A Meta-Analysis of Facebook-Assisted Learning Outcomes and Their Gender Differences

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ABSTRACT

Social media applications such as Facebook have received wide attention in their use in education. However, it is still hard to arrive at a conclusion regarding whether a Facebook-assisted approach is effective in education and whether there are any significant gender differences in the learning outcomes. Based on rigid inclusion criteria, this study included 21 peer-reviewed high-quality journal articles. Through a meta-analysis using Reviewer Manager 5.3, the authors concluded that a Facebook-assisted approach could obtain significantly higher learning outcomes than the non-Facebook-assisted one with a medium effect size (d = 0.42) and that females could achieve significantly better learning outcomes than males with a very small effect size (d = -0.21) in the Facebook-assisted education. Future research could examine the effect of educational use of other social media applications, as well as in sociological, psychological, or educational dimensions.

KEYWORDS

Facebook, Gender Difference, Learning Outcome, Meta-Analysis

INTRODUCTION

Facebook could greatly help students and teachers when used in education. It could provide social and emotional support for students and promote interpersonal relationships via convenient interactions (Wu, 2012). It could also promote cooperation among students in learning, encourage peer discussions, cultivate critical thinking, and present their profiles, personalities, and preferences to form a cooperative learning atmosphere (Baek, Holton, Harp, & Yaschur, 2011). This comprehensive and instant sharing could complement the limitations of profile introduction in the traditional teacher-fronted learning situation (Pempek, Yermolayeva, & Calvert, 2009). Sharing of teachers' profiles could also increase their credibility and improve learning activities (Hew, 2011).

However, there are also numerous limitations to the use of Facebook in education. Facebook is designed primarily for the purpose of social interaction rather than education. Students and teachers

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mainly use it for communication, information sharing, and discussions instead of academic work (Davies, 2012; Grosseck, Bran, & Tiru, 2011). The reason why many students and teachers apply Facebook to education is that its functions realize collaborative learning and promote learning outcomes. Even, the serious games provided by Facebook could also facilitate and motivate students to engage in learning activities (Wu, 2012). Despite the globalization of online learning, designers still tend to keep consistent with national traditions (Rynning, 2021).

Although there have been numerous studies committed to Facebook-assisted education (e.g. Chang et al., 2017; Saini & Abraham, 2019; Sheeran & Cummings, 2018; Kimmons, Rosenberg, & Allman, 2021), it is still difficult to arrive at the conclusion regarding whether a Facebook-assisted approach is effective in learning and teaching. It is also hard to determine if there are no statistically significant gender differences in Facebook-assisted learning outcomes.

We proposed two research questions based on the previous literature, i.e. (1) what is the effect of the Facebook-assisted approach on learning outcomes? (2) Are there any statistically significant gender differences in Facebook-assisted learning outcomes?

THEORETICAL FRAMEWORK

We conducted the study under the theoretical framework of connected learning. A considerable amount of literature has been published on connected learning (e.g. (Esteban-Guitart, DiGiacomo, Penuel, & Ito, 2020; Vartiainen et al., 2019). In this study, the term "connected learning" that will be used refers to an activity, practice, or experience that bridges the gap between learner interests, motivation, achievements, and learning opportunities, which is supported by peer interactions (Esteban-Guitart, DiGiacomo, Penuel, & Ito, 2020). The connected learning could facilitate peer collaborative learning, improve learning interest, and promote learning effectiveness in either formal or extracurricular learning environments, enhancing students' competitive ability in the global market (Brown, Czerniewicz, & Noakes, 2016).

Acquisition of knowledge is a process needing connected and socially constructed information and behaviors (Piaget, 1971; Vygotsky, 1978). Without social connections and constructions, knowledge becomes isolated and independent blocks for students to absorb. When connected through social media applications, knowledge tends to be structurally and systematically organized. Students prefer the organized to the isolated knowledge. Social media applications such as Facebook, Skype, and Blogs could cultivate friendship-driven communities and connect learning behaviors, based on which learning interactions could emerge, coupled with improved student engagement in learning activities and better academic achievements (Nissinen, Vartiainen, Vanninen, & Pollanen, 2019). It is thus meaningful to examine the effect of Facebook use on learning outcomes. In this study, Facebook is considered a totally unique entity rather than learning environment. Thus, we did not categorize Facebook-assisted learning as one instance of a social learning platform that assembles a whole range of digital tools for communication and collaboration.

Social media and other mobile technologies could connect the environment with personalized learning, facilitate the learning flow, and improve learners' engagement, where gender could mediate the learning outcomes (Rodriguez-Ardura, & Meseguer-Artola, 2021). There is a gender gap in social media assisted connected learning and group work plays an important role in improving female participation in connected learning (Barksdale, Scharber, & Chang, 2020). Therefore, it is also appropriate to determine the gender differences in connected learning such as Facebook assisted learning.

Literature Review

This section will review the learning outcomes of Facebook-assisted education in terms of various dimensions, e.g., satisfaction, disclosure, pressure, social presence, interactions, motivation, self-regulation, and engagement, as well as the limitations.

Satisfaction, Disclosure, and Pressure

Facebook could greatly improve teacher-student interactions and provide plentiful learning resources for learners (Chen, 2018). It could also cause positive outcomes of physical activity, enhance positive psycho-social outcomes, and improve learners' satisfaction (Joseph et al., 2015). Higher disclosure of teachers through the Facebook website could improve students' motivation, affection, teacher credibility, and in-class learning atmosphere than the lower disclosure (Mazer et al., 2007). Facebook could act as an effective tool to provide students with more opportunities and reduce their pressure, improving English learning outcomes and improving learning attitude and motivation (Wang et al., 2017). Establishing Facebook groups could make course evaluation convenient and promote communication and learning effectiveness (O' Bannon et al., 2013).

Social Presence

The original definition of social presence is "degree of salience of the other person in a mediated communication and the consequent salience of their interpersonal interactions" (Short et al., 1976: 65). Later, it was defined as the sense of being together with another social being (Biocca et al., 2003). Social presence has caught researchers' attention in terms of social media application-assisted learning and teaching since then (Akcaoglu & Lee, 2018). With lower social presence, online education has been much criticized for its isolation (Veletsianos & Navarrete, 2012), leading to lower engagement and higher dropout rates. Social presence was positively correlated with learning motivation and learning outcomes. In other words, the more social presence learners have, the better learning outcomes they will achieve (Borup et al., 2012).

