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Technology-supported management education: a systematic review of antecedents of learning effectiveness

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Abstract

This paper provides a systematic, multidisciplinary review of antecedents of the effectiveness of technology-supported management learning and highlights potential directions for future research. Passive knowledge acquisition in physical classrooms is no longer the hallmark of higher education. Instead, the introduction of new technologies allows for active knowledge construction in increasingly virtual spaces. Such changes in the learning environment affect the education of the managers of tomorrow. Nevertheless, research on technology-supported management learning and its implications for management educators is fragmented and inconsistent across research areas. This paper uses a systematic approach to structure and integrate results from the fields of educational psychology, educational technology, higher education, and management education. This allows us to derive a comprehensive overview of the antecedents of the effectiveness of technology-supported management learning from the various disciplines. Our work reveals several areas that require further investigation, including: (i) the best way to blend and flip formats for different management disciplines and content types, (ii) the selection, design, and richness of the technologies used, (iii) the instructor's teaching style, including feedback and deliberate confusion, and (iv) learners' affective states, such as their motivations and emotions, and the role of prior knowledge.

Keywords: Educational technology, Learning effectiveness, Management education, Systematic review

Introduction

Technology has reshaped management education—in contrast to the traditional format of passive knowledge acquisition in synchronous and analog classrooms, much of management education now involves active knowledge construction in increasingly asynchronous and virtual learning spaces (Arbaugh, 2000c; Garrison & Kanuka, 2004). The formerly prevalent *objectivist model* of learning assumes that there is an objective reality that can be transferred, which supports the traditional lecture format (Leidner & Jarvenpaa, 1995). In contrast, the *constructivist model* of learning posits several representations of reality, and assumes that students learn better when they construct knowledge themselves by actively engaging with and making sense of information (Arbaugh & Benbunan-

Fich, 2006). The constructivist model is typically facilitated by technology. Sun, Tsai, Finger, Chen, and Yeh (2008) thus regard technology-supported management learning as the "paradigm of modern education."

This technological penetration of management education has triggered a substantial amount of research into management learning beyond the traditional classroom (Arbaugh, 2014; Arbaugh & Duray, 2002; Redpath, 2012). Both conceptual and empirical work has been conducted in various disciplines. For instance, research has emerged in the fields of *educational psychology* (Leutner, 2014; Mayer, 2002; Moreno & Mayer, 2007; Park, Plass, & Brünken, 2014), *educational technology* (Alavi, 1994; Evans, 2008; Piccoli, Ahmad, & Ives, 2001; Selim, 2003, 2007; Sun et al., 2008), *higher education* (Liu, 2012; O'Neill & Sai, 2014; Snowball, 2014; Xu & Jaggars, 2014), and *management education* (Alavi & Gallupe, 2003; Arbaugh & Benbunan-Fich, 2006; Arbaugh, DeArmond, & Rau, 2013). According to Arbaugh et al. (2009), "the volume and quality of research in online and blended business education has increased dramatically during the past decade."

However, the different research areas pursue different objectives and approaches. For example, educational psychologists, on the one hand, tend to follow a *learner-centered approach*: They investigate how learning occurs through the human cognitive architecture and they propose technical applications to facilitate related processes. Educational technology scholars, on the other hand, take a *technology-centered approach* in which they suggest pushing technological innovations into the classroom while expecting learners to adapt (Mayer, 2002). Moreover, the extant research shows that some antecedents of technology-supported management learning have similar effects across disciplines, while others lead to contradictory outcomes. Thus, the current state of the literature is highly fragmented and partially inconsistent. No literature review that integrates findings from the various fields, much less one with a dedicated focus on management education, is available.

Therefore, this paper addresses the widespread academic discourse on technology-supported management learning by systematically investigating the antecedents of that learning. As Buttner and Black (2014) note, "no single learning theory accounts for all aspects of learning." Thus, we contrast and integrate prevailing concepts from educational psychology and educational technology research with central themes in the management education and higher education literature. In addition, this paper enriches established theories with more recent research topics, such as confusion and emotions (D'Mello, Lehman, Pekrun, & Graesser, 2014; Dindar & Akbulut, 2016; Knoerzer, Bruenken, & Park, 2016).

Our paper makes two contributions. First, by conducting a systematic, interdisciplinary review of the extant literature, we integrate the dispersed knowledge on the antecedents of the effectiveness of technology-supported management learning from the various disciplines. Second, we critically reflect on conceptual and empirical findings from prior work, and we derive an agenda for future research based on the identified commonalities, inconsistencies, and research gaps. On this basis, we encourage scholars to explore different ways of blending and flipping management learning environments to identify the ideal instruction formats for the different management disciplines and content types. This includes an in-depth study of the impact of collaboration and interaction. In addition, we ask researchers to examine different technology applications and related features to more systematically and effectively select and design learning

technologies. We also emphasize the importance of additional research on instructors' teaching styles in technology-supported management education, as instructors continue to play a critical but changing role. This examination includes feedback and deliberate confusion. Moreover, we call for more research on the prior knowledge and affective states of learners, particularly regarding motivation and emotions, which are still under-researched but can be expected to play an important mediating and/or moderating role in learning outcomes.

Background on the research topic

Management education research is a subdiscipline of the business sciences. According to Arbaugh and Hwang (2015), it can be defined as "formal business and management education learning in the context of higher education in academic institutions." Even though precursors of the *Journal of Education for Business* date back to 1928, today's predominant publication outlet, the *Academy of Management Learning and Education*, only came into existence in 2002. The most-cited articles in this field were published during the last 20 years (Arbaugh & Hwang, 2015). Hence, management education is an emerging research area.

One stream of research in the management education literature investigates the importance of information technologies and attempts to bring them into the management learning space (Arbaugh, 2000b; Arbaugh & Duray, 2002). Publications include narratives by instructors, examinations of learner perceptions, and experiments with different formats and technologies. Experimental conditions range from technological advances in traditional lectures (Alavi, 1994) to flipped environments (Lancellotti, Thomas, & Kohli, 2016) to full online programs (Eom, Wen, & Ashill, 2006). Given the limited history of the field of management education (Arbaugh & Hwang, 2015) and the lack of dedicated scholars of management learning and education (Arbaugh, 2016), the respective studies build on research from related disciplines, such as educational psychology (Mayer, 2002; Moreno & Mayer, 2007), education technology (Selim, 2007; Sun et al., 2008), and higher education (Liu, 2012; Snowball, 2014).

Educational psychology research follows a *learner-centered approach* (Mayer, 2002). It assumes that the human system for information processing remains constant in different learning environments (Mayer, 2003). Therefore, educational psychologists study how learning occurs in the human cognitive system, explore the cognitive processes behind selected learner characteristics, and propose technical applications to facilitate these processes. Research results indicate that cognitive and affective factors, such as learner attitude (Scheiter & Gerjets, 2007), motivation (Mayer, 2014), metacognition (Moreno & Mayer, 2007), and emotions (Leutner, 2014), as well as prior knowledge (Seufert, 2003) are important for learning effectiveness independent of the learning environment. These learner characteristics can partially be influenced by the instructor's teaching style, guidance and feedback behavior (D'Mello et al., 2014; Mayer & Moreno, 2003; Park, Moreno, Seufert, & Brünken, 2011).

Educational technology research, on the other hand, follows a *technology-centered approach*, which attempts to bring technological innovations into the classroom, while learners are expected to adapt (Mayer, 2002). It primarily examines the role of technology characteristics based on the *technology acceptance model (TAM)* developed by Davis (1986) and the *task-technology fit (TTF)* proposed by Goodhue and Thompson

(1995). Frequently analyzed factors resulting from these concepts are perceived ease of use, perceived usefulness, technology quality, technology reliability, and technology richness (Huang, 2014; McGill & Klobas, 2009; Selim, 2003; Song, Singleton, Hill, & Koh, 2004). The effects of these technology characteristics are further differentiated based on learner characteristics, such as demographics, prior experiences, and motivation (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011; Woo, 2014), instructor characteristics, such as attitude, control over the technology, and teaching style (Selim, 2007; Webster & Hackley, 1997), and format characteristics, such as flexibility, interaction, and assessment diversity (Concannon, Flynn, & Campbell, 2005; Sun et al., 2008).

Higher education research on technology-supported learning environments builds on these two approaches and examines learners' perceptions and their engagement with different formats of instruction, i.e., different levels of technology use in higher education (Carini, Kuh, & Klein, 2006; Ituma, 2011; Zhao & Kuh, 2004). This includes an investigation of the opinions of learners who are in favor of or against technology-supported learning (O'Neill & Sai, 2014; Snowball, 2014). Furthermore, scholars examine the impact of different learner characteristics, such as demographics, motivation, and learning approaches (Haggis, 2009; Xu & Jaggars, 2014), format characteristics, such as flexibility and community (Reed & Reay, 2015; Zhao & Kuh, 2004), and technology characteristics, such as technology selection and quality (Kintu, Zhu, & Kagambe, 2017). In addition, higher education research places particular emphasis on student engagement (Carini et al., 2006; Ituma, 2011).

Across these disciplines, online activity (Asarta & Schmidt, 2013; Fritz, 2011), technology self-efficacy (Piccoli et al., 2001; Webster & Hackley, 1997), cognitive processing (Mayer, 2003; Mayer & Moreno, 2003), perceived learning (Arbaugh, 2000a; Evans, 2008), test performance (Arbaugh, 2000c; Krentler & Willis-Flurry, 2005), satisfaction (Concannon et al., 2005; Wu, Tennyson, & Hsia, 2010), and dropout rates (Deschacht & Goeman, 2015; López-Pérez et al., 2011) are commonly used as measures of effectiveness.

The brief overview of research activities in the fields of management education, educational psychology, educational technology, and higher education highlights that the antecedents of technology-supported management learning effectiveness can be classified into four dimensions: *learner, instructor, format,* and *technology* characteristics. These dimensions are illustrated in Fig. 1 and serve as the basis for our work.

Methodology

The search for relevant literature was carried out in three steps as illustrated in Fig. 2. First, we identified potentially relevant publications through a database search and

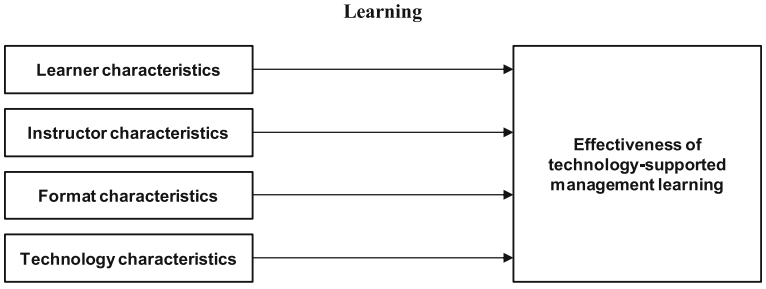

Fig. 1 Dimensions of Antecedents of Effectiveness of Technology-Supported Management Learning

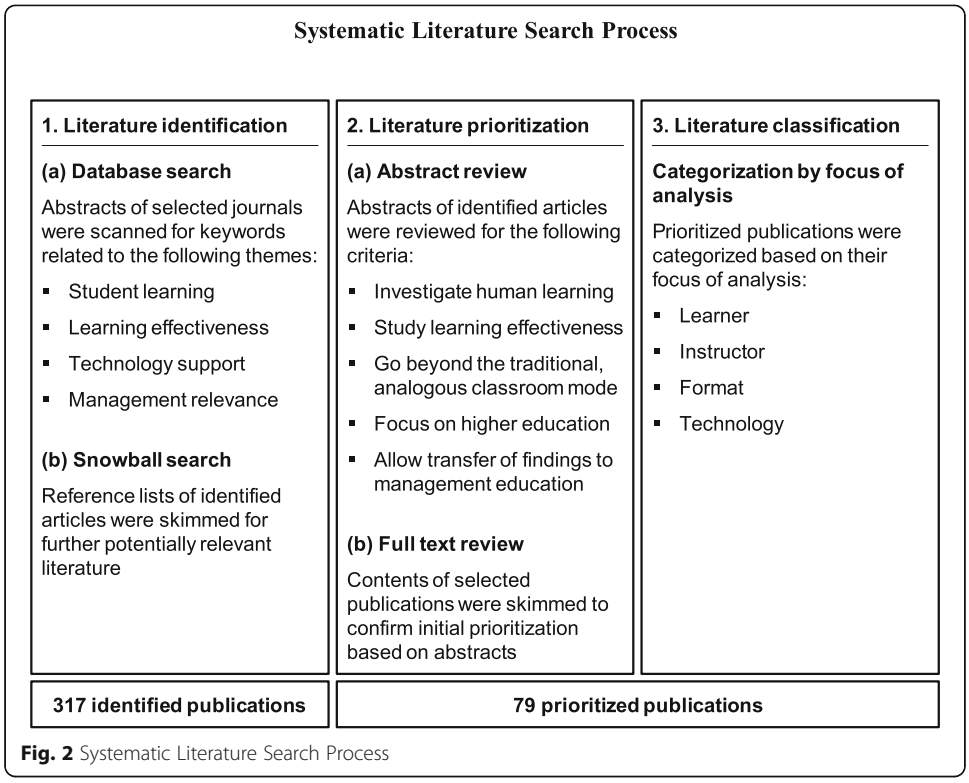

Fig. 2 Systematic Literature Search Process

snowballing. Second, those publications were prioritized by skimming abstracts and full texts. Third, prioritized publications were classified according to their analytical focus.

