ARTICLE

The Effect of Blended Instruction on Student Performance: A Meta-Analysis of 106 Empirical Studies from China and Abroad

Baomin Li,[1] Qing Yu,[1] Fenglei Yang[2]

1. *Faculty of Education, East China Normal University, Shanghai 200062, China*
2. *School of Computer Engineering and Science, Shanghai University, Shanghai 200444, China*

Abstract. *Blended instruction integrating off-line and on-line teaching has become an important instrument for promoting educational reform and innovation. However, the results of current empirical studies diverge on the effect of blended instruction on student performance, which necessitates further research on the effectiveness of blended instruction and related factors. This study, using an evidence-based meta-analytical approach, conducts a quantitative analysis of 106 experimental and quasi- experimental studies published from January 2000 to September 2021 in China and abroad, and systematically examines the effectiveness of blended instruction. The research finds that: i) The summary effect size (ES) of the included sample is 0.669 (n=142), indicating that blended instruction has above-moderate positive effects on student performance, especially on student learning motivation and academic emotions and attitude; ii) In terms of education levels, experimental periods and class sizes, blended instruction has the most significant positive effect on junior and senior secondary school students, on a teaching period from one to three months, and on a class size of 51 to 100 students; iii) Regarding the proportion and interactive patterns of online teaching, 50% composition of online teaching and synchronous or synchronous + asynchronous interaction exert the most significant positive effects on student learning. iv) Teaching methods including task-driven learning, role-playing, inquiry-based teaching, and case-based teaching have greater positive effects on student performance than other methods. Group study yields a greater effect on promoting student learning compared to individual study. Based on the findings, the present study also makes suggestions for the effective practice of blended instruction.*

Best Evidence in Chinese Education 2022; 10(1):1395-1403.
Doi: 10.15354/bece.22.ar018.

***How to Cite**: Li, B., Yu, Q., & Yang, F. (2022). The effect of blended instruction on student performance: A meta-analysis of 106 empirical studies from China and abroad. Best Evidence in Chinese Education, 10(2):1395-1403.*

***Keywords**: Blended Instruction, Blended Learning, On-Line Learning, Student Performance, Meta-Analysis*

***About Authors:** Baomin Li, Faculty of Education, East China Normal University, Shanghai 200062, China. E-mail: lbmlinda@126.com*

Qing Yu, Faculty of Education, East China Normal University, Shanghai 200062, China. E-mail: 2429560977@qq.com

***Correspondence to:** Fenglei Yang, School of Computer Engineering and Science, Shanghai University, Shanghai 200444, China. E-mail: flyang@shu.edu.cn*

***Conflict of Interests**: None.*

Introduction

BLENDED instruction, a combination of traditional face-to-face and online teaching, has prevailed worldwide since 2020. Through effective instructional design and technological application, it integrates the two teaching modes (Allen & Seaman, 2010; Garrison & Kanuka, 2004; Li & Zhao, 2004) and incorporates the advantages of both modes such as flexible learning time and space, easy access to and sharing of resources, and augmented interaction (Lock, 2006). It is regarded by some researchers as a critical instruction format in overcoming the limitations of traditional teaching and pure online learning (Schlager, Fusco, & Schank, 2002; Feng, Wang, & Wu, 2018). Feng, Sun, and Cao (2019) believe that blended instruction is an innovation in teaching reform; Garrison and Kanuka (2004) suggest that it provides educators with opportunities to re-examine and reconstruct teaching practice.

To evaluate the effectiveness of blended instruction, scholars have undertaken substantial research. The conclusions of their research vary and can be classified into the following three categories: 1) Blended instruction yields significant positive effects on the improvement of student performance; 2) There is no significant difference between blended instruction and traditional teaching; 3) Blended instruction is not as effective as traditional teaching. These conflicting results hinder the universalization of blended instruction.

In the context of the ongoing development of "Internet+" education and new educational requirements in the post-pandemic era, blended instruction tends to become the new normal mode of teaching (Porter et al., 2014). Given that some educational administrators and teachers cannot understand the role of blended instruction clearly with no idea how to reasonably configurate online learning and face-to-face instruction, and contradictory results exist in the current empirical studies of the effects of blended instruction, it is imperative to conduct a systematic study on this topic. A meta-analysis is a systematic quantitative synthesis of results from a series of independent studies under the same research topic (Lipsey & Wilson, 2001), which is effective in alleviating ambiguities and uncertainties in the findings of social sciences and prompting new scientific discoveries (Li & Qu, 2021).

