have caused result bias. Chen's study (2018) did not measure the association between learning outcomes and the features of Facebook such as communication, collaboration, and learning material sharing (Manasijević et al., 2016; Mazman & Usluel, 2010, 2011; Sharma et al., 2016). This might have caused the lack of enough evidence regarding learning outcomes of Facebook use since multiple functions of Facebook might greatly influence the learning outcomes.

It is unsurprising to find no significant changes in learning outcomes assisted with Facebook. Chang, Guo, & Lin (2017) adopted a self-report to collect data regarding learning outcomes and engagement in Taiwan. This might have caused biased reporting and negatively influenced the conclusions since medical teachers could use Facebook to incorporate cultural competence and personalized education into education and training. Wang, Lin, Tsai, & Chuang's study (2017) was limited to a small sample size in the context of Taiwan, which might have weakened the generalization of the findings in other contexts. The learning outcomes were limited to listening, speaking, reading, and advanced writing skills in English learning assisted with Peer Interaction-Based Learning Community through Facebook. Other learning outcomes, e.g. social presence, remained unexplored. The generalizability of the finding is thus limited to Taiwan.

Findings in the context of the UK were not convincing enough to be widely generalized. Merely two studies (Kazanidis, Pellas, Fotaris, & Tsinakos, 2018; Prescott, 2014) included examined the use of Facebook in the UK. This small sample size might not provide solid grounds for the negative findings regarding Facebook-assisted learning outcomes. Kazanidis, Pellas, Fotaris, & Tsinakos (2018) determined the Facebook-assisted learning outcomes after merely six weeks' intervention and the gender of the sample was seriously imbalanced (predominantly males). These disadvantages might have caused biased findings. Prescott's study (2014), subject to controversy or disputes, was limited to one university in the UK with a small sample size and without enough qualitative data, which weakened the reliability of the findings.

It was generally reported that the use of Facebook could improve learning outcomes in various countries or regions (e.g. O'Bannon, Beard, & Britt, 2013; Saini & Abraham, 2019; Barrot, 2020). The Facebook-assisted learning provided social space for learners and teachers to engage in social and academic activities and to build up social relationships, mutual trust, and fair learning atmosphere

(Kreijns et al., 2007). In this case, social presence would definitely be improved, which would also increase the frequency of learning interactions. Influenced by peers or teachers, learners' performance would possibly be enhanced by way of mutual interactions and engagement in learning activities, followed by enhanced self-efficacy and learning motivation.

Facebook allows for personal interactions, group conversations, and community communication. Learning with Facebook is not the same as learning in a classroom or library, where learners' attention is distracted. To avoid distractions, learners can learn in a quiet corner. If they are stuck in a concept or problem in the learning process, they may then use Facebook to look for organizing partners, send text or voice messages, and resort for help. If they encounter more difficult problems, they may discuss the topic to make them clearer and easier to understand. They can also initiate group chat or post them on the forum to obtain the most extensive and effective advice and opinions on the topic. This online collaboration through Facebook is undoubtedly beneficial for learners and can surely improve learning outcomes.

It is important for learners to share their opinions and discuss difficult issues through Facebook. In the Internet age, it makes no sense to struggle with problems on learners' own. Otherwise, the next time when they come across a test or assessment, this problem tends to be still a threshold they haven't overcome or understood. Actively using Facebook and seeking help from peers and teachers will make problem solution easier and faster. In this way, learners' performance, as well as self-efficacy and motivation, will be improved. Opinion and problem sharing can also shorten the social distance between learners and make their relationships closer. Social presence will thus be enhanced in the Facebook-assisted learning process. This will possibly relax learners and cultivate a comfortable learning environment.

Facebook is certainly neither perfect nor omnipotent. Facebook-assisted learning can bring about a lot of obstacles in the learning period. The most obvious one is the distraction caused that can reduce learners' attention. They may discuss an issue or topic through active chatting, but then they have to restrain themselves from viewing other irrelevant information and distracting websites. Self-regulation is an important quality to learn through Facebook. They are expected to lock the mobile phone, tablet, laptop or even disconnect while the learning activity does not need them. They may also take effective measures to help them focus. For example, they may take feasible methods to stop from watching irrelevant videos, news or other irrelevant entertainment programs on Facebook. They may take a break when tired. They may also try to do something else to relax themselves and improve learning effectiveness.

