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The effect of blended learning on student performance at course-level in higher education: A meta-analysis

Hien M. Vo[a,b,*], Chang Zhu[a], Nguyet A. Diep[a]

[a] Department of Educational Sciences, Vrije Universiteit Brussel, Belgium
[b] Graduate School, Can Tho University, Vietnam

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ABSTRACT

The present paper analyzes the impact of blended learning (BL) on the academic achievement of higher education students. A meta-analysis ($k = 51$ effect sizes) was conducted to perform a statistical synthesis of studies contrasting student performance in BL conditions with traditional classroom instruction. We include disciplines and instructors' end-of-course evaluation method as moderating variables. The results show that BL demonstrates a small summary effect ($g^+ = 0.385$, $p < 0.001$) compared to traditional teaching methods A significantly higher mean effect size was found in STEM disciplines ($g^+ = 0.496$) compared to that of non-STEM disciplines ($g^+ = 0.210$). Nevertheless, the weighted mean effect sizes reveal no significant differences regarding of end-of-course assessment methods, namely one-moment and multiple-component assessment. The finding confirms that BL is significantly associated with greater learning performance of STEM-disciplined students than with traditional classroom practice. Accordingly, discussion concerning the findings and implications for future research are elaborated.

1. Introduction

Around the turn of the twenty-first century, the term blended learning (BL) emerged as a new trend in teaching models and learning styles. Initially, BL was defined as "the mixture of e-learning and classroom learning" (Masie, 2006) by the training field, as a promising alternative to e-learning because of the limitations in terms of fostering "interaction, context, and remediation" (Masie, 2006) of the latter. Subsequently, Graham (2006) elaborates BL as a combination of face-to-face instruction and computer-mediated instruction. Considered as the "new normal" mode of training (Norberg, Dziuban, & Moskal, 2011), the effect of BL on student performance has been researched in different contexts, e.g. higher education, adult education, and workplace training. The results have shown a positive impact of BL (Larson & Sung, 2009; López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011), but questions remain unanswered as to the impact of BL on student performance as a function of disciplines, in higher education particularly, and methods of end-of-course evaluation. Answers to this question bear research and practical significance. First, there is an imbalance observed in studies on the effect of BL across disciplines, which results in the variation of the BL effect. Therefore, instructors and institutions may hesitate in introducing BL given the unknown effect for their respective majors. Bernard, Borokhovski, Schmid, Tamim, and Abrami (2014b) found a non-significant moderating effect of subject matter (STEM vs. non-STEM) and course level (undergraduate vs. graduate) on student learning in post-secondary settings. However, the results indicate that courses in STEM subject matters display a higher average effect size than non-STEM ones. Interestingly, subject matter was found to exert a moderating effect in Schmid et al. (2014) when levels of technology use were used to sub-divide the control condition, i.e. no technology and some technology use. Moreover, Schmid et al. (2014) found that non-STEM subjects revealed a higher effect size than STEM subjects when allowing for some technology used in the control condition. The findings from these two studies imply that further examination of the effect of subject matter is necessary given that mixed findings have been found. Also, Schmid et al. (2014) recommend that pedagogical approaches should be analyzed to provide more insights before we can come up with an explanation for the differences in the impact of BL in a variety of disciplines. In this respect, it is recognized that methods of end-of-course evaluation will have an effect on students' learning approaches and subsequently their performance (Struyven, Dochy, Janssens, Schelfhou, & Gielen, 2006). Previous meta-analyses, except one recently conducted by Spanjers et al.

* Corresponding author at: Department of Educational Sciences, Vrije Universiteit Brussel, Belgium.
E-mail addresses: mvo@vub.ac.be, minh.hien.vo@vub.be (H.M. Vo).

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(2015), have not addressed how different types of end-of-course assessment methods may moderate the effect of BL on students' learning outcomes. Therefore, the present study examines the effect of BL in comparison to traditional methods of teaching in higher education, taking into account the moderating effect of disciplines and end-of-course assessment methods. The objectives are two-fold: (1) to confirm the effect of BL in higher education contexts in which disciplines are diverse and more distinguished, and (2) to guide more pedagogical implications for higher education instructors in both disciplines.