Social presence could predict learning outcomes and learner satisfaction (Sung & Mayer, 2012) and facilitate a sense of community especially in the online learning environment (Rovai, 2002). Facebook could connect independent individuals and distribute learning resources among them. Students could address difficult problems through discussion in a Facebook group and obtain a variety of learning resources through a Facebook bank. Students could apply Facebook to extracurricular learning activities and share different opinions through Facebook (Bowman & Akcaoglu, 2014). The use of Facebook could also improve cognitive and emotional interactions and academic collaborations (Veletsianos & Navarrete, 2012) by enhancing social presence of learners.

Social constructivists think that a social community could create community-based enquiry and practice and facilitate learning effectiveness (Chambers, 2019). Since the Community of Inquiry Framework attracted the attention of researchers (Garrison, & Arbaugh, 2007), it has been validated and developed towards new directions (Garrison, Anderson, & Archer, 2010).

Interactions

Social media applications such as Facebook could improve learning outcomes by promoting interactions. Based on situated learning theory, a learning activity can be classified into a socially related dimension (Greeno, Collins, & Resnick, 1996), where social interactions play an important role in either formal or informal learning outcomes (Lave & Wenger, 1991). In human society, the dominant interaction occurs between different human individuals. Interpersonal interactions are thus considered an important factor to foster a positive learning atmosphere and improve learning effectiveness (Rovai, 2002). Interactions may occur between peers, students and teachers, and learners and teaching materials. Student-teacher and peer interactions could increase learning motivation and facilitate the learning process (Offir, Lev, & Bezalel, 2008), as well as student satisfaction and attitudes towards learning experiences (Sung & Mayer, 2012). Positive satisfaction and attitudes could also improve learning outcomes in the interactive learning environment, especially assisted with social media such as Facebook.

Motivation, Self-Regulation, and Engagement

Based on the Self-determination Theory (SDT) proposed by Ryan & Deci (2000), learners might be autonomously motivated and self-regulated when their psychological needs were satisfied (Gorozidis, Yannis, Krommidas, & Papaioannou, 2020). The psychological needs include autonomy, competence, and relatedness. Learners could be autonomously and psychologically satisfied when they used Facebook to communicate with peers, friends, and colleagues, motivating and regulating them to engage in learning activities (Sheldon, 2008). Moreover, in the case that learners are familiar with the use of Facebook especially in learning, they may be motivated to communicate with peers for learning and engage in academic group discussions (Manca & Ranieri, 2013). This could also facilitate their learning competence and improve their satisfaction with learning outcomes via Facebook. They also tend to be greatly satisfied with the knowledge acquired through Facebook-assisted collaborative learning and the knowledge can in turn improve their technological affordances and professional skills (Armour & Yelling, 2007). Facebook is also integrated with functions for learning and communication, enabling learners to carry out portable and convenient learning.

Numerous studies have been devoted to psychological profiles of heavy Facebook usage. For example, "Big Five" personality traits were examined, where extraversion, neuroticism, self-esteem and narcissism were unrelated to Facebook use, while openness was able to facilitate interaction with peers in Facebook assisted learning (Skues, Williams, & Wise, 2012). Use of Facebook in education could improve some personality traces such as extraversion and narcissism, while reduce conscientiousness and social loneliness (Ryan, & Xenos, 2011).

Limitations

Although Facebook has been widely used in education, there are still several limitations to its use. Examples are privacy security issues, file transmitting limitations, and legal policy of information sharing. Other factors may influence the use of Facebook in education, e.g., technological affordance, pedagogical feasibility, social interactions, easiness of use, idea and resource sharing, communicative barriers, collaborative ability, and sociable skills (Manca & Ranieri, 2013; O'Bannon, Beard, & Britt, 2013). The learners with stronger sociable skills and higher technological affordance may be more successful users of Facebook than those with weaker sociable skills and lower technological affordance. Those with stronger sociable, communicative, and collaborative capabilities could also obtain more satisfactory learning outcomes than those with lower capabilities.

Hypothesis 1

Comprehensively considering the above literature review, we proposed the first null hypothesis, i.e., there is no significant effect of the Facebook-assisted approach on learning outcomes compared with the face-to-face traditional approach.

Gender Differences

Numerous researchers (e.g., Mazman & Usluel, 2011; McCarthy, 2010) have examined socio-cognitive differences, e.g., gender differences, in social media-assisted education and they have explored the role of gender in the use of social media applications in education. Frequent use of Facebook could reduce male self-efficacy in learning, while no significant changes were found among female students (Lin, 2018). Significantly more males did not think teachers should register on Facebook than females, while females believed that student-teacher relationship would change if students had access to teachers' profiles through Facebook (Prescott, 2014). With Facebook, female students could possess significantly more positive teaching presence, cognitive presence, and overall learning experience than male students (Kazanidis et al., 2018).

Hypothesis 2

Considering different findings in gender differences, we proposed the second null hypothesis, i.e., there are no statistically significant gender differences in Facebook-assisted learning outcomes.

Research Methods

This meta-analysis was generally carried out based on the Preferred Reporting Items for Systematic Reviews and Meta Analyses (PRISMA) (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). The research was not registered due to its characteristics and we obtained the waiver of registration from the academic review board. We broke down an initial number of potentially relevant articles of around 500 to only 21 based on inclusion and exclusion criteria, as well as University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003).

Literature Search

We searched, included, and excluded the literature based on the PRISMA framework. We obtained 592 results in Web of Science by keying in TITLE: (Facebook) and SUBJECT: (education), ranging from 2008 to 2020. Web of Science is a popular online database, including Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index- Science (CPCI-S), Conference Proceedings Citation Index-Social Science & Humanities (CPCI-SSH), Emerging Sources Citation Index (ESCI), Current Chemical Reactions (CCR-EXPANDED), and Index Chemicus (IC).