Given this, the present study adopts evidence-based meta-analysis to examine the effect of blended instruction on student learning and its major moderating factors, such as the ratio of online teaching to face-to-face instruction and the sequence of the two components in blended instruction. It aims to answer the following questions: 1) How effective is blended instruction compared to traditional teaching? What effects does it have on the improvement of student performance in various dimensions? 2) How do the ratio of online teaching and sequence of online and offline teaching in the combination impact student learning? 3) What influences do teaching periods, education levels, and class sizes have on blended instruction? 4) What are the differences among various teaching methods and learning styles in blended instruction?

Research Design

Research Methods and Instruments

The present study extracts sample sizes, means, and standard deviations from related literature and integrates results from studies on the same research topic. The effects of blended instruction on student learning performance are measured by standardized mean differences (SMD), denoting effect sizes.

Research Processes

Literature Search

In search for relevant studies, the present study uses keywords including blended learning, blended instruction, hybrid learning, hybrid instruction, mixed mode learning, learning outcomes, learning effect, learning achievement, learning gains, learning performance, and academic achievement, and consult English bibliographic databases such as Web of Science, Google Scholar, ERIC, EBSCO, Science Direct and ProQuest. For literature in Chinese, the search is focused on CNKI's core-listed journals and CSSCI-indexed journals and keywords like blended instruction, blended learning, learning effect, learning outcomes, and experimental intervention. The included studies were published from January of 2000 to September of 2021.

Literature Screening and Inclusion Criteria

In the present study, the following criteria are applied to decide whether to include a study in the analysis: 1) aiming to investigate the relationship between blended instruction and student learning performance; 2) using experimental design, quasi-experimental design or any other form of empirical research in the investigation; 3) including experimental group and control group, with the former being intervened by blended instruction while the latter being spared of any interventions including pre-test and posttest; 4) providing complete data such as the sample size, mean, standard deviation, t-value, p-value or relevant coefficients to calculate the effect values.

Samples in this study are independent. When duplication or overlapping occurs among samples, the more detailed or the larger sample is selected. After screening, there remain 98 articles in English and 8 ones in Chinese. SMD is adopted in calculating effect value. As there is more than one effect size in some studies, finally 142 effect sizes are drawn. The experimental group consists of 7064 students and the control group 6733 students.

Literature Coding

Literature coding in this study covers author information, years of publication, sample sizes, education levels, disciplines, experimental periods, proportions of online teaching, teaching methods, online interactive patterns, and other contents. Education levels range from basic to higher education levels and disciplines here include most of the subjects in place at all education levels. An experimental period can be less than one week, less than one month, less than six months, or more than six months. The proportion of online teaching can be less than 30%, 31% - 49%, 50%, 51% - 70%, or 71% - 80%.

Data Analysis

To comprehensively examine the effect of blended instruction, we follow Cooper's (2009) analytical procedures and conduct data analysis using the software CMA 2.0. Through literature review, it is found that the effect of blended instruction on student performance is also correlated with miscellaneous factors such as subjects (students) of the research and learning content. When the results of the meta-analysis are affected by different qualities of literature, the random-effects model can make them more reasonable and scientific. Therefore, this study chooses the random-effects model as statistical model and confirms the appropriateness of random-effects model by heterogeneity test.

Research Results

The Overall Effect of Blended Instruction on Student Learning Performance

This study uses the standardized mean difference as effect value and the summary effect of 142 effect sizes is 0.669. Cohen (1992) prescribes that an effect size less than 0.2 means a weak effect, an effect size of around 0.5 signifies a moderate effect, and an effect size larger than 0.8 indicates a substantial effect. The results of analysis reveal that blended instruction yields an above-moderate effect on the improvement of student learning outcomes.

To further analyze the differences in the effects of blended instruction on student performance in various dimensions, this study investigates its impact on non-cognitive elements such as learning satisfaction, emotions and attitude, and learning motivation as well as on cognitive elements such as higher order thinking (like critical thinking and innovation mentality), academic achievements, and practical skills. A more concrete demonstration of the effects of blended instruction on student performance can be reflected in the following sequence (from strong to weak): learning motivation (SMD = 0.936) > emotions and attitude (SMD = 0.788) > higher order thinking (SMD = 0.764) > academic achievements (SMD = 0.696) > practical skills (SMD = 0.544) > learning satisfaction (SMD = 0.516). It shows that blended instruction most significantly improves student learning motivation and emotions and attitude; the positive effect of blended instruction on student critical thinking, innovation mentality and academic achievements is above moderate level; it also has moderate positive effects on student satisfaction and practical skills. The between-group effect value $p = 0.240 > 0.05$ is not statistically significant, indicating that there are no significant differences in the effect of blended instruction on student performance in different dimensions.