In the first step, we conducted a keyword search for leading peer-reviewed publications to ensure the relevance and quality of potential sources. We searched the *EBSCO Academic Search Premier* and *EBSCO Business Source Premier* databases for the following journals in the educational psychology, educational technology, higher education, and management education fields: *Academy of Management Learning and Education, British Journal of Educational Technology, Computers and Education, Decision Sciences Journal of Innovative Education, Educational Psychologist, Educational Psychology Review, Educational Technology Research and Development, Higher Education, Information Systems Research, Innovative Higher Education, International Journal of Management Education, Internet and Higher Education, Journal of Computer Assisted Learning, Journal of Education for Business, Journal of Educational Psychology, Journal of Educational Technology and Society, Journal of Higher Education, Journal of Management Education, Learning and Instruction, Management Learning, MIS Quarterly, Research in Higher Education,* and *Studies in Higher Education*. We then searched the abstracts in these journals for keywords related to student learning (i.e., education, learner, learning, student), learning effectiveness (i.e., achievement, effective, effectiveness, outcome, performance, success), technology support (i.e., computer, digital, electronic, internet, multimedia, online, technology), and management (i.e., accounting, business, economics, finance, management, marketing). Literature with abstracts containing any of the following terms was excluded, as it typically does not focus on technology-supported management education: children, knowledge management, machine learning, organizational learning, school. In addition, we searched the reference

lists of the identified articles to uncover any frequently cited scholars and publications that had not yet been found. We repeated this process several times. A total of 317 potentially relevant publications were identified.

In the second step, the abstracts of the identified publications were reviewed to determine whether the findings were related to this paper's objective. Papers had to meet five criteria for inclusion in our review: investigate human learning rather than organizational learning, study learning effectiveness, go beyond the traditional lecture mode to take technology support into account, focus on higher education situations in which management is taught, and enable a transfer of findings to management education if the findings were not already related to management. If the abstracts appeared to indicate that the focal paper was insufficient for evaluation, full texts were searched. As a result, we selected 79 publications for this review.

In the third step, the selected publications were classified for a detailed review. Based on their analytical focus, the articles were assigned to one or more of the previously identified dimensions of antecedents of the effectiveness of technology-supported management learning: *learner, instructor, format,* and *technology*. The selected publications and their key findings are listed in Table 1.

Antecedents of effectiveness of technology-supported management learning

Technology characteristics

The integration of technologies into learning environments has been studied for about 30 years. Davis (1986) developed the first version of the *technology acceptance model (TAM)* to examine antecedents of a technology's acceptance. He proposed that the capabilities of a technology trigger learners' motivation to use it, which in turn leads to actual use. More specifically, the features of a technology are assumed to affect *perceived ease of use* and *perceived usefulness*, which then affect attitudes toward using that technology and, thus, actual use. Although this model is not explicitly tailored to learning, it has evolved as a basis for educational technology research. Several studies of technology-supported management learning show that perceived ease of use and perceived usefulness affect satisfaction but do not directly predict perceived learning (Arbaugh, 2000a, 2000b; Huang, 2014). Terpend et al. (2014) find that perceived ease of use predicts technology adoption. Selim (2003) also provides evidence that perceived ease of use and usefulness predict technology acceptance, and reveals that ease of use is mostly mediated by usefulness. Sun et al. (2008) conclude that ease of use enables e-learners to focus on the content rather than the technology.

Goodhue and Thompson (1995) introduce *task-technology fit (TTF)* and argue that "for an information technology to have a positive impact on individual performance, the technology must be utilized and must be a good fit with the tasks it supports." Related antecedents of technology-supported management learning effectiveness that are frequently analyzed include *technology quality* and *technology reliability*. In an early experiment with synchronous technology-supported distance learning based on online lectures and videos, Webster and Hackley (1997) find that both variables influence attitude toward the format and the technology, and that technology quality also influences the relative advantage of the format (i.e., perceived learning). They argue that reliable, efficient, and effective technology interfaces promote learner motivation, while technical complications have the opposite effect. However, they do not find relationships

Table 1 Overview of Findings from the Extant Literature

Author	Method	Sample	Dimension	Selected findings
Alavi (1994)	Empirical	79 treatment, 48 control students (MBA)	Format, technology	Computer-mediated collaborative learning increases skill development, perceived and actual learning, and satisfaction.
Arbaugh (2000a)	Empirical	97 MBA students	Learner, instructor, format, technology	Instructor efforts to create an interactive environment (i.e., interaction ease and emphasis, classroom dynamics) predict perceived internet-based learning. Technology features (i.e., ease of use, usefulness), student characteristics (i.e., gender, age, prior experience, time online), and flexibility (i.e., course flexibility, program flexibility) are not significant.
Arbaugh (2000b)	Empirical	111 MBA students in 5 courses	Format, technology	Technology flexibility and an interactive environment are more important for learner satisfaction than the ease or frequency with which the medium can be used.
Arbaugh (2000c)	Empirical	27 treatment, 33 control students (MBA)	Format, technology	Internet-based courses do not diminish learning and lead to increased female participation in class discussions.
Arbaugh (2008)	Empirical	656 students in 55 MBA courses	Learner, instructor, format, technology	The Community of Inquiry framework (i.e., social, teaching, and cognitive presence) predicts perceived online learning and satisfaction with the delivery medium. Gender affects perceived learning. Gender, semester, and number of prior online courses predict satisfaction.
Arbaugh (2014)	Review	n/a	Format, technology	Learner control and group collaboration enhance learning in blended environments.
Arbaugh and Benbunan-Fich (2006)	Empirical	579 MBA students in 40 course sections	Instructor, format	Collaborative online learning results in higher perceived learning and satisfaction than individual online learning, independent of the teaching approach. Group learning is positively moderated by objectivist teaching (i.e., knowledge transmission), while individual learning is positively moderated by constructivist teaching.
Arbaugh and Duray (2002)	Empirical	120 MBA students	Format, technology	Perceived web-based learning and satisfaction are positively affected by flexibility and negatively affected by class size. Prior online learning experience influences satisfaction.
Arbaugh et al. (2009)	Review	n/a	Learner, instructor, format, technology	Online courses are at least comparable to classroom courses with respect to learning outcomes. Antecedents of learning effectiveness differ across

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
				business disciplines.
Arbaugh and Rau (2007)	Empirical	575 MBA students in 40 course sections	Format, technology	Different management disciplines cease to be significant predictors of perceived online learning when accounting for structural (i.e., class size, media variety, exams, projects) and behavioral (i.e., interaction with peers, instructor, interface) characteristics. However, differences among disciplines remain significant predictors of satisfaction. Some characteristics predict satisfaction and outcomes in opposite directions (e.g., media variety, peer interaction).
Asarta and Schmidt (2013)	Empirical	179 students in 3 course sections	Learner, technology	Timing and regularity of online access predict student performance, while number and length of access do not.
Asarta and Schmidt (2017)	Empirical	347 students across 4 treatment groups, 257 students across 3 control groups	Learner	Previously weak students perform better in traditional environments, while previously strong students perform better in blended environments. The environment does not matter for average students.
Beege, Schneider, Nebel, and Rey (2017)	Empirical	88 mostly undergraduate students across 4 treatment groups	Instructor, technology	Educational videos with a frontal (rather than lateral) instructor orientation positively influence retention, as para-social interaction may trigger beneficial affective states and deeper cognitive processing. Instructor proximity does not affect learning.
Buttner and Black (2014)	Empirical	82 treatment, 64 control students	Learner, format, technology	Implementation of an online learning system improves test results. Neither an additional test nor more time invested moderate outcomes.
Concannon et al. (2005)	Empirical	600 undergraduate students	Learner, instructor, format	Preferred educational resources, attitudes toward computers, study patterns, and career plans affect e-learner satisfaction. However, the main antecedents are peer interaction and instructor support.
D'Mello et al. (2014)	Empirical	Study 1: 63 undergraduate students; Study 2: 76 undergraduate students	Learner, format	Deliberate confusion positively affects actual learning. Prior knowledge shows small moderation effects.
Daspit and D'Souza (2012)	Empirical	203 undergraduate students	Format, instructor	In a wiki environment, teaching and social presence affect cognitive presence, which confirms that the instructor retains an important role in technology-mediated settings.
Demetriadis, Papadopoulos, Stamelos, and	Empirical	Study 1/Study 2: 8 treatment, 8 control undergraduate students	Learner, instructor, format	Scaffolding (e.g., via appropriate questioning) positively influences knowledge

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
Fischer (2008)				acquisition and transfer in a technology-enhanced environment. Learners with critical thinking skills benefit the most from scaffolding.
Deschacht and Goeman (2015)	Empirical	1883 undergraduate students	Format	Blended environments lead to increased dropout rates and better exam performance.
Dindar and Akbulut (2016)	Empirical	572 undergraduate students across 7 treatment conditions	Learner	Concurrent multitasking and daily media exposure negatively affect retention. Concurrent multitasking impedes topic interest. Sequential multitasking, digital device experience, and daily multitasking habits are not related to retention.
Eid and Al-Jabri (2016)	Empirical	203 undergraduate and 105 graduate students	Format, technology	Chatting, online discussions, and file sharing predict knowledge sharing, which in turn predicts perceived learning. Enjoyment and entertainment also predict learning.
Eom and Ashill (2018)	Empirical	305 undergraduate and 67 graduate students	Learner, instructor, format	Six interdependent factors (i.e., course-design quality, instructor, student motivation, student-student dialog, student-instructor dialog, and self-regulated learning) explain perceived e-learning, which predicts satisfaction.
Eom et al. (2006)	Empirical	397 graduate and undergraduate students	Learner, instructor, format	While course structure, instructor feedback, self-motivation, learning style, interaction, and instructor facilitation affect satisfaction, only instructor feedback and learning style directly predict perceived e-learning. Satisfaction also predicts perceived e-learning.
Evans (2008)	Empirical	196 undergraduate students	Technology	For review, podcasts are superior to textbooks or student notes in terms of time required and perceived learning.
Fritz (2011)	Empirical	Students in 131 courses	Learner, technology	Students who are more active in the learning management system earn higher grades.
Fryer and Bovee (2016)	Empirical	975 undergraduate students	Learner, instructor	Instructor support has direct and indirect effects on learner motivation. Effort beliefs predict task value and ability beliefs, which predict e-learning completion.
Garrison and Kanuka (2004)	Review	n/a	Format	Communities of Inquiry (i.e., cognitive, social, and teaching presence) are relevant for both face-to-face and online settings. Blended environments can enhance meaningful learning.
Grabe and Christopherson	Empirical	329 undergraduate students	Learner, technology	The use of online resources and class attendance is