We included the studies based on a rigid procedure (Figure 1). We obtained 516 results after removing 76 duplicates. Then two researchers read abstracts, titles, and other key contents. Two researchers obtained 303 results after removing unrelated publications. Both of the researchers highly agreed with the screened results. we excluded those with lower quality or without full texts and obtained 90 full-text articles after excluding 213 results. We then assessed the full-text articles using University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003) and finally obtained 21 results after excluding 69 results (Inter-rater Cohen's kappa coefficient = 0.86) (Table 1).

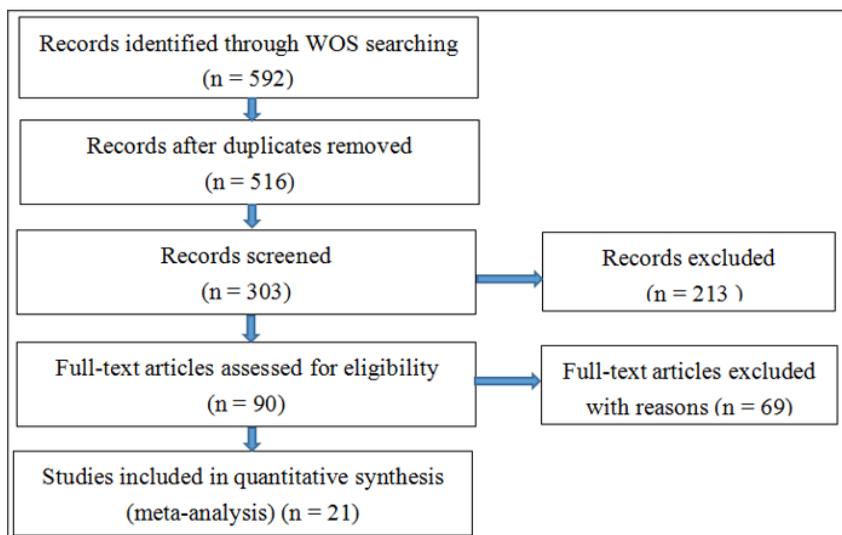**Figure 1. A flowchart of literature inclusion**

Table 1. A summary of selected literature

N	Author/publication year	Focus	Source
1	Gorozidis et al., 2020	Satisfaction, motivation, frustration, and self-efficacy	Taylor & Francis Group
2	Chen, 2018	Communication, content delivery, information exchange, resource sharing, and educational experience	
3	O'Bannon et al., 2013	Academic achievements	
4	Chang et al., 2017	Knowledge, awareness, self-efficacy, and skills	Elsevier ScienceDirect
5	Saini & Abraham, 2019	Learning achievement and engagement	
6	Joseph et al., 2015	Outcome expectations, self-regulation self-efficacy, and social support from friends and family	
7	Liu et al., 2013	Rapport, recommendation, impression, performance, and satisfaction	Springer
8	Wang et al., 2017	Preference, attitude, and motivation	
9	Prescott, 2014	Gender differences in attitudes towards the student-staff relationship in the use of Facebook	Sage
10	Barrot, 2020	ESL learners' writing performance e.g. task achievement, coherence and cohesion, lexical resource, grammar range and accuracy, and overall score	Taylor & Francis Group
11	Kazanidis et al., 2018	Teaching presence, cognitive presence, and overall learning experience	
12	Camus et al., 2016	Effects of Facebook on student participation, learning, and overall course performance	
13	Tufekci, 2008	Social grooming and presentation of the self	
14	Mazer et al., 2007	Motivation, affective learning, and classroom climate	
15	Boukes, 2019	More frequent use of Facebook decreases knowledge acquisition.	
16	Mazer et al., 2009	Participants accessing the Facebook website of a teacher high in self-disclosure had higher levels of teacher credibility than in lower self-disclosure.	
17	Akcaoglu & Lee, 2018	Students in Facebook groups positively evaluated social presence, learning interactions, and sociability.	
18	Liu et al., 2017	There was no significant difference between pre- and post-study quiz scores in Electrocardiogram training based on Facebook and Twitter.	Elsevier ScienceDirect
19	Lin, 2018	High Facebook addiction was associated with decreased self-efficacy for learning.	Springer
20	Sheeran & Cummings, 2018	Differences for students who had a course with a Facebook group (official or unofficial) compared to those who did not in terms of valuing, sense of belonging, and identity.	
21	Wang et al., 2012	Students were generally satisfied with the use of Facebook in pedagogy.	Wiley online library

Criteria for Study Inclusion

To obtain high-quality literature, we designed criteria for study inclusion consisting of seven points: (1) The study should adopt a quantitative research method or mixed methods; (2) The studies should be peer-reviewed journal articles; (3) The study should be written in English; (4) The study should focus on Facebook-assisted learning outcomes and their gender differences; (5) Participants of the study should be divided into treatment and control groups; (6) The study should report *mean, standard deviation*, and *the total number* of participants in both groups; (7) The study should pass the evaluation through University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003) (see Appendix). Two experienced professors cross-examined the quality of each article. Both of them agreed on all the included studies.

In cases where the data were incomplete, we attempted to obtain them by corresponding with the authors. If we failed to obtain the complete data, they were excluded from the study. Those written in languages other than English were excluded because of the limitation to researchers' knowledge and

library resources. We included only peer-reviewed journal articles and excluded books, dissertations, reports, and conference proceedings, etc.

Coding Of Included Studies

We coded the included studies for further analysis. The coded items include *author of the article, publication year, mean, standard deviation, the total number of participants* of both groups, *source of the literature, and the research focus*.

RESULTS

We entered the selected literature into Review Manager 5.3 with a view to conducting the meta-analysis.

Calculation of Effect Sizes

We calculated the effect sizes of the selected literature using the software Review Manager 5.3, where the standardized mean difference (SMD) or Cohen *d* was the indicator. The effect size will be classified into *very small* in case $d = 0.1$, *small* in case $d = 0.2$, *medium* in case $d = 0.5$, *large* in case $d = 0.8$, *very large* in case $d = 1.2$ and *huge* in case $d = 2.0$ (Sawilowsky, 2009). We used the formula to calculate the effect size, i.e., d = mean difference between the experimental (with Facebook) and the control (without Facebook) groups/the standard deviation of pooled results (Table 2). We also revealed the research results via forest and funnel plots according to the proposed null hypotheses:

H1: There is no significant effect of the Facebook-assisted approach on learning outcomes compared with the face-to-face traditional approach.