2. Theoretical background

2.1. Blended learning

Graham (2006) posits that as a combination of traditional face-to-face instruction and online learning, BL allows for more interactive and reflective knowledge construction. Multi-format resources, archived discussions, instructors' changing role as facilitators, and more time and scaffolding for discussion and reflection in this learning mode have been augmented by technologies (Mebane, Porcelli, Iannone, Attanasio, & Francescato, 2008). As a learning approach, Köse (2010) proposes that "Blended learning is a learning approach that contains different types of education techniques and technologies" (p.2795). This means that the nature of BL greatly depends on what instructional design aims to achieve. According to Graham and Robinson (2007), if the goal is to increase access and convenience, the use of technologies merely helps to alleviate space and time barriers. However, when student interactiveness and improved pedagogy are the focus, it is expected that a student-centered approach coupled with frequent online interaction and feedback is more evidenced than just using the online learning platform as a communication channel. Despite the differences in BL conceptualization, researchers in the field take BL as an innovative approach to optimizing student learning (Köse, 2010). On the one hand, the approach provides students with a more efficient learning environment where they can have more interactions and learning support with the availability of online learning facilities (Köse, 2010). On the other hand, it is believed that BL can enhance the quality of face-to-face meetings (seat time) provided that students can benefit from the online learning activities and resources (Köse, 2010).

To conceptualize and effectively operationalize BL for the purpose of their meta-analysis, Bernard, Borokhovski, Schmid, and Tamim (2014a); Bernard et al. (2014b) define BL as a "mix of classroom instruction (i.e., face-to-face) and out-of-class online learning where the online work substituted for class time" (p. 91). In this study we adopt Bernard et al. (2014a), Bernard's et al. (2014 b) definition of BL and Allen and Seaman's (2009) recommendation for the configuration of the proportion of the blends such that the course content delivered online ranges between 30 percent and 79 percent. The lower end of the range is sufficient to eliminate studies "of incidental uses of the Internet, such as downloading references and turning in assignments" (Means, Toyama, Murphy, & Bakia, 2013, p.5) and to differentiate BL from pure online learning (Allen & Seaman, 2009).

2.2. STEM and non-STEM disciplines categorization

According to Schommer-Aikins, Duell, and Barker (2003), the difference between hard and soft disciplines is that researchers working in the former discipline have a commonly accepted paradigm that guides their research methodology and basic concepts. Put another way, the advancement in disciplinary understanding relies on "established facts and demonstrable theories rather than uncertainties and relativities" (Neumann, Parry, & Becher, 2002, p. 407). On the contrary, knowledge-building in the soft discipline has a spiral configuration (Bruner, 1967, as cited in Neumann et al., 2002) and thus course structures are less hierarchical. As a result, soft-disciplined researchers accept diversity regarding conceptualizations and research methodologies. Therefore, discipline differences initiate the need for the instructors to use different teaching approaches. It is plausible to hypothesize that BL's effect on student performance will be

Table 1
Course categorization based on STEM and non-STEM disciplines.

STEM-discipline (n = 30)	Non-STEM discipline (n = 20)
Accounting Information Systems	Business and Management
Algebra	English as a second language
Basic Sciences	Introduction to Social Sciences
Biochemistry	Introductory Psychology
Chemistry	Islamic culture
Computer Networks and Communication	Nursing (Electrocardiography)
Dentistry (Introductory Radiology)	Nursing (Foundations of Nursing)
Descriptive Anatomy	Physical Education
Engineering (Nonlinear Equations and Interpolation)	Principles of Microeconomics
General Accounting	Wellness
General Health	
Health Sciences (Health Care Delivery System)	
Human Anatomy	
Human-Computer Interaction	
Introduction to Biology	
Introduction to Probability Theory	
Introduction to Software Engineering	
Introduction to Symbolic logic	
Mathematics Content and Methods for the Elementary School	
Multimedia Applications	
Multimedia Design and Production	
Numerical methods	
Orthodontics	
Program Development Models	
Public Health	
Statistical Methods for the Life and Health Sciences	