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
(2008)				positively related to exam performance. Online resources may compensate for a lack of class attendance.
Guo, Kim, and Rubin (2014)	Empirical	6.9 million sessions across 4 edX courses, interviews with 6 edX staff	Instructor, technology	Shorter videos are more engaging. Videos with a personal feel can be more engaging than high-quality studio recordings. Informal videos in which the speaker is visible are more engaging than slides alone. Instructors who speak faster and with enthusiasm are more engaging.
Hazari, CO'M, and Rutledge (2013)	Empirical	102 undergraduate students	Format, technology	Blogs can improve outcomes by fostering deeper learning and engagement in an interactive environment. Peer interaction can be used as part of constructive feedback and self-evaluation.
Huang (2014)	Empirical	389 undergraduate students	Learner, technology	Perceived usefulness and playfulness are related to mobile learning satisfaction, which in turn predicts the intent to continue. Resistance to change has a minor influence on satisfaction. Self-management moderates the relationships between perceived usefulness, playfulness, and resistance to change and satisfaction as well as the relationship between satisfaction and the intent to continue.
Hwang and Arbaugh (2006)	Empirical	196 undergraduate students	Learner, technology	Discussion board feedback-seeking behaviors are related to actual learning if triggered by a competitive attitude (i.e., preventing others from getting ahead of oneself or personal diligence to get ahead of others). Traditional feedback-seeking measures of asking the instructor or peers do not have a positive effect on learning performance.
Kember, McNaught, Chong, Lam, and Cheng (2010)	Empirical	595 students	Technology	Features that promote constructive dialogue and interactive activities encourage deeper learning and enhance understanding of contents.
Kizilcec, Bailenson, and Gomez (2015)	Empirical	Study 1: 2951 participants; Study 2: 12,468 participants	Instructor, technology	Videos in which the instructor can be seen need to balance the increased extraneous load with gains from social and other nonverbal cues. When the instructor is visible, the cognitive load and perceived social presence increase, but learning outcomes and attrition remain constant. There is no "one-size-fits-all" approach.
Knoerzer et al.	Empirical	75 students across 3 treatment	Learner,	Negative emotions positively

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
(2016)		groups	format	affect online learning, perhaps due to more detailed information processing. Positive emotions negatively affect learning, perhaps because they distract from the material. Emotions do not influence motivation.
Kreijns, Kirschner, and Vermeulen (2013)	Conceptual	n/a	Format	Sociability, social space, and social presence determine social interaction, which predicts learning.
Krentler and Willis-Flurry (2005)	Empirical	549 undergraduate students	Learner, technology	Online discussion boards enhance student learning. The relationship between technology usage and learning is moderated by student major (i.e., marketing and computer information systems) and total amount of internet use (i.e., university and private use).
Lancellotti et al. (2016)	Empirical	247 treatment, 232 control undergraduate students	Technology	Watching a set of short, concept-focused videos improves exam scores. Gender and ethnicity do not moderate this effect.
Liu (2012)	Empirical	11,351 undergraduate and graduate students	Format	Motivation for taking a course, students' class status, and instructors' academic rank have significant impacts on distance learning.
López-Pérez et al. (2011)	Empirical	985 students in 17 groups	Learner, format	Blended environments reduce dropout rates and improve exam performance. Learning depends on motivation, age, prior experience, and class attendance for both face-to-face and online elements. Gender, perceived utility, and satisfaction do not predict learning.
Macfadyen and Dawson (2010)	Empirical	118 undergraduate students in 5 classes	Learner, technology	15 variables tracked by the learning management system predict actual learning. They correctly predict 81% of failing students. Key variables, such as number of contributions, mails sent, and completed assessments, explain more than 30% of the variance in final grades.
Markel (1999)	Review	n/a	Format, instructor	The literature offers negative descriptions of teacher-centered lectures, which can scare away potential teachers. The false dichotomy between boring lecturers and exciting distance educators inaccurately suggests that the technology, not the teacher, makes a good course.
Mayer (2002)	Review	n/a	Format	Nine instructional design principles affect cognitive processing: multimedia, spatial contiguity, temporal contiguity,

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
				coherence, modality, redundancy, pretraining, signaling, and personalization.
Mayer, Dow, and Mayer (2003)	Review	n/a	Format	Four methods foster cognitive processing and, thereby, learning across media. The multimedia effect combines words and pictures, the coherence effect excludes extraneous material, the spatial contiguity effect places text next to corresponding pictures, and the personalization effect applies a less formal presentation style.
Mayer and Chandler (2001)	Empirical	Study 1: 30 undergraduate students; Study 2: 29 undergraduate students (2 treatment groups in both studies)	Format	Presenting information in separate parts allows learners to build multiple mental representations that can be integrated when watching the parts or the entire presentation again (i.e., partial revision). Learner control over pace leads to skipping of sections (i.e., learners end up with shorter parts), which benefits cognitive processing.
Mayer et al. (2003)	Empirical	Study 1: 52 students across 2 treatment groups; Study 2: 78 students across 4 treatment groups; Study 3: 54 students across 2 treatment groups; Study 4: 39 students across 2 treatment groups	Format	Students learn better if animations are complemented with spoken language rather than printed text (i.e., modality principle), if they are able to control the pace and order of the presentation (i.e., interactivity principle), and if they answer conceptual questions while learning (i.e., self-explanation principle). Complementing narrated text with the instructor's image does not enhance actual learning due to the additional extraneous load (i.e., presence principle).
Mayer and Moreno (2003)	Conceptual	n/a	Format	Cognitive load is central to multimedia design. Strategies such as off-loading, segmenting, pretraining, weeding (i.e., cutting into parts), signaling, aligning, eliminating redundancy, synchronizing, and individualizing diminish extraneous load and free up capacity for germane load.
McGill and Klobas (2009)	Empirical	267 students	Technology	Task-technology fit (TTF) directly and indirectly predicts perceived learning through attitude toward technology use and actual technology use. The direct effect on actual learning is marginal. TTF also predicts expected consequences of technology use but these are not related to actual technology use. Instructor norms predict technology use.

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
				Perceived learning does not predict actual learning.
McLaren (2004)	Empirical	208 undergraduate students in 5 courses, 2 treatment types each	Format	While online delivery increases dropout rates, actual learning is independent of the format of instruction.
Moreno (2006)	Review	n/a	Format, technology	The modality principle (i.e., combination of visual and audio) moderates learning across media. A method that has learning benefits in a lower technology environment also supports learning with higher technologies. The latter does not have additional learning benefits. A "media-enables-method" hypothesis is derived (as opposed to "method-affects-learning" and "media-affects-learning").
Moreno and Mayer (2007)	Review	n/a	Learner, format	Cognitive learning theories should account for learner motivation, metacognition, and prior knowledge. Design principles for interactive multimedia environments include guidance, reflection, feedback, control, and pretraining, as they encourage relevant and/or reduce extraneous cognitive load.
Nemanich, Banks, and Dusya (2009)	Empirical	149 undergraduate students across 2 treatment groups	Learner, instructor, format	Perceived instructor expertise, content relevance, and social richness enhance student enjoyment. Perceived confidence in instructor expertise and content relevance also strengthen the understanding of course concepts. Enjoyment is positively associated with learning performance in the classroom, while student ability is positively associated with learning performance online.
Nihalani, Mayrath, and Robinson (2011)	Empirical	Study 1: 42 students across 2 treatment groups, 24 control students ("novice" undergraduates); Study 2: 42 students across 2 treatment groups, 20 control students ("expert" undergraduates)	Learner, instructor	Learners with little prior knowledge benefit more from individual feedback than from collaboration with other novices. For students with high prior knowledge, individual feedback may inhibit learning and reverse the benefits of expertise.
O'Flaherty and Phillips (2015)	Review	n/a	Format	There is no "one-size-fits-all" approach to flipped learning, but core features include content in advance, educator awareness of students' understanding, and higher-order learning during classes.
O'Neill and Sai (2014)	Empirical	48 students	Format	Respondents believe they learn better face-to-face. They are aware of the greater risk of

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
				failure or dropout in online courses.
Owston, York, and Murtha (2013)	Empirical	577 students in 11 courses	Format	High achievers are most satisfied with blended courses, would take one again, and prefer them to fully face-to-face or online courses. They also find blended courses more convenient engaging, and feel they learn key concepts better in blended courses than in traditional face-to-face courses.
Palocsay and Stevens (2008)	Empirical	327 undergraduate students across 4 treatment groups	Learner, instructor, technology	Teacher experience and student academic competence predict actual learning. The specific technology used for web-based homework does not affect learning.
Piccoli et al. (2001)	Empirical	70 students across 2 treatment groups, 76 students across 2 control groups (all undergraduate)	Learner, format, technology	Actual learning in virtual versus traditional environments is similar. Hence, the increased learner control in the virtual environment does not benefit learning. Satisfaction in the virtual environment is even lower. Only computer self-efficacy is higher.
Plass, Heidig, Hayward, Homer, and Um (2014)	Empirical	Study 1/Study 2: 121/103 graduate students across 4 treatment conditions	Learner, format	Distinct choices and combinations of instructional design features (e.g., colors, shapes) can induce positive emotions, which predict comprehension and knowledge transfer in multimedia learning.
Redpath (2012)	Review	n/a	Format, technology	Online delivery provides sufficient interaction, collaboration, and learning outcomes to support a quality business education.
Scheiter and Gerjets (2007)	Review	n/a	Learner, format, technology	Self-controlled multimedia environments are well suited for improving learning among students with high prior knowledge, better self-regulatory skills, and more positive attitudes.
Selim (2003)	Empirical	403 undergraduate students	Technology	Usefulness and ease of use predict acceptance and use of a course website. Ease of use is mainly mediated by usefulness.
Selim (2007)	Empirical	538 undergraduate students	Learner, instructor, format, technology	Eight determinants of e-learning satisfaction across four categories: instructor characteristics (attitude toward and control of technology, teaching style), student characteristics (motivation and technical competency, interactive collaboration, course content and design), technology (ease of access, infrastructure), and university support.
Seufert (2003)	Empirical	86 students across 2 treatment	Learner,	The effect of help depends on

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
		groups and one control group	instructor	learners' prior knowledge. In cases of low prior knowledge, help negatively effects comprehension and recall performance. For medium prior knowledge, directive (as opposed to non-directive) help enhances both recall and comprehension due to its summarizing and repeating function. In cases of high prior knowledge, help barely affects learning.
Sloan and Lewis (2014)	Empirical	70 undergraduate students in 2 course sections	Learner, technology	Access to lecture-capture videos is associated with higher exam scores, even after controlling for previous exam performance.
Snowball (2014)	Empirical	50 undergraduate students	Format, technology	Partially replacing lectures with online activities and resources improves actual learning. More active online resources (e.g., multiple-choice questions) are most beneficial for student performance. Some essentially passive activities (e.g., short online lectures, mini-movies) may be useful for demonstrating how to explain and apply concepts.
Solimeno, Mebane, Tomai, and Francescato (2008)	Empirical	82 treatment students, 88 control students (all graduate)	Learner, instructor, technology	Technology improves perceived and actual learning among students with low anxiety, high problem-solving efficacy, and time-management problems. Tutor characteristics do not influence learning.
Song et al. (2004)	Empirical	76 graduate students (all participated in a survey, 14 were also interviewed)	Learner, format	Course design, learner motivation, time management, and comfort with the technology affect perceived online learning. Technical problems, a lack of community, time constraints, and difficulty in understanding the course objectives are challenges.
Sun et al. (2008)	Empirical	295 students	Learner, instructor, format, technology	E-learner satisfaction is affected by learner computer anxiety, instructor attitude toward e-learning, course flexibility, course quality, perceived usefulness of e-learning, perceived ease of use, and diversity in assessments. Learners' attitude toward computers, learners' internet self-efficacy, timeliness of instructors' responses, technology quality, internet quality, and perceived interaction with others do not predict satisfaction.
Terpend, Gattiker, and Lowe (2014)	Empirical	180 undergraduate students in 6 course sections	Technology	Perceived ease-of-use and price predict e-textbook adoption. Perceived usefulness, internet self-efficacy, and environmental concerns are not significant. The grades of e-textbook

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
				adopters and hardcopy users do not differ.
Um, Plass, Hayward, and Homer (2012)	Empirical	118 undergraduate students across 4 treatment groups	Learner, format	Positive emotional design negatively influences perceived task difficulty and positively affects motivation. It promotes comprehension, transfer, and satisfaction. Emotional design does not increase extraneous cognitive processing.
Volery and Lord (2000)	Empirical	47 students	Learner, instructor, format, technology	Technology (ease of access and navigation, interface design, interaction), instructor (attitude toward students, technology control/technical competence, teaching style/interaction), and learners' prior technology experience predict perceived learning. Internet access at home, study program, country of origin, and gender are not significant.
Walker, Curren, Kiesler, Lammers, and Goldenson (2013)	Empirical	516 students	Format, technology	Peer networking via discussion boards leads to better performance. Reading discussions and posting improve final grades.
Webster and Hackley (1997)	Empirical	247 mainly graduate distance-learning students	Learner, instructor, format, technology	Medium richness relates to all perceived outcome variables. Other important antecedents include technology reliability, technology quality, instructors' attitudes, teaching style, instructors' control over the technology, number of student locations, students' comfort with their images on screen, and classmates' attitudes.
Woo (2014)	Empirical	63 undergraduate students	Learner	Motivation and cognitive processing predict actual online learning.
Wu et al. (2010)	Empirical	212 e-learning participants	Learner, format, technology	Computer self-efficacy, system functionality, content features, and interaction affect performance expectations. Interaction also affects the learning climate. Performance expectations and the learning climate affect satisfaction with blended environments.
Xu and Jaggars (2014)	Empirical	More than 40,000 students	Learner, technology	All types of students suffer in online courses. Those exhibiting the most decline are males, younger students, black students, and students with lower GPAs. Controlling for individual and peer effects as well as disciplines shows the widest performance gaps.