This research question attempts to identify the effect of the Facebook-assisted approach on learning outcomes through the forest plot of mean differences and the 95% confidence interval of the 21 articles (Figure 2). we used Review Manager 5.3 (2014) to compare the mean differences between the Facebook-assisted group (experimental group) and the non-Facebook-assisted group (control group). The non-Facebook-assisted group is considered a control group focusing on the face-to-face traditional approach. The horizontal lines in the right section of the forest plot indicate various ranges of different confidence intervals. There is a negative correlation between the width of the pooled diamond and the confidence interval. The vertical line in the middle of the right section is termed a no-effect line, meaning that in case the diamond touches it or passes the zero value, the result will be considered not statistically significant ($p > .05$).

The item I^2, ranging from 0% to 100% in value, decides the range of heterogeneity. If $I^2 < 50\%$, then the specific study will not be deemed as heterogeneous. We can meta-analytically review it using a fixed-effect model. On the contrary, if $I^2 > 50\%$, the study will be considered heterogeneous. We can then meta-analytically review it through a random-effect model. In this study, the value of I2 in this study is 94% ($p < .00001$), significantly higher than 50%. We, therefore, alternatively conducted the meta-analysis using a random-effect model.

The item "weight", an influencing power, means the extent to which a specific study influences the pooled result. The variable "weight" is calculated based on the formula: $W = 1/V$, where W indicates weight and V indicates the within-study variance if the fixed-effect model is adopted, while the within-study variance plus the between-study variance if the random-effect model is adopted. There is a positive correlation between the value of weight and the influencing power. In other words, the larger the value of weight is, the stronger the influencing power will be.

Via Stata/MP 14.0, we drew a funnel plot (Figure 3), a scatterplot of studies, to visualize the presence or lack of publication bias. The results are *mean differences* (MD) and the precision is the standard error of MD. Each dot of the plot stands for a specific study. The funnel plot has two

Table 2. Effect sizes (d)

Studies	*d*
The effect of the Facebook-assisted approach on learning outcomes	**.42**
Gorozidis et al., 2020	.15, .32, .36, .76, -.30, -.36, .48
Chen, 2018	-.26, -.36, .06, .06, .32, .12, -.13, .22, -.12, .30, -.07, .09
O'Bannon et al., 2013	1.87
Chang et al., 2017	-.03, .13, -.04, .01
Saini & Abraham, 2019	.53, 1.49, 1.11, 1.65
Joseph et al., 2015	.92, .38, 2.85, .22, .66
Liu et al., 2013	.78, .89, .68, .83, .58
Wang et al., 2017	1.12, .49, 1.17, 4.66
Barrot, 2020	.66, .64, .13, .52, .65
Camus et al., 2016	6.39, -13.51, -4.19, -2.95, 8.82
Tufekci, 2008	-.06, .19
Mazer et al., 2007	.17, .19, .13
Boukes, 2019	.80
Mazer et al., 2009	.60, .67, .47
Akcaoglu & Lee, 2018	1.35, 1.31, 1.13, 1.02, -.61
Liu et al., 2017	.34, .31
Sheeran & Cummings, 2018	-.08, .32, .28, .18, -.16, -.02, .25, .08, .02, .10
Wang et al., 2012	.27, .48, .27, .38, .59
Gender differences in Facebook-assisted learning outcomes	**-.21**
Kazanidis et al., 2018	-.87, -.80, -.66, -.69
Lin, 2018	-.17, -.13, .12, .52
Prescott, 2014	.52, -.47

dotted lines on either side of the middle line, representing 95% confidence intervals. The middle line indicates the overall effect from the meta-analysis. An ideal funnel plot is the one where the included studies have symmetrically scattered on either side of the overall effect line. Symmetry to either side as shown in Figure 3 may indicate the absence of publication bias (Egger's test coefficient = -1.14, SE = .68, t = -1.67, p = 0.099, 95% CI = -2.50, .22). A sensitivity analysis (Figure 4) indicates that the results of meta-analysis are stable since the meta-analysis estimates are all positioned between the lower and upper CI limits given a named study is omitted.

To address the effect of the Facebook-assisted approach on learning outcomes, we analyzed 18 studies and around 83 effect sizes (Table 2). We obtained a medium effect size (*d* = *.42*) in the studies on the effect of the Facebook-assisted approach on learning outcomes, with a 95% confidence interval of *0.28* to *0.56*. The pooled result did not touch the no-effect vertical line, nor did it pass through the zero value (mean difference = 0.43, range = 0.34-0.53). Therefore, the pooled mean of the treatment group is significantly larger than that of the control group at the *.05* level. This means that the use of Facebook may lead to significantly (*z = 9.18, p < 0.00001*) higher learning outcomes than non-use of Facebook, where females perform significantly better than males. We, therefore, reject the null