The Effects of Blended Instruction at Different Education Levels

The effect sizes at all education levels are consistently above 0.5. SMDs at senior secondary, junior secondary, higher education, primary, and adult education levels are

0.867, 0.758, 0.647, 0.566 and 0.565 respectively. The effect sizes at senior secondary and junior secondary levels are both above 0.75, indicating that blended instruction has significant positive effects on student performance at these two levels; the effect sizes at higher education, primary, and adult education levels are all above 0.5, showing the positive effects of blended instruction at these education levels are above moderate. The between-group effect value $p = 0.550 > 0.05$ shows no statistical significance and indicates that there are no significant differences in the impact of blended instruction on student performance at different education levels. Yet, it is worth noting that it has an exceptionally great positive effect at the senior secondary level.

The effects of blended instruction in different class sizes

Blended instruction can replace partial classroom teaching with online instruction and aids in alleviating the problems typical in teaching with large class sizes, such as low effectiveness and insufficient learning room. SMDs of class sizes of 51 - 100 students, 100 + students, 31 - 50 students and 1- 30 students are 0.752, 0.704, 0.663, and 0.562 respectively. The four effect sizes are all above 0.5, indicating that the positive effects of blended instruction in any of the four class sizes are above moderate level. The between-group effect value $p = 0.485 > 0.05$ shows no statistical significance and indicates that there are no significant differences in the effects of blended instruction in different class sizes.

The Effects of Blended Instruction of Different Teaching Periods

In this study, the experimental periods are classified into three groups, namely experimental periods of less than one month, one to three months, and more than three months. The effect sizes of blended instruction of the three periods are all above 0.5, indicating moderate positive effects. Among them, the experimental period of one to three months yields the most significant effect (SMD = 0.845), followed by the periods of less than one month (SMD = 0.705) and more than three months (SMD = 0.530). The between-group effect value $p = 0.017 < 0.05$ shows significant difference in the effects of blended instruction among different experimental periods, which reveals that teaching periods can moderate the effects of blended instruction.

The Effects of Blended Instruction under Different Teaching Methods

To investigate the impact of different teaching methods on the effects of blended instruction, this study codes and analyzes ten teaching methods, namely case-based teaching, task-driven learning, project-based learning, lecturing, role-playing, inquiry-based teaching, learning by discussion, peer instruction, Q & A teaching, and demonstrative teaching. Data analysis results show that the effect sizes of blended instruction under task-driven learning, role-playing, inquiry-based teaching, and case-based teaching are all above 0.8, indicating these four teaching methods have substantial positive effects on student learning performance; the positive effects of project-based learning, peer

instruction, and learning by discussion are above moderate level (SMD > 0.6); lecturing and demonstrative teaching have moderate positive effects on student performance; Q & A teaching (P > 0.05) shows no significant effect on student performance. The between-group effect value p = 0.121> 0.05 indicates that there are no significant differences in the effects of distinct teaching methods on student learning performance in blended instruction.

The Effects of Blended Instruction in Different Learning Organization Forms

This study codes and analyzes data of two learning organization forms, that is, group learning and independent learning. The effect sizes (SMDs) of them are 0.678 and 0.584 respectively, indicating that group learning is more effective than independent learning in blended instruction. The positive effect of group learning on student performance is above moderate level and that of independent learning is moderate. The between-group effect value p = 0.433 > 0.05 shows that distinct learning organization forms engender no significant differences in the effects on student learning performance.

The Effects of Blended Instruction with Different Proportions of Online Teaching

This study classifies the proportions of online teaching into five groups, namely lower than 30%, 30% - 49%, 50%, 51% - 69%, and 70% - 80%. The effect sizes of all five groups are above 0.3, basically indicating blended instruction with whatever proportion of online teaching exerts positive effects on student learning performance. SMDs of proportions of 50%, 30% - 49%, 51% - 69%, lower than 30%, and 70% - 80% are 0.792, 0.525, 0.468, 0.346, and 0.313 respectively. Blended instruction with 50% online teaching yields the most significant positive effect on student learning performance. Blended instruction with 30% - 49% and 51% - 69% online teaching has moderate positive effects on student performance. It is worth noticing that both the lowest proportion (lower than 30%) and the highest one (70% - 80%) produce the least significant effects. The between-group effect value p = 0.000 < 0.05 indicates that blended instruction with distinct proportions of online teaching has remarkably different effects on student performance.