Table 1 Overview of Findings from the Extant Literature *(Continued)*

Author	Method	Sample	Dimension	Selected findings
Yourstone, Kraye, and Albaum (2008)	Empirical	190 undergraduate students in 4 course sections across 2 treatment types	Technology	Immediate feedback technologies, such as clickers, have a positive impact on actual learning.
Zacharis (2015)	Empirical	134 undergraduate students	Format, technology	Four out of 29 system measures predict 52% of the variance in final grades: reading and posting messages, content creation, quiz efforts, and number of files viewed.

with involvement and participation, cognitive engagement, technology-self-efficacy, or usefulness of the technology. Song et al. (2004) confirm that technical problems are perceived as disadvantages for online learning. Sun et al. (2008) examine technology and internet quality in e-learning but find no effects on the satisfaction of management students. Notably, internet quality may be taken for granted. McGill and Klobas (2009) examine the role of learning management systems and provide empirical evidence that TTF strongly influences perceived learning and weakly affects actual learning. They also show an indirect relationship between TTF and perceived learning through learners' attitudes toward technology utilization and actual use. Interestingly, they also reveal an effect of TTF on the expected consequences of technology use, although this does not affect actual usage.

Webster and Hackley (1997) note that *technology richness* has a positive impact on involvement and participation, cognitive engagement, technology self-efficacy, perceived usefulness, attitudes toward technology and format, and perceived learning. They argue that technology richness supports the accessibility of instructors and their feedback, which moderates learner motivation, thereby predicting technology use and perceived learning. Yourstone et al. (2008) state that immediate feedback technologies, such as clickers, can have a positive impact on learning outcomes. Work by Snowball (2014) confirms that passive online activities, such as videos, can be useful for introducing new concepts, while more active components, such as quizzes, are more beneficial for learning. Sloan and Lewis (2014) suggest that lecture-capture videos are related to higher exam scores. Kember et al. (2010) find that technological features that promote constructive dialogue and interactive learning improve understanding. Volery and Lord (2000) and Wu et al. (2010) note that the design and functionality of a learning management system predict perceived learning. Arbaugh and Rau (2007) investigate online learning with different systems and, interestingly, find a negative relationship between technology variety and perceived learning but a positive relationship between technology variety and satisfaction. In addition, Huang (2014) identifies a positive relationship between *technology playfulness* and satisfaction in a mobile learning environment. He finds that learners' self-management skills moderate the effects of usefulness and playfulness on satisfaction. These technology-related antecedents of the effectiveness of technology-supported management learning are summarized in Fig. 3.

Format characteristics

While the format of instruction has traditionally been based on the physical classroom, the advent of technologies in management education allows for the emergence of new

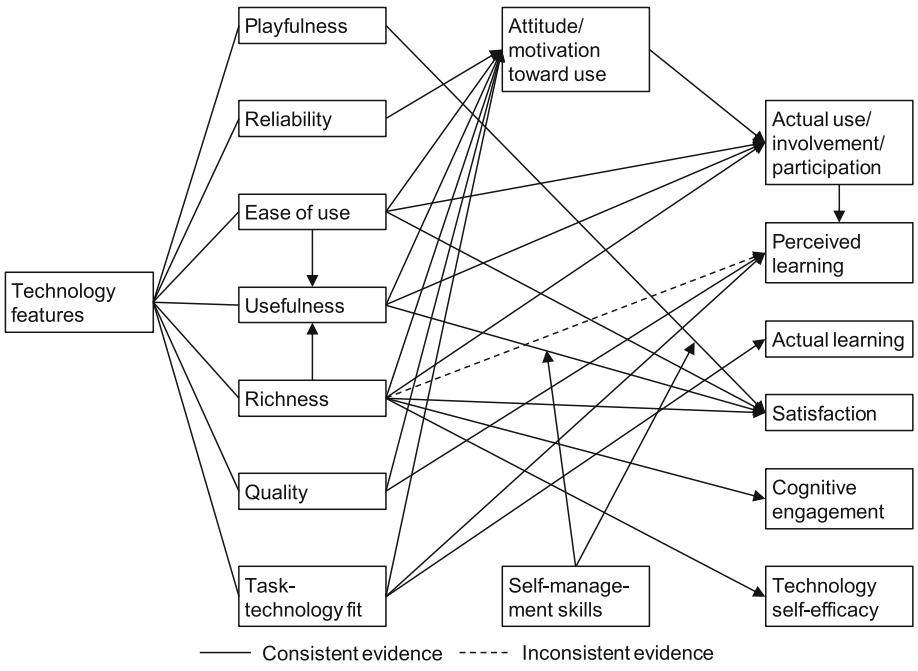

Fig. 3 Technology-Related Antecedents

settings. Higher education research proposes a *blended learning environment* that is independent from the technology employed. According to Garrison and Kanuka (2004), this format is an "integration of face-to-face and online learning experiences – not a layering of one on top of the other." López-Pérez et al. (2011) show that blended environments that combine face-to-face classes with online activities (e.g., crosswords, matching, fill in the blank, multiple-choice tests, wikis, forums) reduce dropout rates and improve exam performance. In line with TAM, they show that the *perceived utility* of online learning is correlated with the motivation generated by the technology, which in turn predicts satisfaction. However, they find that actual learning mainly depends on variables unrelated to blended environments, such as learners' age, class attendance, or prior experiences—perceived utility and satisfaction do not predict actual learning. Notably, according to Grabe and Christopherson (2008), a lack of class attendance may be offset through online resources. Deschacht and Goeman (2015) find better exam performance for blended environments that integrate self-study, online collaboration, and classroom teaching. However, they also find that these environments are associated with higher dropout rates. They argue that the learning effect may be subject to survivorship bias. McLaren (2004) demonstrates that persistence in online delivery is significantly lower, while learning performance is independent of the format.

Although blended learning environments capture the benefits of technological innovations, such as flexibility in terms of time and place and learner control over pace and content, they also capture the benefits of physical classrooms (i.e., personal interaction through collaboration and community) (Arbaugh, 2014; Concannon et al., 2005). Educational technology research has found that *course flexibility* leads to e-learning

satisfaction (Arbaugh, 2000b; Sun et al., 2008). The rationale is that flexibility allows learners to balance their personal commitments, such as work, family, and other activities, with their studies. Higher education research suggests that learner independence is crucial for building critical thinking skills (Garrison & Kanuka, 2004). Educational psychology research emphasizes that learner control over materials can have a positive impact on cognitive processing due to the possibility of pacing (Mayer et al., 2003; Moreno & Mayer, 2007). *Pacing* refers to a flexible presentation speed that encompasses pause, rewind, and fast-forward options. While pausing allows learners to restrict cognitive processing at a certain point of time, rewinding can intensify cognitive processing because the learner repeatedly receives the same information. The fast-forward option allows for certain sections to be skipped so that learners end up with shorter sections, which also benefit cognitive processing. The presentation of information in separate parts gives learners the opportunity to gradually build multiple mental representations that can be integrated later (Mayer & Chandler, 2001). Scheiter and Gerjets (2007) note that learner control in multimedia environments stimulates interest and motivation and, thereby, triggers more active and constructive processing. While Arbaugh and Duray (2002) show positive relationships between flexibility and both perceived learning and satisfaction in web-based environments, Arbaugh (2000a) finds no direct relationship between flexibility and perceived learning.

In blended learning environments, the flexibility of online learning is integrated with the preeminent characteristic of classroom teaching: *interaction*. Alavi (1994) finds that technology-supported learner collaboration and the associated interaction lead to greater satisfaction, self-reported learning, and enhanced exam performance. Collaboration can empower the structuring and sharing of information, leading to exposure to different views and opinions. This requires reiterating prior information when explaining knowledge to others, resolving opposing perspectives through discussions, and internalizing explanations from more knowledgeable peers. Eventually, this leads to more active knowledge processing and construction (Kreijns et al., 2013).

Eid and Al-Jabri (2016) provide evidence that online discussions and chats promote the exchange of knowledge that predicts perceived learning. Furthermore, networking via discussion forums leads to better performance (Walker et al., 2013). Arbaugh (2000a) also finds connections between perceived learning and interaction ease, interaction emphasis, and classroom dynamics. Arbaugh and Benbunan-Fich (2006) investigate online learning among 579 MBA students and find that group learning leads to higher perceived learning and satisfaction than individual learning. While group learning is moderated by an objectivist teaching approach, individual learning is moderated by constructivist instruction. Song et al. (2004) find that a perceived lack of community is detrimental to perceived online learning. In contrast, Eom et al. (2006) state that distance interactions lead to an adaptation of information that assists learners in overcoming feelings of remoteness. They find that interaction predicts satisfaction with online learning, which in turn fosters perceived learning. However, they do not find a direct link between interaction and perceived learning. Concannon et al. (2005) also find that interaction affects the satisfaction of e-learners, while Sun et al. (2008) find no relationship. Eom and Ashill (2018) find direct relationships between both learner-learner and learner-instructor interaction and perceived online learning. They also show that peer interactions in e-learning are beneficial for the self-regulation that predicts perceived learning. Perceived learning, in turn, causes satisfaction (Wu et al., 2010). Hazari et al.

(2013) suggest that peer interactions via blogs lead to constructive feedback and self-assessments. On the other hand, Arbaugh and Rau (2007) find that peer interaction in online courses can negatively influence satisfaction, while it can positively affect perceived learning. Wu et al. (2010) reveal that the *learning climate* in a blended environment mediates the effect of interaction on satisfaction. According to Solimeno et al. (2008), online interaction can be even more beneficial for learning than personal interaction, as the former overcomes much of the interpersonal noise.

A variant of blended environments is *flipped learning*. According to higher education research, there is no single approach to flipped learning. However, the most important aspects include the provision of content in advance and higher-order learning during face time (O'Flaherty & Phillips, 2015). Therefore, introductions, explanations, and theories are studied individually and asynchronously at each student's own pace, typically facilitated by a learning management system, while application and transfer problems are handled during class time. Solimeno et al. (2008) emphasize the benefits of asynchronous preparation, including flexibility in consulting materials and reviewing online comments from peers. Such a shift in the individual workload from reworking to preparing fosters ownership before class and enables deeper discussions in class that can be initiated by the learners themselves (O'Flaherty & Phillips, 2015). Flipped learning also supports the *pre-training effect* proposed in educational psychology research (Moreno & Mayer, 2007). The aim in this regard is to provide learners with relevant prior knowledge or to reactivate it if it is already available. This prepares the human memory with selected knowledge, which can later be integrated with new information. Consequently, pretraining facilitates meaning making and improves cognitive processing (Moreno & Mayer, 2007).

Educational technology research finds that *assessment diversity* in online environments increases satisfaction, as it enables multiple forms of feedback (Sun et al., 2008). Concannon et al. (2005) suggest that the use of some online tests during a semester reshapes study patterns by triggering continuous review and feedback. These format-related antecedents of the effectiveness of technology-supported management learning are outlined in Fig. 4.

Instructor characteristics

Instructors play a central role in any learning environment (Webster & Hackley, 1997). This role remains important in technology-supported management education, but it is changing (Daspit & D'Souza, 2012; Volery & Lord, 2000). Therefore, examinations of instructor characteristics should consider not only the personalities of instructors but also their roles, particularly with regard to learner-instructor interactions.