Figure 2. A forest plot of the effect of the Facebook-assisted approach on learning outcomes
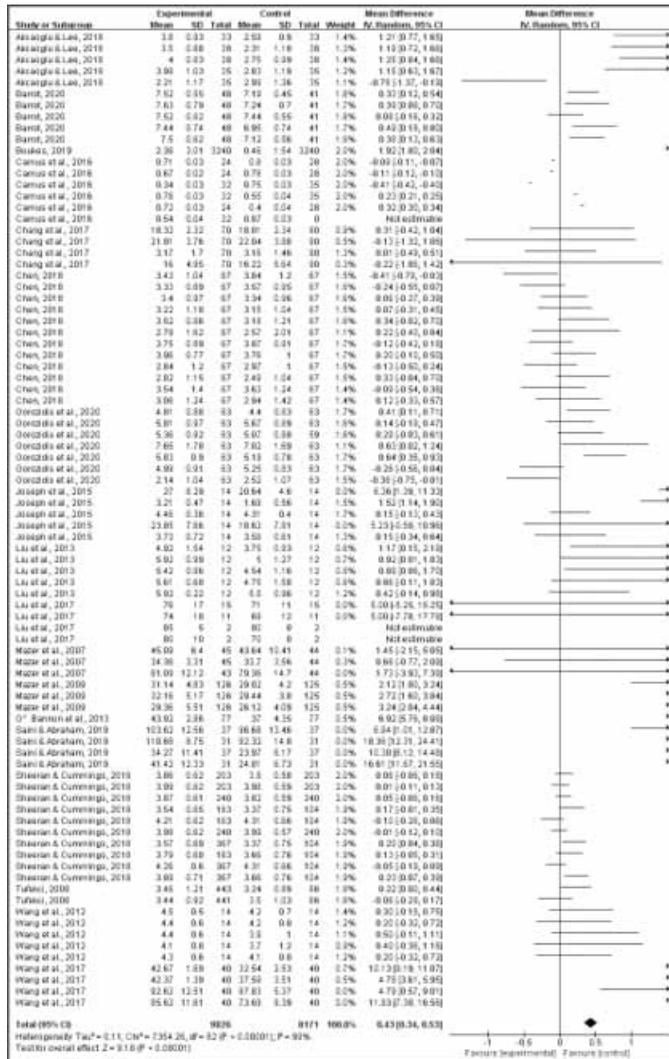
hypothesis that there is no significant effect of the Facebook-assisted approach on learning outcomes compared with the face-to-face traditional approach with a medium effect size *(d = 0.42)*.

H2: There are no statistically significant gender differences in Facebook-assisted learning outcomes.

"Gender differences in Facebook-assisted learning outcomes" is another examined subgroup in this study. Approximate symmetry to either side as shown in the funnel plot (Figure 6) indicates the absence of publication bias (Egger's test coefficient = -2.02, SE = 1.37, t = -1.47, p = 0.185, 95% CI = -5.26, 1.23). The results are considered stable since the all the meta-analysis estimates are located between the lower and upper CI limits given a named study is omitted (Figure 7).

Gender differences in Facebook-assisted learning outcomes are an important factor when we study the effect of social media on education. We included three studies and obtained nine mean differences from them (Figure 5). Under the fixed-effect model, I^2 is 84%, significantly larger than

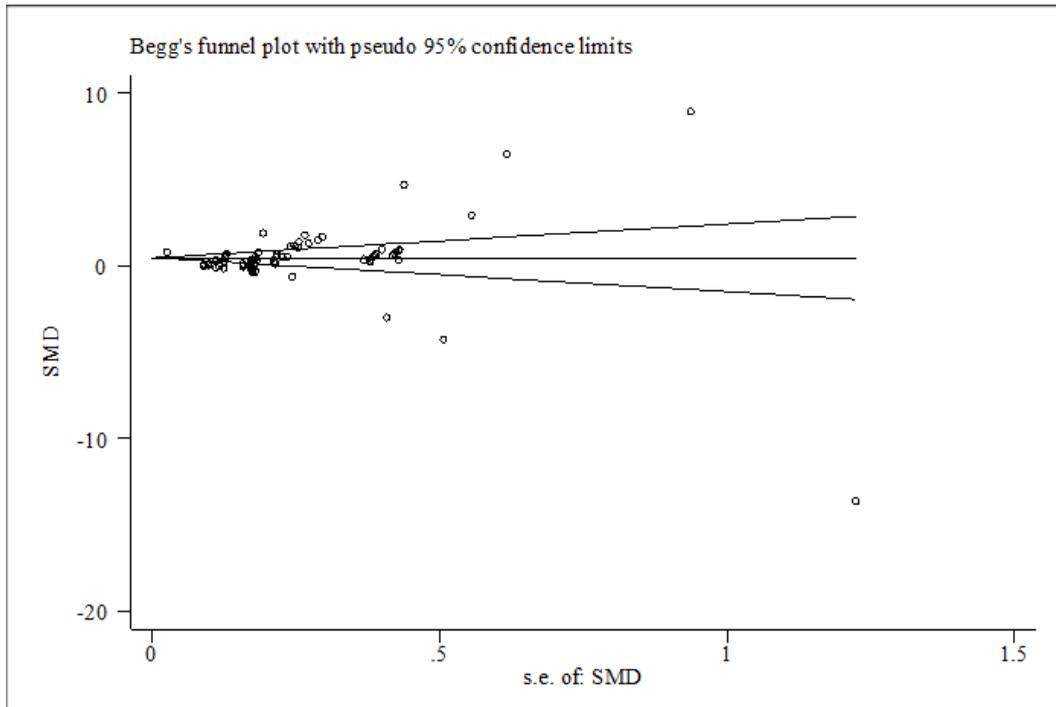**Figure 3. A funnel plot of the effect of the Facebook-assisted approach on learning outcomes**