The Effects of Blended Instruction with Different Sequences of Online Teaching and Face-to-Face Teaching

To investigate the effects of blended instruction with different sequences of online teaching and face-to-face teaching on student learning performance, this study summarizes five categories of sequences including “weekly alternation”, “weekly online + face-to-face teaching”, “online teaching followed by face-to-face teaching”, “face-to-face teaching followed by online teaching”, and “face-to-face teaching + online teaching + face-to-face teaching.” “Weekly alternation” is a sequence wherein on-line and

face-to-face teaching occur alternately by the week. In "weekly online + face-to-face teaching", both online and face-to-face teaching happen in every week. "Online teaching followed by face-to-face teaching", "face-to-face teaching followed by online teaching", and "face-to-face teaching + online teaching + face-to-face teaching" are sequences of the two components in the whole experimental period. SMDs for "face-to-face teaching + online teaching + face-to-face teaching", "online teaching followed by face-to-face teaching", "weekly online + face-to-face teaching", "face-to-face teaching followed by online teaching", and "weekly alternation" are 0.757, 0.718, 0.668, 0.649, and 0.363 respectively. With the largest effect size, "face-to-face teaching + online teaching + face-to-face teaching" has the most significant positive effect on student learning performance; the positive effects of "online teaching followed by face-to-face teaching", "weekly online + face-to-face teaching", and "face-to-face teaching followed by online teaching" are above moderate. The between-group effect value $p = 0.908 > 0.05$ indicates there is no significant difference in the effects of blended instructions with different sequences of online and face-to-face teaching.

The Effects of Blended Instruction with Different Teacher-Student Online Interactive Patterns

To investigate the effects of teacher-student online interactions on student learning performance in blended instruction, this study groups them into four patterns, that is, synchronous interaction, asynchronous interaction, synchronous + asynchronous interaction, absence of interaction. SMDs for synchronous + asynchronous interaction, synchronous interaction, asynchronous interaction, and absence of interaction are 1.189, 1.134, 0.521, and 0.130 respectively, which means that synchronous + asynchronous interaction and synchronous interaction have the most significant effects in promoting student learning performance while the positive effect of asynchronous interaction is moderate. The between-group effect value $p = 0.000 < 0.05$ indicates that there is significant difference in the effects of distinct teacher-student online interactive patterns on student learning performance.

References

Allen, I.E. & Seaman, J. (2010). Class differences: Online education in the United States. *The Slogan Consortium*. 15-25.

Cohen, J. (1992). A power primer. *Psychological Bulletin*,112(1):155-159.DOI: https://doi.org/10.1037/0033-2909.112.1.155

Cooper, H., Valentine, J.C., & Hedges, L.V. (2009). Handbook of Research Synthesis and Meta-Analysis. Russell Sage Foundation.

Feng, X.Y., Sun, Y.W., & Cao, J.T. (2019). Blended learning in the era of "Internet +": Foundation of learning theories and teaching methods. *Distance education in China*, 2019(2):7 -16 + 92

Feng, X.Y., Wang, R.X., & Wu, Y.J. (2018). Review of the status quo of research on hybrid teaching in China and abroad: An analytical framework based on hybrid teaching. *Journal of distance education*, 36(3):13-24.

Garrison, D.R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2):95-105.

Lock, J.V. (2006). A new image: Online communities to facilitate teacher professional development. *Journal of Technology and Teacher Education*, 14(4):663-678.

Lipsey, M.W., & Wilson, D.B. (2001). Practical meta-analysis. Thousand Oaks: SAGE Publications, Inc: pp1-10.

Li, K.D., & Zhao, J.H. (2004). Principles and application models of Blended Learning. *E-education Research*, 2004(7):1-6.

Li, X., & Qu, J.S. (2021, July 31). A review of the application and progress of meta-analysis in the field of Social Sciences. *Data Analysis and Knowledge Discovery*: 1-15. Retrieved from: http://kns.cnki.net/kcms/detail/10.1478.g2.20210722.0923.002.html

Porter, W.W., Graham, C.R., Spring, K.A., & Welch, K.R. (2014). Blended learning in higher education: Institutional adoption and implementation. *Computers and Education*, 2014(75):185-195. DOI: https://doi.org/10.1016/j.compedu.2014.02.011

Schlager, M., Fusco, J., & Schank, P. (2002). Evolution of an Online Education Community of Practice. In K. Renninger & W. Shumar (Eds.), Building Virtual Communities: Learning and Change in Cyberspace (Learning in Doing: Social, Cognitive and Computational Perspectives, pp. 129-158). Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511606373.010

The Chinese version of this article has been published in Open Education Research, 2022, 28(1):75-78. The English version has been authorized for being publication in BECE by the author(s) and the Chinese journal.

李宝敏, 余青, 杨风雷. (2022). 混合教学对学生学习成效的影响-基于国内外 106 篇实证研究的元分析. 开放教育研究，28(1):75-78.

Received: 15 February 2022
Revised: 27 February 2022
Accepted: 10 March 2022