Research on instructors' personality in technology-supported environments mainly focuses on instructors' attitudes toward and control over the technology. Webster and Hackley (1997) find that the instructor's *attitude toward the technology* affects learners' attitudes toward the format and technology, technology self-efficacy, and perceived learning. In turn, learners' technology self-efficacy predicts perceived learning (Wu et al., 2010). However, they find no relationship between the instructor's attitude toward the technology and learners' involvement and participation, cognitive engagement, or perceived usefulness of the technology. Concannon et al. (2005) find a positive relationship between the instructor's attitude toward the technology and e-learners'

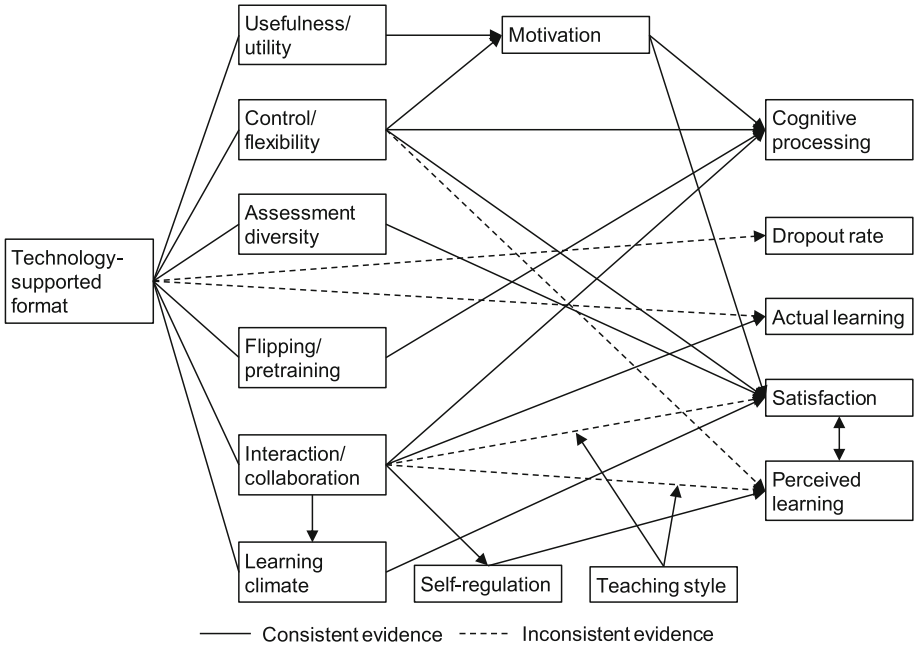

Fig. 4 Format-Related Antecedents

motivation to use that technology. López-Pérez et al. (2011) show that learner motivation influences actual learning in both the physical and virtual elements of blended environments. In addition, Sun et al. (2008) show a positive effect of the instructor's attitude on the satisfaction of e-learners. They also emphasize the importance of the instructor's technical competence.

Webster and Hackley (1997) demonstrate that the instructor's *control over the technology* has a positive impact on learners' attitudes toward a technology, its perceived usefulness, cognitive engagement, and perceived learning. However, they do not find relationships with involvement and participation or technology self-efficacy. Selim (2007) confirms that both attitudes toward and control over the technology affect business students' e-learning satisfaction.

While the purpose of a traditional lecture is to deliver knowledge, instructors in a technology-supported environment should support active learning as facilitators and mentors (Solimeno et al., 2008). Markel (1999) proposes a change from "a sage on the stage into a guide on the side," while Volery and Lord (2000) expect the role of the instructor to shift toward being "a learning catalyst and knowledge navigator." Webster and Hackley (1997) find that such an *interactive teaching style* has a positive impact on learners' involvement and participation, cognitive engagement, and attitudes toward format and technology. They find no relationships between an interactive teaching style and the perceived usefulness of the technology, technology self-efficacy, or perceived learning. However, Arbaugh (2000a) shows that efforts to create an interactive online environment predict perceived learning, and that the emphasis on interaction is directly related to satisfaction (Arbaugh, 2000b). Selim (2007) also shows that instructor characteristics, including the teaching style, influence business students' satisfaction with e-learning.

Interactions between learners and instructors comprise both *guidance* (i.e., process input) and *feedback* (i.e., essential input) (Moreno & Mayer, 2007). On the one hand, process-related input promotes learners' engagement in the right activities, especially the selection, organization, and integration of relevant information that strengthens relevant cognitive processing (Mayer & Moreno, 2003). On the other hand, essential input reduces learners' extraneous cognitive processing by replacing misconceptions in the human memory (Moreno & Mayer, 2007). Extraneous processing refers to cognitive processes that are irrelevant for making sense of information and, thus, should be minimized. However, feedback must be well designed to avoid additional extraneous processing. For technology-supported environments, Demetriadis et al. (2008) suggest that *scaffolding*, a technique of appropriate questioning, can trigger learner reflection and deeper processing. They find that scaffolding leads to more knowledge acquisition and knowledge transfer. Moreno and Mayer (2007) confirm that reflection on prior information leads to more active organization and integration of new information. According to Eom et al. (2006), both guidance and feedback increase learner satisfaction, but only feedback improves perceived learning in an online environment. Hwang and Arbaugh (2006) show that feedback does not influence actual learning in blended environments. However, if the search for feedback is triggered by a competitive attitude (i.e., getting ahead of others or preventing others from getting ahead of oneself), it has a positive impact on actual learning. Sun et al. (2008) show that the timeliness of an instructor's response has no influence on satisfaction with e-learning.

Instructor feedback in technology-supported environments has also been studied in connection with learners' prior knowledge. Seufert (2003) finds that feedback in a computer-based learning task barely affects learners with a high level of prior knowledge. However, it positively moderates the comprehension of learners with intermediate prior knowledge, presumably due to its summarizing and repetitive nature. At the same time, feedback negatively moderates the recall performance of learners with little prior knowledge. Interestingly, in a computer-based simulation, Nihalani et al. (2011) find that learners with low prior knowledge learn better with the support of the instructor than in cooperation with other beginners and that feedback is disadvantageous for learners with high levels of prior knowledge.

As a variant of feedback, educational psychology scholars study *confusion* in online environments, which is defined as "the result of contradictions, conflicts, anomalies, erroneous information, and other discrepant events" (Park et al., 2014). They propose that when confusion is "induced, regulated, and resolved appropriately," it can positively influence learning. D'Mello et al. (2014) find that knowledge and transfer are higher when confusion is deliberately triggered and successfully resolved. Learners' prior knowledge has small moderation effects. Confusion is assumed to lead to deeper engagement with new information, thereby improving learning (Leutner, 2014).

Although feedback embodies interaction between instructors and learners, the physical presence of the instructor is not essential for improving cognitive processing (Redpath, 2012). Personal interaction can occur through a collaborative online environment or personalized online communication (Arbaugh, 2000c). Mayer (2002) proposes the *personalization principle,* which posits more effective processing for a conversational communication style in learning materials than for a formal communication style. This increases learners' attention and encourages them to refer content to themselves (Moreno, 2006). In addition, Beege et al.

(2017) find that frontal, as opposed to lateral, instructor orientation in learning videos promotes retention, as para-social interactions can trigger deeper cognitive processing and beneficial affective states. The lack of body language in online settings can be addressed through the use of humor, anecdotes, or emoticons (Whitaker, New, & Ireland, 2016). Guo et al. (2014) find that instructors who speak faster and with more enthusiasm in learning videos increase learner engagement. These instructor-related antecedents of technology-supported management learning effectiveness are illustrated in Fig. 5.

Learner characteristics

The learners themselves play an important role in the effectiveness of technology-supported management learning. Educational technology research initially examined the demographic background and prior experience of learners in technology-supported formats. While it is unclear whether *gender* predicts perceived learning in an online environment (Arbaugh, 2000a, 2008; Volery & Lord, 2000), both Arbaugh (2000b) and Arbaugh (2008) find that gender does not influence satisfaction. Furthermore, Lancellotti et al. (2016) find no connection between gender and actual learning. *Age* does not influence perceived e-learning (Arbaugh, 2000a), but it positively predicts actual learning in the physical and virtual settings of a blended environment (López-Pérez et al., 2011).

Prior technological experience also influences actual online learning (López-Pérez et al., 2011), while its relationships with perceived learning and satisfaction are not always significant (Arbaugh, 2000a, 2008; Arbaugh & Rau, 2007; Selim, 2007; Song et al., 2004; Volery & Lord, 2000). Piccoli et al. (2001) examine 146 management students

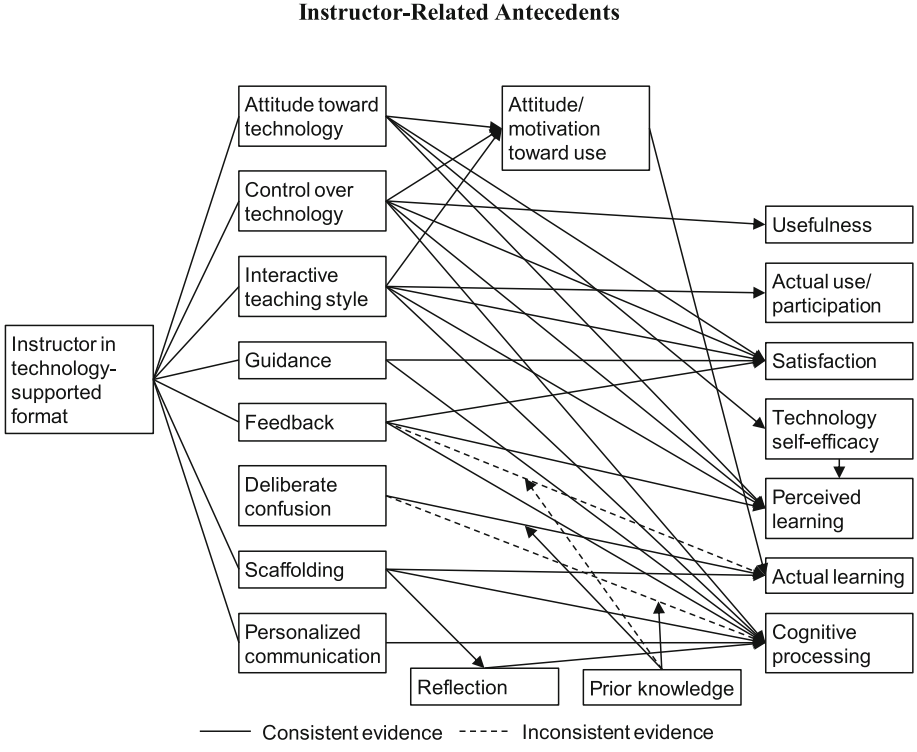

Fig. 5 Instructor-Related Antecedents

and posit that previous technology experience can be beneficial, while a lack of such experience can promote feelings of anxiety and isolation. Sun et al. (2008) find that computer anxiety has a negative impact on satisfaction with e-learning, as it can hamper a learner's attitude, which is essential for technology-supported learning (Scheiter & Gerjets, 2007). Solimeno et al. (2008) show that technology promotes perceived and actual learning among learners with low computer anxiety.

In addition to previous technological experience, research has examined the role of *prior academic achievements*. Nemanich et al. (2009) and Palocsay and Stevens (2008) find that learners' academic abilities are associated with learning outcomes, particularly in online environments. Scheiter and Gerjets (2007) assume that a high level of prior knowledge moderates learning in multimedia environments. Asarta and Schmidt (2017) show that blended formats have a positive influence on exam performance for learners with high prior performance, while weaker students perform better in traditional formats. Owston et al. (2013) find that high achievers show the highest satisfaction with blended learning environments because they view blended learning as more convenient and engaging, and they feel that they learn key concepts better than in traditional classes.

Educational psychology scholars have considered affective aspects, such as learner motivation and emotions (Park et al., 2014). *Motivation* is defined as an "internal state that initiates, maintains, and energizes the learner's effort to engage in learning processes" (Mayer, 2014). The corresponding work is based on the assumption that motivational factors can mediate learning by increasing or decreasing cognitive engagement (Moreno & Mayer, 2007). Selim (2007) shows that motivation affects e-learning acceptance and satisfaction. According to Song et al. (2004), e-learners expect their motivation to be related to learning. López-Pérez et al. (2011) find that motivation predicts actual learning in both the physical and virtual settings of a blended environment. Woo (2014) confirms the correlation between motivation and actual online learning. Eom et al. (2006) also find that motivation in an online environment affects satisfaction, although they do not find a direct link to perceived learning.

Plass et al. (2014) and Um et al. (2012) investigate *emotions* induced by videos in online learning, and find that positive emotions can promote comprehension and transfer. Their findings suggest that round, face-like shapes and warm colors reinforce the positive emotions that not only reduce the perceived difficulty of the task but also increase motivation and cognitive processing. This effect of emotions on performance can be mediated by motivation and/or moderated by prior knowledge (Leutner, 2014). In contrast, Knoerzer et al. (2016) find that positive emotions induced through music and autobiographic recall reduce actual online learning, possibly because they distract learners from the focal material. However, they find that negative emotions increase learning, possibly due to a perceived need for deeper information processing. They find no connection between emotions and motivation.