Figure 4. A sensitivity analysis of the effect of the Facebook-assisted approach on learning outcomes
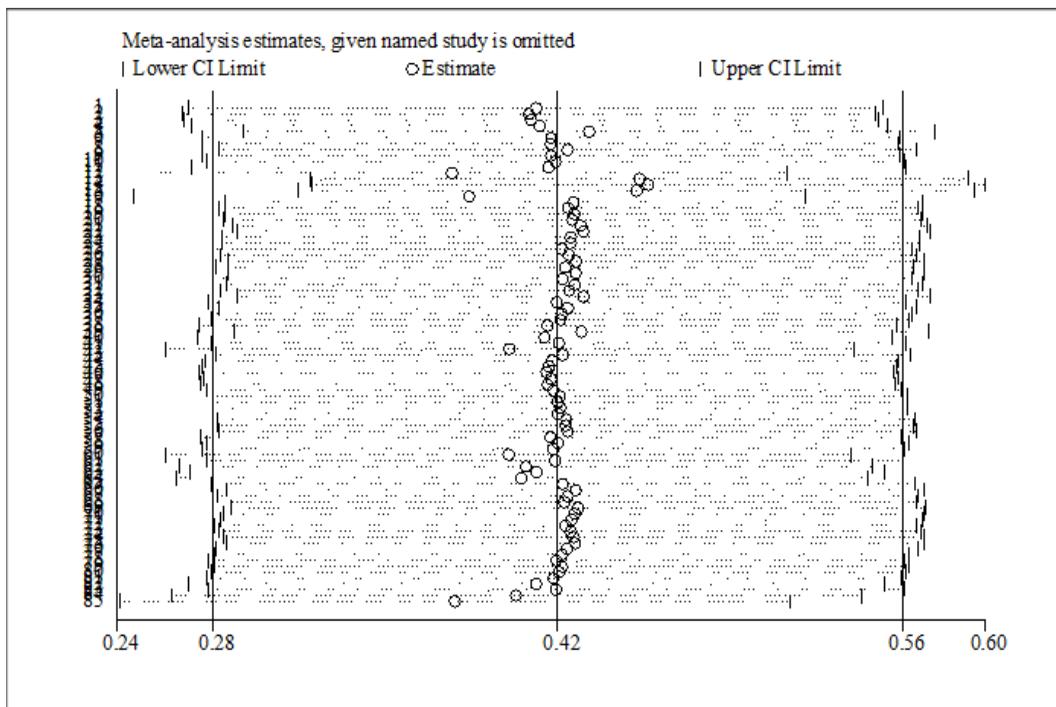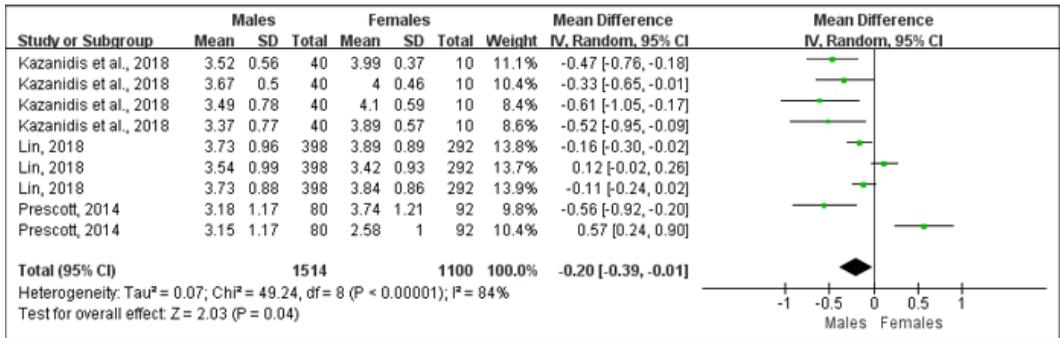
Figure 5. A forest plot of gender differences in Facebook-assisted learning outcomes

Study or Subgroup	Males Mean	SD	Total	Females Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Kazanidis et al., 2018	3.52	0.56	40	3.99	0.37	10	11.1%	-0.47 [-0.76, -0.18]
Kazanidis et al., 2018	3.67	0.5	40	4	0.46	10	10.4%	-0.33 [-0.65, -0.01]
Kazanidis et al., 2018	3.49	0.78	40	4.1	0.59	10	8.4%	-0.61 [-1.05, -0.17]
Kazanidis et al., 2018	3.37	0.77	40	3.89	0.57	10	8.6%	-0.52 [-0.95, -0.09]
Lin, 2018	3.73	0.96	398	3.89	0.89	292	13.8%	-0.16 [-0.30, -0.02]
Lin, 2018	3.54	0.99	398	3.42	0.93	292	13.7%	0.12 [-0.02, 0.26]
Lin, 2018	3.73	0.88	398	3.84	0.86	292	13.9%	-0.11 [-0.24, 0.02]
Prescott, 2014	3.18	1.17	80	3.74	1.21	92	9.8%	-0.56 [-0.92, -0.20]
Prescott, 2014	3.15	1.17	80	2.58	1	92	10.4%	0.57 [0.24, 0.90]
Total (95% CI)			1514			1100	100.0%	-0.20 [-0.39, -0.01]

Heterogeneity: Tau² = 0.07; Chi² = 49.24, df = 8 (P < 0.00001); I² = 84%
Test for overall effect: Z = 2.03 (P = 0.04)

50% (p < .002). Thus, the results are not homogeneous, and a fixed-effect model is not appropriate. Consequently, we switched to a random-effect model for meta-analysis. As shown in Figure 5, the pooled result for the mean differences of gender differences does not cross the no-effect vertical line and the confidence interval (Mean difference = -.20, ranging from -.39 to -0.01) does not go through the zero value. Thus, the result is statistically significant and the mean in the female group is significantly larger than that in the male group. There are significant gender differences ($z = 2.03$; $p = 0.04$) at the *.05* level in Facebook-assisted learning outcomes. We, therefore, reject the null hypothesis that there are no statistically significant gender differences in Facebook-assisted learning outcomes with a very small effect size ($d = -0.21$).