Learners with stronger self-regulation or proper learning strategies can obtain significantly better learning outcomes than those with weaker self-regulation or improper learning strategies. If their self-regulation is not strong enough, Facebook may not bring benefits to their learning outcomes. The use of Facebook may distract them from learning activities. Learners should also use appropriate learning strategies and equip themselves with proper qualities, e.g. concentration and persistence, when they learn assisted with Facebook. The case of failure in Facebook-assisted learning may be caused by the lack of learning strategies and enough learning qualities. Designers and teachers could also consider both advantages and disadvantages of Facebook-assisted learning when they design the software and implement the teaching practice.

Another innovative way to improve Facebook-assisted educational outcomes is to fully immerse learners using virtual reality and online learning technologies. Since most learners can't afford to travel another country for weeks or even months at a time, virtual immersion provides the opportunity to realize this dream. Virtual reality simulations present real learning experiences across the world to learners with a simple click and learners can then obtain a sea of learning resources from each corner of the world. Through the online learning platform, learners can share learning experiences and deliver knowledge conveniently without the necessity to travel with heavy books and computers.

6. CONCLUSIONS

This concluding section includes major findings, limitations of the study, and implications for future research.

6.1 Major Findings

Generally, this meta-analysis concludes that the Facebook-assisted learning approach may improve learning outcomes in different countries or regions although there are still controversies. The controversies lie in different findings in Taiwan, Switzerland, and UK, where no significant results are revealed regarding the use of Facebook for educational purposes. Future research may include more high-quality studies written in varied languages via interdisciplinary research methods. Future research could also examine the effect of gratitude through Facebook on learning outcomes (Valdez et al., 2022), as well as the effects of gender (Yu & Yu, 2021), school year, and department variables (Tinmaz & Lee, 2021) on the use of Facebook for educational purposes.

6.2 Limitations

Although the research is rigidly designed, there are still several limitations. Firstly, the library source is limited and we cannot reach for all the resources. Secondly, we merely include peer-reviewed articles written in English. Those written in other languages are excluded. Thirdly, publication bias still exists, which may have caused random errors in the findings. Fourthly, there may be different scenarios in the countries or regions excluded from this study. This study cannot cover all of the countries or regions across the world, which may have limited the generalizability of the finding. Fifthly, this study did not examine technical challenges in the use of Facebook such as data inadequacy and time complexity (Liu et al., 2019). Finally, merely focusing on Facebook-assisted learning might not be considered as a dominant research in social media-assisted education as there are many other resources or platforms which have been utilized such as WeChat, Twitter, LinkedIn, Coursera, etc.

6.3 Implications for Future Research

This study indicates many aspects for future researchers to take into consideration in terms of online education. Future research could focus on the construction of a sustainable online learning model (Yu et al., 2022a) by considering the changes in student roles, digital literacy, learning achievements, and motivation (Yu, 2022a). Future research could also highlight the classic theory such as Community of Inquiry (Yu & Li, 2022) and the use of advanced technologies such as virtual reality in online education (Yu & Xu, 2022). In the future, researchers could examine gender differences in self-efficacy, satisfaction, motivation, attitude, and performance in online learning contexts (Yu & Deng, 2022).

Future research can also include other mobile applications such as MOOCs (Yu, 2021; Yu et al., 2022c), videos, Rain Classroom (Yu et al., 2023; Yu & Yu, 2021), and Superstar Learning System (Yu, 2022b). Researchers can analyze their utilizations, suggest the ways to address the current challenges these mobile applications brought about and propose a solution for future research and practice. Digital infrastructures may be an important factor that exerts an influential impact on the effectiveness and efficiency of mobile applications used for educational purposes. The design and interactions may be also essential components in mobile application-assisted education.

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