Educational psychology research on multimedia learning further posits that "metacognitive factors mediate learning by regulating cognitive processing and affect" (Moreno & Mayer, 2007). Metacognition mainly occurs in the form of self-regulation and reflection during the organization and integration of new information. Moreno and Mayer (2007) find that *reflection* is beneficial for cognitive processing, which leads to better learning outcomes. Eom and Ashill (2018) show that *self-regulation* in an e-learning environment mediates the relationship between motivation and perceived learning, which is related to

satisfaction. Metacognition seems to be particularly important for non-interactive (i.e., distance) phases in which it is not triggered by interactions. However, metacognition is also important in an interactive setting if "the lesson can be performed in a superficial or automatic fashion" (Moreno & Mayer, 2007).

According to Fryer and Bovee (2016), "although a variety of factors influence learning, few are as important as time on task." Macfadyen and Dawson (2010) distinguish between *online activity* and *time online,* noting that online activity (i.e., written posts, sent messages, completed assessments) indicates learner engagement and predicts actual outcomes, while time online does not. Fritz (2011) also shows that higher activity in the learning management system affects actual learning, while Asarta and Schmidt (2013) as well as Buttner and Black (2014) find no correlation between time online and learning. Based on learning analytics, Zacharis (2015) finds that four online activities predict 52% of the variance in the final grade: number of files viewed, reading and posting messages, content creation contribution, and quiz efforts. These learner-related antecedents of technology-supported management education are illustrated in Fig. 6.

Discussion

In this paper, we have presented a systematic and comprehensive review of peer-reviewed, scientific publications from several research disciplines related to the effectiveness of technology-supported management learning. Although our search for literature was not limited to a specific timeframe, the current relevance of the topic is evident from the identified publications. Research on this topic began to emerge in the 1990s and it has since flourished. With regard to the field of management education, the most cited articles were published in the current millennium (Arbaugh & Hwang, 2015). We found that the antecedents of technology-supported management learning effectiveness include more than technological characteristics and learners' abilities to deal with them. More specifically, the introduction of technologies into the management learning space has implications for formats, instructors, and learner characteristics, all of which are highly interdependent. The desired format of instruction, for example, which is chosen by the instructor, determines the appropriate technology and the role of the instructor. Characteristics of the selected technology, such as quality, reliability, and richness, and characteristics of the instructor, such as attitude, control, and teaching style, impact learners' perceptions, metacognition, and affect. These relationships are, in turn, moderated by learners' demographic characteristics and previous experiences. Eventually, all four dimensions—learner, instructor, format, and technology—directly or indirectly influence technology-supported learning effectiveness. These findings are independent from the measurement of effectiveness (i.e., online activity, cognitive processing, perceived learning, satisfaction, actual results, or dropout rates).

These antecedents of technology-supported management learning effectiveness are summarized in Fig. 7. The subsequent section derives detailed implications for future research based on the identified inconsistencies and interdependencies.

Implications for future research

In investigating antecedents of technology-supported management learning effectiveness, we have identified several inconsistencies and research gaps in the extant

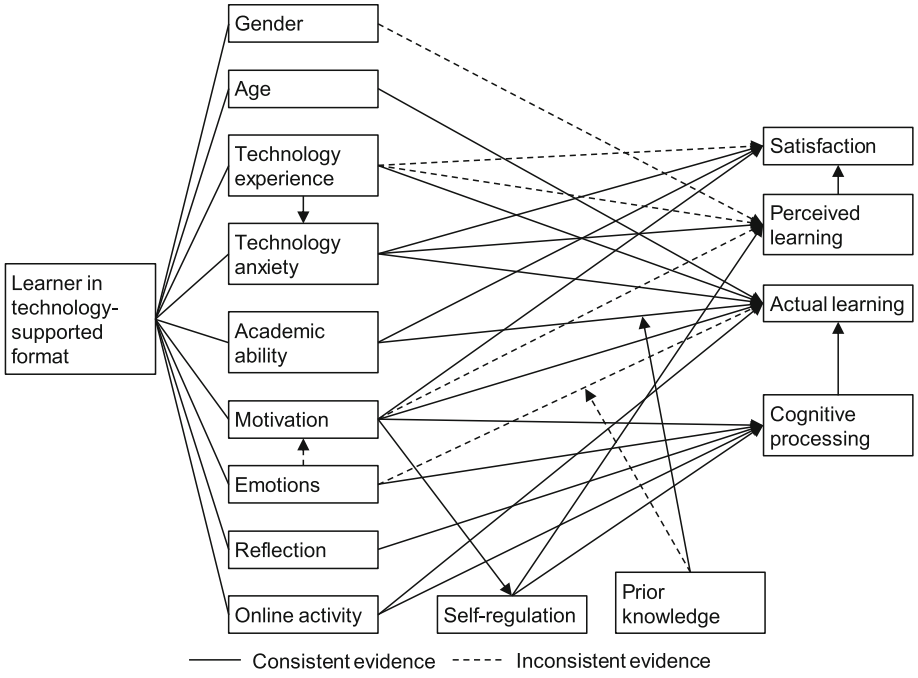

Fig. 6 Learner-Related Antecedents

literature. We encourage management education scholars to study these issues in order to develop additional insights into technology-supported management learning. Such research will advance the young field of management education and make a positive contribution to overall management research and education. In Table 2, we highlight aspects that provide opportunities for further research.

As far as the overall effectiveness of technology-supported formats is concerned, research has produced a number of inconsistent results. For instance, there is disagreement about the impact of blended environments on dropout rates (Deschacht & Goeman, 2015; López-Pérez et al., 2011). Moreover, whether the use of technology is beneficial for learning remains unclear. Twenty years ago, Arbaugh (2000a) found that the format of instruction is more important than the specific technology employed. To date, theoretical concepts on how to blend and flip learning content in relation to subject areas and content types are still lacking (O'Flaherty & Phillips, 2015). Although there might not be a "one-size-fits-all" approach, it is possible to examine which course structures and format features, such as collaboration and interaction, are more appropriate for certain types of content. Due to the wide variety of management disciplines, scholars in management education are predestined to investigate different variants of blended and flipped learning (Arbaugh & Rau, 2007). Such studies can reveal connections among content type, optimal course format, and technology use.

Another key question is why learners continue to prefer face-to-face classes to online courses (O'Neill & Sai, 2014) even though they regularly use electronic devices and increasingly strive for individualism and flexibility. As technologies are likely to continue to play a central role in society, different learning formats should be studied in relation

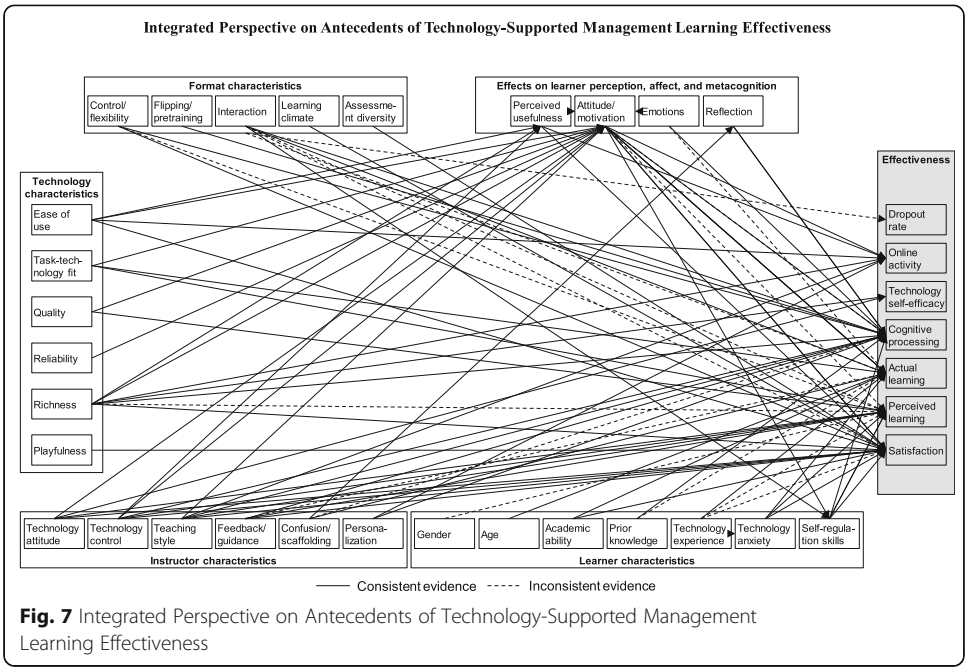

Fig. 7 Integrated Perspective on Antecedents of Technology-Supported Management Learning Effectiveness

to specific technologies and their richness of features. Such studies can further investigate whether the use of technology actually equalizes learners' performance (Krentler & Willis-Flurry, 2005). Moreover, Piccoli et al. (2001) argue that the investigation of new formats and technologies for management education requires an examination of optimal class sizes. They argue for an inverted U-shape relationship between class size and learning effectiveness, as the presence of more learners increases perspectives until a point is reached at which information overload and coordination difficulties outweigh the benefits of additional learners. However, this requires further examination.

Scholars agree that instructors play an important role in technology-supported management education, but how their role will change remains unclear (Arbaugh, 2000a; Volery & Lord, 2000). Some suggest a shift from "a sage on the stage into a guide on the side" (Markel, 1999), which implies a shift from an objectivist to a constructivist teaching approach. Nevertheless, collaborative management learning in a technology-supported environment seems to be moderated by an objectivist teaching approach (Arbaugh & Benbunan-Fich, 2006), which contradicts the plea for an interactive teaching style (Selim, 2007; Webster & Hackley, 1997). Furthermore, findings on the role and effects of feedback are inconsistent, particularly with regard to the moderating role of learners' prior knowledge (Nihalani et al., 2011; Seufert, 2003). Deliberate confusion, a variant of feedback, has also been under-researched, and there are some indications that learners' prior knowledge could play a moderating role (D'Mello et al., 2014; Leutner, 2014). Therefore, the design and impact of teaching style and instructor feedback on cognitive processing and actual learning should be further investigated, especially with regard to potential moderating variables, such as learners' prior knowledge.

Since Moreno and Mayer (2007) proposed a *cognitive-affective theory of learning with media*, it has become clear that learning also depends on affective aspects, such as motivation and emotions. Although the related antecedents have not yet been fully researched, initial results suggest that the design of multimedia materials and interfaces

Table 2 Selected Opportunities for Further Research

Dimension	Research gap	Related findings/references
Format	Performance, retention	- Blended formats improve actual learning and reduce dropout rates (López-Pérez et al., 2011). - Blended formats improve actual learning but increase dropout rates (Deschacht & Goeman, 2015). - Blended formats do not affect actual learning but increase dropout rates (McLaren, 2004).
	Collaboration, interaction	- Collaboration leads to higher perceived learning and satisfaction (Arbaugh & Benbunan-Fich, 2006). - Interaction predicts online learning satisfaction, which affects perceived learning (Eom et al., 2006). - A perceived lack of community is disadvantageous for perceived learning (Song et al., 2004). - Peer interaction can negatively influence satisfaction (Arbaugh & Rau, 2007).
Technology	Richness	- Technology richness promotes feedback and benefits perceived learning (Webster & Hackley, 1997). - Technology features that encourage constructive dialogue foster understanding (Kember et al., 2010). - Technology design and functions affect perceived learning (Volery & Lord, 2000; Wu et al., 2010). - Technology variety benefits satisfaction but impedes perceived learning (Arbaugh & Rau, 2007).
Instructor	Teaching style	- Group learning is moderated by an objectivist teaching approach and individual learning is moderated by a constructivist teaching approach (Arbaugh & Benbunan-Fich, 2006).
	Feedback, confusion	- Feedback benefits learners with medium prior knowledge and hinders learners with low prior knowledge. It barely affects learners with high prior knowledge (Seufert, 2003). - Learners with low prior knowledge learn better individually with instructor support. Learners with high prior knowledge are hindered by feedback (Nihalani et al., 2011). - Deliberate confusion is beneficial for learning. Prior knowledge has small moderation effects (D'Mello et al., 2014).
Learner	Motivation	- Motivation can mediate learning through cognitive engagement (Moreno & Mayer, 2007). - E-learners expect their motivation to be related to learning (Song et al., 2004). - Motivation affects e-learning acceptance and satisfaction (Selim, 2007). - Motivation predicts actual learning in both physical and virtual settings (López-Pérez et al., 2011). - Motivation affects satisfaction but is not directly related to perceived learning (Eom et al., 2006).
	Emotions	- Positive emotions can improve comprehension and transfer (Plass et al., 2014; Um et al., 2012). - Positive emotions diminish actual learning. Negative emotions enhance it (Knoerzer et al., 2016). - Emotions may be mediated by motivation and/or moderated by prior knowledge (Leutner, 2014). - There is no relationship between emotions and motivation (Knoerzer et al., 2016).

should take into account features that trigger motivation and emotion (Mayer, 2014). However, while Plass et al. (2014) and Um et al. (2012) find that positive emotions can strengthen comprehension and transfer, Knoerzer et al. (2016) come to the opposite conclusion when they induce emotions in a different way. Another unresolved aspect of inducing emotions is whether the instructor should be shown speaking in educational videos. While this can create a positive sense of personalization, it may also increase the extraneous load (Kizilcec et al., 2015; Mayer, 2003). Furthermore, Leutner (2014) suggests that the effect of emotions on learning might be mediated by motivation or moderated by prior knowledge. As such, the interdependence and effects of

motivation and emotions on cognitive processing and actual learning deserve further investigation. In addition, potentially moderating variables, such as learners' prior knowledge, should be investigated.