Figure 6. A funnel plot of gender differences in Facebook-assisted learning outcomes
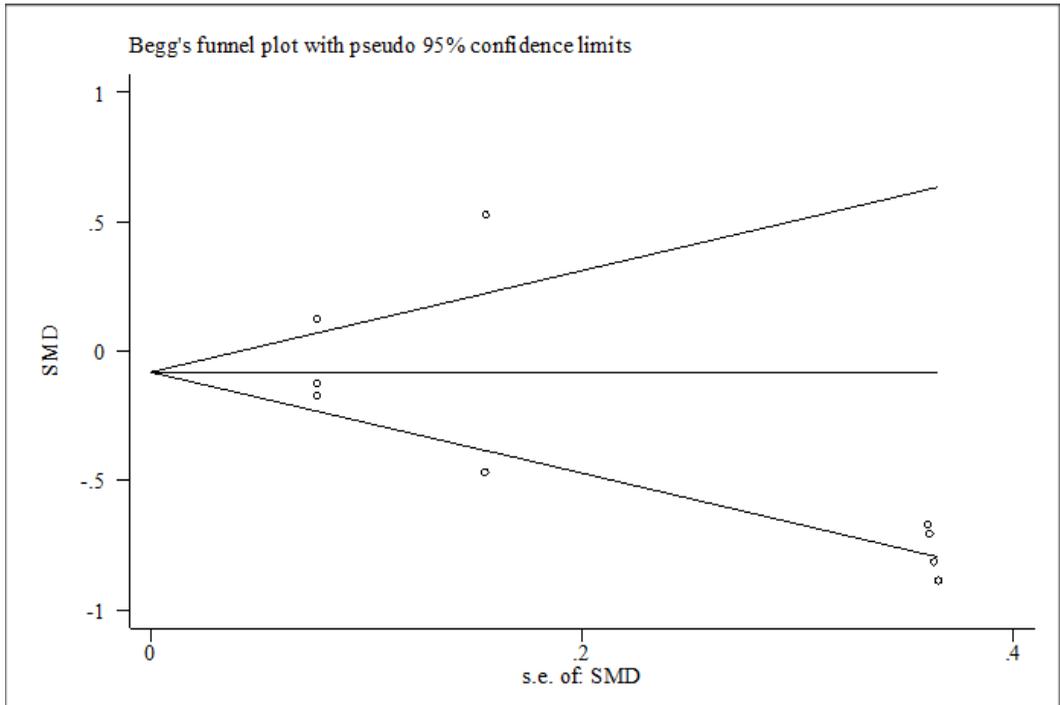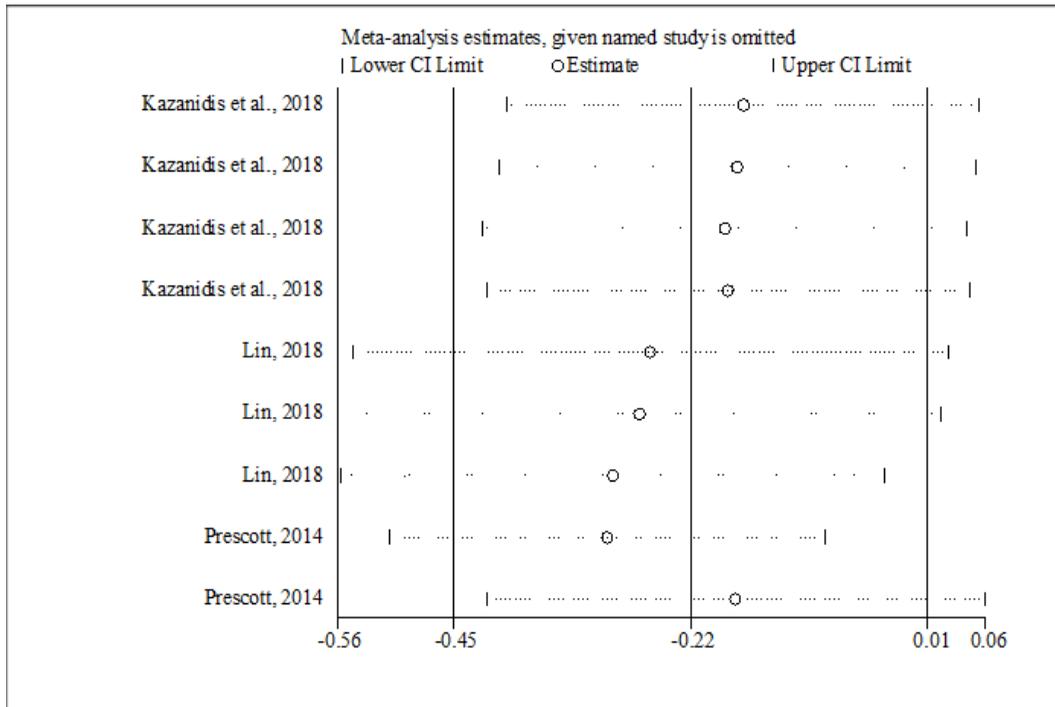
Figure 7. A sensitivity analysis of gender differences in Facebook-assisted learning outcomes

Discussion

The findings of this study are generally consistent with those of previous research. This study reveals a significant effect of the Facebook-assisted approach on learning outcomes and significant gender differences in them. Females perform significantly better than males in the Facebook-assisted learning approach. Female learners possessed a significantly higher degree of presence than their male counterparts in the educational use of Facebook (Kazanidis et al., 2018). This gender difference shows different attitudes towards the use of Facebook in education (Prescott, 2014). The findings are considered reliable because we included the studies and conducted the meta-analysis rigidly based on the framework of PRISMA.

The positive effect of Facebook-assisted learning approach is beneficial to the educational shift in this special COVID-19 pandemic time. Learners can stay home interacting with peers and teachers by using Facebook without running risks of being infected. They can also share learning resources, watch educational movies, discuss and address difficult issues, and improve learning outcomes using Facebook. Teachers can also deliver instruction notes and conduct teaching practice using Facebook. Learners can receive the instruction videos either synchronously or asynchronously at home. They do not need to carry heavy books and attend the physical classes running the risks of being infected.

The studies conducted by Saini & Abraham (2019) and Liu et al. (2017) have the lowest weight (0.0%), and thus both studies exert the least influence on the pooled result. By contrast, the studies authored by Camus et al. (2016) and Sheeran & Cummings (2018) have the highest weight (1.9-2.0%) and exert the strongest influence on the pooled result.

Similarly, the studies authored by Saini & Abraham (2019) and Liu et al. (2017) have the longest horizontal line (IV =5.0-18.36), and thus has the lowest reliability. The lines of the studies conducted by Sheeran & Cummings (2018) (IV = -0.01-0.23) and Camus et al. (2016) (IV = -0.41-0.32) are among the shortest. Thus, they are considered the most reliable studies.

There may be some limitations in the study authored by Saini & Abraham (2019). The researcher acted as the instructor for both groups, possibly leading to instructor bias. The sample size is relatively small (Total N = 68, N of experimental group = 31, and N of control group = 37), which might have caused sample bias, negatively influencing the results.

Nine results of effect sizes included in analysis of gender differences appear reliable since all of the horizontal lines are not too long, and their weights are also within an appropriate scope. The study authored by Kazanidis, Pellas, Fotaris and Tsinakos (2018), with high weights (8.6%-11.1%), adopted the most commonly accepted quasi-experimental design (Cohen, Manion, & Morrison, 2007: 283) in education to identify gender differences. It also adopted a mixed method where qualitative and quantitative research methods were integrated to foster valid and reliable results, to enrich the results, and to obtain a variety of data (Jick, 1979).