Limitations

Although this review followed a systematic procedure, it has some limitations that can be attributed to either our methodology or our research focus. With regard to our methodology, the literature-identification process revealed that numerous publications from a variety of research areas have examined technology-supported learning. Although we have tried to systematically identify all major publications investigating this issue that are relevant for the management context, we cannot guarantee that our results are exhaustive. Furthermore, although we broadened our scope to include publications beyond management education research, we deliberately limited our search to educational psychology, educational technology, and higher education research. These three disciplines appeared to be the most promising during an initial interdisciplinary skimming of the literature. However, we cannot exclude the possibility that relevant research may have been conducted in other disciplines. Moreover, given the interdisciplinary nature of the sources, our literature prioritization and classification revealed that some results were more general in nature, while others were developed explicitly from management education research. In our search in the field of educational technology, we tried to limit our findings to those that came from a management context. Nevertheless, this paper also includes findings from other disciplines when they appeared to be transferable to the management environment. Decisions regarding this transferability were made by the authors.

In terms of the research focus, management is a broad field covering various subdisciplines, including accounting, economics, finance, marketing, and strategy. Some of these fields are comparable in terms of concepts and terminologies, while others are not. Some fields are rather qualitative, and others are strongly quantitative. In addition, the spectrum of management learners ranges from freshmen in undergraduate programs to highly senior MBA students participating in executive programs. Similarly, the use of technologies in education covers a broad field ranging from traditional classroom teaching sporadically facilitated using electronic devices to programs taught fully online. As our objective was to examine antecedents of management learning in a technology-supported environment as a whole, we did not restrict the learning environment in terms of the technologies employed.

Concluding remarks

This paper has shown that educational technologies are quickly becoming an integral part of management education, both in theory and in practice. Although we have identified a number of research gaps and ideas for further research, educational authorities, institutions, and practitioners should not wait for additional research to be completed. Passive knowledge transfer in synchronous, analogue classroom sessions can no longer be viewed as the most effective educational format. In addition, there are already some indications of what constitutes effective technology-supported management education. In the meantime, researchers from different disciplines should pursue investigations of technology-supported settings in relation to management education and beyond.

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Authors' contributions
FAM developed the research idea, conducted the systematic literature analysis, structured the results, and derived future research priorities. TW drafted the work, was a major contributor, and substantially revised the manuscript. All authors read and approved the final manuscript. All authors have agreed both to be personally accountable for the author's own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

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References

Alavi, M. (1994). Computer-mediated collaborative learning: An empirical evaluation. *MIS Quarterly*, *18*, 159–174. https://doi.org/10.2307/249763 .
Alavi, M., & Gallupe, R. B. (2003). Using information technology in learning: Case studies in business and management education programs. *Academy of Management Learning and Education*, *2*, 139–153. https://doi.org/10.5465/amle.2003.9901667 .
Arbaugh, J. B. (2000a). How classroom environment and student engagement affect learning in internet-based MBA courses. *Business Communication Quarterly*, *63*, 9–26. https://doi.org/10.1177/108056990006300402 .
Arbaugh, J. B. (2000b). Virtual classroom characteristics and student satisfaction with internet-based MBA courses. *Journal of Management Education*, *24*, 32–54. https://doi.org/10.1177/105256290002400104 .
Arbaugh, J. B. (2000c). Virtual classroom versus physical classroom: An exploratory study of class discussion patterns and student learning in an asynchronous internet-based MBA course. *Journal of Management Education*, *24*, 213–233. https://doi.org/10.1177/105256290002400206 .
Arbaugh, J. B. (2008). Does the community of inquiry framework predict outcomes in online MBA courses? *International Review of Research in Open and Distributed Learning*, *9*, 1–21. https://doi.org/10.19173/irrodl.v9i2.490 .
Arbaugh, J. B. (2014). What might online delivery teach us about blended management education? Prior perspectives and future directions. *Journal of Management Education*, *38*, 784–817. https://doi.org/10.1177/1052562914534244 .
Arbaugh, J. B. (2016). Where are the dedicated scholars of management learning and education? *Management Learning*, *47*, 230–240. https://doi.org/10.1177/1350507615595773 .
Arbaugh, J. B., & Benbunan-Fich, R. (2006). An investigation of epistemological and social dimensions of teaching in online learning environments. *Academy of Management Learning and Education*, *5*, 435–447. https://doi.org/10.5465/amle.2006.23473204 .
Arbaugh, J. B., DeArmond, S., & Rau, B. L. (2013). New uses for existing tools? A call to study on-line management instruction and instructors. *Academy of Management Learning and Education*, *12*, 635–655. https://doi.org/10.5465/amle.2011.0018A .
Arbaugh, J. B., & Duray, R. (2002). Technological and structural characteristics, student learning, and satisfaction with web-based courses: An exploratory study of two on-line MBA programs. *Management Learning*, *33*, 331–347. https://doi.org/10.1177/1350507602333003 .
Arbaugh, J. B., Godfrey, M. R., Johnson, M., Pollack, B. L., Niendorf, B., & Wresch, W. (2009). Research in online and blended learning in the business disciplines: Key findings and possible future directions. *Internet and Higher Education*, *12*, 71–87. https://doi.org/10.1016/j.iheduc.2009.06.006 .
Arbaugh, J. B., & Hwang, A. (2015). What are the 100 most cited articles in business and management education research, and what do they tell us? *Organization Management Journal*, *12*, 154–175. https://doi.org/10.1080/15416518.2015.1073135 .
Arbaugh, J. B., & Rau, B. L. (2007). A study of disciplinary, structural, and behavioral effects on course outcomes in online MBA courses. *Decision Sciences Journal of Innovative Education*, *5*, 65–95. https://doi.org/10.1111/j.1540-4609.2007.00128.x .
Asarta, C. J., & Schmidt, J. R. (2013). Access patterns of online materials in a blended course. *Decision Sciences Journal of Innovative Education*, *11*, 107–123. https://doi.org/10.1111/j.1540-4609.2012.00366.x .
Asarta, C. J., & Schmidt, J. R. (2017). Comparing student performance in blended and traditional courses: Does prior academic achievement matter? *Internet and Higher Education*, *32*, 29–38. https://doi.org/10.1016/j.iheduc.2016.08.002 .
Beege, M., Schneider, S., Nebel, S., & Rey, G. D. (2017). Look into my eyes! Exploring the effect of addressing in educational videos. *Learning and Instruction*, *49*, 113–120. https://doi.org/10.1016/j.learninstruc.2017.01.004 .
Buttner, E. H., & Black, A. N. (2014). Assessment of the effectiveness of an online learning system in improving student test performance. *Journal of Education for Business*, *89*, 248–256. https://doi.org/10.1080/08832323.2013.869530 .
Carini, R. M., Kuh, G. D., & Klein, S. P. (2006). Student engagement and student learning: Testing the linkages. *Research in Higher Education*, *47*, 1–32. https://doi.org/10.1007/s11162-005-8150-9 .
Concannon, F., Flynn, A., & Campbell, M. (2005). What campus-based students think about the quality and benefits of e-learning. *British Journal of Educational Technology*, *36*, 501–512. https://doi.org/10.1111/j.1467-8535.2005.00482.x .

D'Mello, S., Lehman, B., Pekrun, R., & Graesser, A. (2014). Confusion can be beneficial for learning. *Learning and Instruction*, *29*, 153–170. https://doi.org/10.1016/j.learninstruc.2012.05.003 .
Daspit, J. J., & D'Souza, D. E. (2012). Using the Community of Inquiry framework to introduce wiki environments in blended-learning pedagogies: Evidence from a business capstone course. *Academy of Management Learning and Education*, *11*, 666–683. https://doi.org/10.5465/amle.2010.0154 .
Davis FD (1986) A technology acceptance model for empirically testing new end-user information systems: Theory and results. Doctoral thesis, Massachusetts Institute of Technology
Demetriadis, S. N., Papadopoulos, P. M., Stamelos, I. G., & Fischer, F. (2008). The effect of scaffolding students' context-generating cognitive activity in technology-enhanced case-based learning. *Computers and Education*, *51*, 939–954. https://doi.org/10.1016/j.compedu.2007.09.012 .
Deschacht, N., & Goeman, K. (2015). The effect of blended learning on course persistence and performance of adult learners: A difference-in-differences analysis. *Computers and Education*, *87*, 83–89. https://doi.org/10.1016/j.compedu.2015.03.020 .
Dindar, M., & Akbulut, Y. (2016). Effects of multitasking on retention and topic interest. *Learning and Instruction*, *41*, 94–105. https://doi.org/10.1016/j.learninstruc.2015.10.005 .
Eid, M. I. M., & Al-Jabri, I. M. (2016). Social networking, knowledge sharing, and student learning: The case of university students. *Computers and Education*, *99*, 14–27. https://doi.org/10.1016/j.compedu.2016.04.007 .
Eom, S. B., & Ashill, N. J. (2018). A system's view of e-learning success model. *Decision Sciences Journal of Innovative Education*, *16*, 42–76. https://doi.org/10.1111/dsji.12144 .
Eom, S. B., Wen, H. J., & Ashill, N. (2006). The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation. *Decision Sciences Journal of Innovative Education*, *4*, 215–235. https://doi.org/10.1111/j.1540-4609.2006.00114.x .
Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers and Education*, *50*, 491–498. https://doi.org/10.1016/j.compedu.2007.09.016 .
Fritz, J. (2011). Classroom walls that talk: Using online course activity data of successful students to raise self-awareness of underperforming peers. *Internet and Higher Education*, *14*, 89–97. https://doi.org/10.1016/j.iheduc.2010.07.007 .
Fryer, L. K., & Bovee, H. N. (2016). Supporting students' motivation for e-learning: Teachers matter on and offline. *Internet and Higher Education*, *30*, 21–29. https://doi.org/10.1016/j.iheduc.2016.03.003 .
Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education*, *7*, 95–105. https://doi.org/10.1016/j.iheduc.2004.02.001 .
Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly*, *19*, 213–236. https://doi.org/10.2307/249689 .
Grabe, M., & Christopherson, K. (2008). Optional student use of online lecture resources: Resource preferences, performance and lecture attendance. *Journal of Computer Assisted Learning*, *24*, 1–10. https://doi.org/10.1111/j.1365-2729.2007.00228.x .
Guo, P. J., Kim, J., & Rubin, R. (2014). How video production affects student engagement: An empirical study of MOOC videos. In M. Sahami, A. Fox, M. A. Hearst, & M. T. H. Chi (Eds.), *Proceedings of the first ACM conference on learning @ scale*, (pp. 41–50). New York: ACM Press.
Haggis, T. (2009). What have we been thinking of?: A critical overview of 40 years of student learning research in higher education. *Studies in Higher Education*, *34*, 377–390. https://doi.org/10.1080/03075070902771903 .
Hazari, S., CO'M, B., & Rutledge, R. (2013). Investigating marketing students' perceptions of active learning and social collaboration in blogs. *Journal of Education for Business*, *88*, 101–108. https://doi.org/10.1080/08832323.2011.654141 .
Huang, R.-T. (2014). Exploring the moderating role of self-management of learning in mobile English learning. *Educational Technology and Society*, *17*, 255–267.
Hwang, A., & Arbaugh, J. B. (2006). Virtual and traditional feedback-seeking behaviors: Underlying competitive attitudes and consequent grade performance. *Decision Sciences Journal of Innovative Education*, *4*, 1–28. https://doi.org/10.1111/j.1540-4609.2006.00099.x .
Ituma, A. (2011). An evaluation of students' perceptions and engagement with e-learning components in a campus based university. *Active Learning in Higher Education*, *12*, 57–68. https://doi.org/10.1177/1469787410387722 .
Kember, D., McNaught, C., Chong, F. C. Y., Lam, P., & Cheng, K. F. (2010). Understanding the ways in which design features of educational websites impact upon student learning outcomes in blended learning environments. *Computers and Education*, *55*, 1183–1192. https://doi.org/10.1016/j.compedu.2010.05.015 .
Kintu, M. J., Zhu, C., & Kagambe, E. (2017). Blended learning effectiveness: The relationship between student characteristics, design features and outcomes. *International Journal of Educational Technology in Higher Education*, *14*, 746. https://doi.org/10.1186/s41239-017-0043-4 .
Kizilcec, R. F., Bailenson, J. N., & Gomez, C. J. (2015). The instructor's face in video instruction: Evidence from two large-scale field studies. *Journal of Educational Psychology*, *107*, 724–739. https://doi.org/10.1037/edu0000013 .
Knoerzer, L., Bruenken, R., & Park, B. (2016). Facilitators or suppressors: Effects of experimentally induced emotions on multimedia learning. *Learning and Instruction*, *44*, 97–107. https://doi.org/10.1016/j.learninstruc.2016.04.002 .
Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. *Educational Psychologist*, *48*, 229–242. https://doi.org/10.1080/00461520.2012.750225 .
Krentler, K. A., & Willis-Flurry, L. A. (2005). Does technology enhance actual student learning? The case of online discussion boards. *Journal of Education for Business*, *80*, 316–321. https://doi.org/10.3200/joeb.80.6.316-321 .
Lancellotti, M., Thomas, S., & Kohli, C. (2016). Online video modules for improvement in student learning. *Journal of Education for Business*, *91*, 19–22. https://doi.org/10.1080/08832323.2015.1108281 .
Leidner, D. E., & Jarvenpaa, S. L. (1995). The use of information technology to enhance management school education: A theoretical view. *MIS Quarterly*, *19*, 265–291. https://doi.org/10.2307/249596 .
Leutner, D. (2014). Motivation and emotion as mediators in multimedia learning. *Learning and Instruction*, *29*, 174–175. https://doi.org/10.1016/j.learninstruc.2013.05.004 .
Liu, O. L. (2012). Student evaluation of instruction: In the new paradigm of distance education. *Research in Higher Education*, *53*, 471–486. https://doi.org/10.1007/s11162-011-9236-1 .
López-Pérez, M. V., Pérez-López, M. C., & Rodríguez-Ariza, L. (2011). Blended learning in higher education: Students' perceptions and their relation to outcomes. *Computers and Education*, *56*, 818–826. https://doi.org/10.1016/j.compedu.2010.10.023 .

Macfadyen, L. P., & Dawson, S. (2010). Mining LMS data to develop an "early warning system" for educators: A proof of concept. *Computers and Education*, *54*, 588–599. https://doi.org/10.1016/j.compedu.2009.09.008 .
Markel, M. (1999). Distance education and the myth of the new pedagogy. *Journal of Business and Technical Communication*, *13*, 208–222. https://doi.org/10.1177/1050651999013002005 .
Mayer, R. E. (2002). Multimedia learning. *Psychology of Learning and Motivation*, *41*, 85–139. https://doi.org/10.1016/S0079-7421(02)80005-6 .
Mayer, R. E. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. *Learning and Instruction*, *13*, 125–139. https://doi.org/10.1016/S0959-4752(02)00016-6 .
Mayer, R. E. (2014). Incorporating motivation into multimedia learning. *Learning and Instruction*, *29*, 171–173. https://doi.org/10.1016/j.learninstruc.2013.04.003 .
Mayer, R. E., & Chandler, P. (2001). When learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Educational Psychology*, *93*, 390–397. https://doi.org/10.1037//0022-0663.93.2.390 .
Mayer, R. E., Dow, G. T., & Mayer, S. (2003). Multimedia learning in an interactive self-explaining environment: What works in the design of agent-based microworlds? *Journal of Educational Psychology*, *95*, 806–812. https://doi.org/10.1037/0022-0663.95.4.806 .
Mayer, R. E., & Moreno, R. (2003). Nine ways to reduce cognitive load in multimedia learning. *Educational Psychologist*, *38*, 43–52. https://doi.org/10.1207/S15326985EP3801_6 .
McGill, T. J., & Klobas, J. E. (2009). A task–technology fit view of learning management system impact. *Computers and Education*, *52*, 496–508. https://doi.org/10.1016/j.compedu.2008.10.002 .
McLaren, C. H. (2004). A comparison of student persistence and performance in online and classroom business statistics experiences. *Decision Sciences Journal of Innovative Education*, *2*, 1–10. https://doi.org/10.1111/j.0011-7315.2004.00015.x .
Moreno, R. (2006). Does the modality principle hold for different media? A test of the method-affects-learning hypothesis. *Journal of Computer Assisted Learning*, *22*, 149–158. https://doi.org/10.1111/j.1365-2699.2006.01595.x .
Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, *19*, 309–326. https://doi.org/10.1007/s10648-007-9047-2 .
Nemanich, L., Banks, M., & Dusya, V. (2009). Enhancing knowledge transfer in classroom versus online settings: The interplay among instructor, student, content, and context. *Decision Sciences Journal of Innovative Education*, *7*, 123–148. https://doi.org/10.1111/j.1540-4609.2008.00208.x .
Nihalani, P. K., Mayrath, M., & Robinson, D. H. (2011). When feedback harms and collaboration helps in computer simulation environments: An expertise reversal effect. *Journal of Educational Psychology*, *103*, 776–785. https://doi.org/10.1037/a0025276 .
O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *Internet and Higher Education*, *25*, 85–95. https://doi.org/10.1016/j.iheduc.2015.02.002 .
O'Neill, D. K., & Sai, T. H. (2014). Why not? Examining college students' reasons for avoiding an online course. *Higher Education*, *68*, 1–14. https://doi.org/10.1007/s10734-013-9663-3 .
Owston, R., York, D., & Murtha, S. (2013). Student perceptions and achievement in a university blended learning strategic initiative. *Internet and Higher Education*, *18*, 38–46. https://doi.org/10.1016/j.iheduc.2012.12.003 .
Palocsay, S. W., & Stevens, S. P. (2008). A study of the effectiveness of web-based homework in teaching undergraduate business statistics. *Decision Sciences Journal of Innovative Education*, *6*, 213–232. https://doi.org/10.1111/j.1540-4609.2008.00167.x .
Park, B., Moreno, R., Seufert, T., & Brünken, R. (2011). Does cognitive load moderate the seductive details effect? A multimedia study. *Computers in Human Behavior*, *27*, 5–10. https://doi.org/10.1016/j.chb.2010.05.006 .
Park, B., Plass, J. L., & Brünken, R. (2014). Cognitive and affective processes in multimedia learning. *Learning and Instruction*, *29*, 125–127. https://doi.org/10.1016/j.learninstruc.2013.05.005 .
Piccoli, G., Ahmad, R., & Ives, B. (2001). Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training. *MIS Quarterly*, *25*, 401–426. https://doi.org/10.2307/3250989 .
Plass, J. L., Heidig, S., Hayward, E. O., Homer, B. D., & Um, E. R. (2014). Emotional design in multimedia learning: Effects of shape and color on affect and learning. *Learning and Instruction*, *29*, 128–140. https://doi.org/10.1016/j.learninstruc.2013.02.006 .
Redpath, L. (2012). Confronting the bias against on-line learning in management education. *Academy of Management Learning and Education*, *11*, 125–140. https://doi.org/10.5465/amle.2010.0044 .
Reed, P., & Reay, E. (2015). Relationship between levels of problematic internet usage and motivation to study in university students. *Higher Education*, *70*, 711–723. https://doi.org/10.1007/s10734-015-9862-1 .
Scheiter, K., & Gerjets, P. (2007). Learner control in hypermedia environments. *Educational Psychology Review*, *19*, 285–307. https://doi.org/10.1007/s10648-007-9046-3 .
Selim, H. M. (2003). An empirical investigation of student acceptance of course websites. *Computers and Education*, *40*, 343–360. https://doi.org/10.1016/S0360-1315(02)00142-2 .
Selim, H. M. (2007). Critical success factors for e-learning acceptance: Confirmatory factor models. *Computers and Education*, *49*, 396–413. https://doi.org/10.1016/j.compedu.2005.09.004 .
Seufert, T. (2003). Supporting coherence formation in learning from multiple representations. *Learning and Instruction*, *13*, 227–237. https://doi.org/10.1016/S0959-4752(02)00022-1 .
Sloan, T. W., & Lewis, D. A. (2014). Lecture capture technology and student performance in an operations management course. *Decision Sciences Journal of Innovative Education*, *12*, 339–355. https://doi.org/10.1111/dsji.12041 .
Snowball, J. D. (2014). Using interactive content and online activities to accommodate diversity in a large first year class. *Higher Education*, *67*, 823–838. https://doi.org/10.1007/s10734-013-9708-7 .
Solimeno, A., Mebane, M. E., Tomai, M., & Francescato, D. (2008). The influence of students' and teachers' characteristics on the efficacy of face-to-face and computer supported collaborative learning. *Computers and Education*, *51*, 109–128. https://doi.org/10.1016/j.compedu.2007.04.003 .
Song, L., Singleton, E. S., Hill, J. R., & Koh, M. H. (2004). Improving online learning: Student perceptions of useful and challenging characteristics. *Internet and Higher Education*, *7*, 59–70. https://doi.org/10.1016/j.iheduc.2003.11.003 .

Sun, P.-C., Tsai, R. J., Finger, G., Chen, Y.-Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. *Computers and Education*, *50*, 1183–1202. https://doi.org/10.1016/j.compedu.2006.11.007 .

Terpend, R., Gattiker, T. F., & Lowe, S. E. (2014). Electronic textbooks: Antecedents of students' adoption and learning outcomes. *Decision Sciences Journal of Innovative Education*, *12*, 149–173. https://doi.org/10.1111/dsji.12066 .

Um, E. R., Plass, J. L., Hayward, E. O., & Homer, B. D. (2012). Emotional design in multimedia learning. *Journal of Educational Psychology*, *104*, 485–498. https://doi.org/10.1037/a0026609 .

Volery, T., & Lord, D. (2000). Critical success factors in online education. *International Journal of Educational Management*, *14*, 216–223. https://doi.org/10.1108/09513540010344731 .

Walker, K., Curren, M. T., Kiesler, T., Lammers, H. B., & Goldenson, J. (2013). Scholarly networking among business students: Structured discussion board activity and academic outcomes. *Journal of Education for Business*, *88*, 249–252. https://doi.org/10.1080/08832323.2012.690352 .

Webster, J., & Hackley, P. (1997). Teaching effectiveness in technology-mediated distance learning. *Academy of Management Journal*, *40*, 1282–1309. https://doi.org/10.2307/257034 .

Whitaker, J., New, J. R., & Ireland, R. D. (2016). MOOCs and the online delivery of business education: What's new? What's not? What now? *Academy of Management Learning and Education*, *15*, 345–365. https://doi.org/10.5465/amle.2013.0021 .

Woo, J.-C. (2014). Digital game-based learning supports student motivation, cognitive success, and performance outcomes. *Educational Technology and Society*, *17*, 291–307.

Wu, J.-H., Tennyson, R. D., & Hsia, T.-L. (2010). A study of student satisfaction in a blended e-learning system environment. *Computers and Education*, *55*, 155–164. https://doi.org/10.1016/j.compedu.2009.12.012 .

Xu, D., & Jaggars, S. S. (2014). Performance gaps between online and face-to-face courses: Differences across types of students and academic subject areas. *Journal of Higher Education*, *85*, 633–659. https://doi.org/10.1353/jhe.2014.0028 .

Yourstone, S. A., Kraye, H. S., & Albaum, G. (2008). Classroom questioning with immediate electronic response: Do clickers improve learning? *Decision Sciences Journal of Innovative Education*, *6*, 75–88. https://doi.org/10.1111/j.1540-4609.2007.00166.x .

Zacharis, N. Z. (2015). A multivariate approach to predicting student outcomes in web-enabled blended learning courses. *Internet and Higher Education*, *27*, 44–53. https://doi.org/10.1016/j.iheduc.2015.05.002 .

Zhao, C.-M., & Kuh, G. D. (2004). Adding value: Learning communities and student engagement. *Research in Higher Education*, *45*, 115–138. https://doi.org/10.1023/B:RIHE.0000015692.88534.de .

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