In Lin's study (2018), the randomly selected sample is large (N = 690) enough to represent the population and the male (N = 398; 57.7%) and female (N = 292; 42.3%) numbers are also balanced. The Chinese translation version of Andreassen et al.'s scale (2012) was adopted to measure Facebook addiction. The original version underwent both forward and backward translation and the translation was reviewed by Chinese-English professors. The scale, containing 18 items and evidenced valid and reliable, was designed by the University of Burgen (Andreassen et al. 2012). This study is thus considered rigidly designed, accounting for short horizontal lines in the forest plot and their strong reliability.

Prescott's study (2014) aims to examine teachers' attitudes towards the use of Facebook in education, as well as the influence of teaching style on the attitudes. The Principles of Adult Learning Scale was evidenced a valid and reliable instrument (Conti, 1982) and the sample reached a fair level of reliability ($\alpha = 0.871$). The researchers also ensured the validity of the survey by requesting for assessment of 10 colleagues. The researchers also adapted the questionnaire from well-founded sources (e.g., Garner, & O'Sullivan, 2010; Moubarak et al., 2011). The above may have supported the high reliability of the study authored by Prescott (2014).

The benefits and educational qualities of Facebook have made it a widely accepted tool used in education (Mazman and Usluel, 2010). For example, as a popular online technology, the Facebook group could act as a vehicle for medical formal curricula in educational institutes (Weber and Vincent, 2014). Facebook could facilitate learning among health professional students and connect their different learning stages (Usher et al., 2014). Facebook has been evidenced effective in the delivery of various academic resources and it could also improve learners' attitudes toward and the engagement in resident training (Galiatsatos et al., 2016). Facebook could also improve learning outcomes by enhancing social, cognitive, and teaching presence (Garrison et al., 2000). For example, in Facebook-assisted learning, awareness of medical safe use has been greatly enhanced in Australia (Benetoli et al., 2015).

While Facebook-assisted learning has led to many positive outcomes, negative findings still exist regarding its use. Frequent use of Facebook causes decline in knowledge of political issues especially for those who hold weak interest in politics (Boukes, 2019). Although Facebook could improve student engagement and promote peer interactions, it failed to more effectively encourage students to develop constructive discussions than a learning management system (Camus et al., 2016).

There are some limitations to the use of Facebook in education, e.g., privacy security issues and file sharing limitations (Gorozidis, Yannis, Krommidas, & Papaioannou, 2020). Users may hesitate to apply Facebook to learning since they worry about the leakage of their personal information during communication. There are also limitations to the size of shared files due to technical issues. This may limit the transfer of files of large sizes such as long videos and audios, leading to discouragement and frustration of students. The growing application of social media to education has led to numerous challenges such as financial support of educational institutes, e-infrastructure, resistance to transformation of the traditional pedagogy, difficulty in text formatting and reading, word typing and editing, and learners' training (Barrot, 2020). These challenges may result in negative effects such as higher drop rates, lower completion rates, and poorer learning outcomes.

CONCLUSION

This concluding section summarizes the major findings, reveals the limitations of this study, and proposes suggestions for future research.

Major Findings

This study found that using Facebook in education had a medium effect size for learning outcomes; in other words, students assisted with Facebook performed significantly better than those without the assistance of Facebook. Students' performance included a number of variables, e.g., satisfaction, motivation, frustration, self-efficacy, communication, content delivery, information exchange, resource sharing, educational experience, academic achievements, knowledge, awareness, skills, engagement, outcome expectations, self-regulation, social support, rapport, recommendation, impression, performance, and social presence, etc. Females perform significantly better than males in Facebook-assisted learning with a very small effect size.

Limitations

There are several limitations to this study. Firstly, the study included a limited number of peer-reviewed articles. Secondly, the study merely included articles written in English. Publications written in other languages are excluded. This might have caused publication bias. Thirdly, the effect size is very small for gender differences in Facebook-assisted learning. This may cause unreliable results. Fourthly, the literature search is limited to one database only based on title and subject. A search that includes the abstract would be more comprehensive. For example, the title might only mention social media, but the tools used might include Facebook. Aggregated databases such as Scopus and/or EBSCO Discover could be included in the future research.

Future Research Directions

Future research could include more high-quality peer-reviewed articles and more publications written in other languages except English. Future research could also examine the effect of educational use of other social media applications such as Twitter, LinkedIn, Pinterest, Instagram, and YouTube, as well as sociological, psychological, or educational dimensions.

Conflicts of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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APPENDIX: UNIVERSITY OF WEST ENGLAND FRAMEWORK FOR CRITICALLY APPRAISING RESEARCH ARTICLES (MOULE ET AL., 2003)

The Introduction

Is there a clear statement about the topic being investigated?
Is there a clear rationale for the research?

The Methods Section

Is the research design clearly described?
Are the research methods appropriate for the topic being investigated?
Are any advantages or disadvantages of the design acknowledged by the researchers?
Is there a clear statement about how the participants were selected?

Data Collection and Analysis

Is there a clear description about how the data was collected?
Was the data collected by appropriate people?
Is the approach to data analysis appropriate to the type of data collected?

Quantitative

Is there any explanation of sample size used?
Are the type of statistical tests used appropriate for the sorts of data collected?

Qualitative

Is the approach taken to data analysis clear?
Is there a clear statement about how the researcher validated interpretations?

Ethics

Is there a clear statement about ethical committee approval? Is there a clear description about gaining consent, maintaining anonymity and or confidentiality?

The Results/Findings

Are the results related back to the literature review?
Are the weaknesses in research design acknowledged?

Quantitative

Is the presentation of results clear and unambiguous? Are all the results presented?
Do the tables and charts used give a clear picture of the sample data and results?
If percentages are recorded, are actual numbers also clearly shown?
Are results of tests interpreted rightly?

Qualitative

Does the research present evidence of the data collected?
Does the data presented as part of a theme support the analysis suggested?
Is there a clear audit trail?

The Conclusions

Are the implications for further research acknowledged? Are areas for further research identified?
    Are further recommendations made for practice that come from the results/discussion?

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