Deliverable 2.1. Analysis report

ALO!-project - Work package 2:

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Content

1 Preface

The main objective of work package 2 is to develop and test design guidelines for blended learning at the micro level, i.e. specific learning activities within a course. The focus is on how several learning activities within a course should be designed and combined in view of establishing more effective learning support. In this deliverable we focus on the current state of research. Two systematic literature reviews were administered to examine the to-date literature about blended learning environments. On the one hand there is focused on how blended learning environments are designed and which elements were present in these design studies and on the other hand there is focused on attributes that support self-regulation in blended learning environments. Below you can find a short summary of both review studies. During the second phase of the project we will combine results of both studies and establish a framework for the description of blended learning environments.

In Search of Attributes That Support Self-Regulation in Blended Learning Environments.

Stijn Van Laer & Jan Elen (KU Leuven, Centre for Instructional Psychology and Technology)

Blended forms of learning have become increasingly popular. Learning activities within these environments are supported by a large variety of online and face-to-face interventions. However, it remains unclear whether these blended environments are successful, and if they are, what makes them successful. Studies suggest that blended learning challenges the self-regulatory abilities of learners, though the literature does little to explain these findings; nor does it provide solutions. In particular, little is known about the attributes that are essential to support learners and how they should guide course design. This systematic literature review (n=95) examines evidence published between 1985 and 2015 on attributes of blended learning environments that support self-regulation. The purpose of this review is therefore to identify and define the attributes of blended learning environments that support learners' self-regulatory abilities. Seven key attributes were found (authenticity, personalization, learner-control, scaffolding, interaction, cues for reflection and cues for calibration). This review is the first to identify and define the attributes that support self-regulation in blended learning environments and may serve to facilitate the design of blended learning environments that meet learners' self-regulatory needs. It also raises crucial questions about how blended learning relates to well-established learning theories and provides a basis for future research on self-regulation in blended learning environments.

Van Laer, S., & Elen, J. (2017). In search of attributes that support self-regulation in blended learning environments. *Education and Information Technologies*, *22*(4), 1395-1454.

How To Design Blended Learning? A Review Study

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Although many instructors in education are increasingly being required to incorporate technology-enhanced learning in their instruction, the research on blended learning remains fragmented across different studies and the literature does not explicitly put forward an overarching framework for designing blended learning environments. Therefore, this study reviews 19 co-existing studies on the design and development of blended learning environments in order to investigate which design features were used until now. The following research questions were addressed: How do blended learning environments deal with (1) learner flexibility, (2) interaction, (3) guiding students' learning processes, and (4) fostering an affective climate? The results showed that few studies provide opportunities for learners to choose between online or classroom-based activities. Second, designers often implemented an initial face-to-face meeting, together with a number of online features, to facilitate a good interpersonal relationship. Third, the most common regulative teaching activities were familiarizing students with technology, and providing online quizzes, organizational information, and feedback. Fourth, clarifying expectations and fostering learners' motivation received attention to foster an affective climate, while dealing with emotions and appraising were often neglected. Finally, we noticed that most of the selected studies only provided little explanation about the assumptions underlying their specific design, and suggest that this should be explained explicitly in future studies.

Boelens, R., De Wever, B., & Voet, M. (2017). Four key challenges to the design of blended learning: A systematic literature review. *Educational Research Review*, *22*, 1-18.

2 In Search of Attributes That Support Self-Regulation in Blended Learning Environments.

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ABSTRACT

Blended forms of learning have become increasingly popular. Learning activities within these environments are supported by a large variety of online and face-to-face interventions. However, it remains unclear whether these blended environments are successful, and if they are, what makes them successful. Studies suggest that blended learning challenges the self-regulatory abilities of learners, though the literature does little to explain these findings; nor does it provide solutions. In particular, little is known about the attributes that are essential to support learners and how they should guide course design. This systematic literature review (n=95) examines evidence published between 1985 and 2015 on attributes of blended learning environments that support self-regulation. The purpose of this review is therefore to identify and define the attributes of blended learning environments that support learners' self-regulatory abilities. Seven key attributes were found (authenticity, personalization, learner-control, scaffolding, interaction, cues for reflection and cues for calibration). This review is the first to identify and define the attributes that support self-regulation in blended learning environments and may serve to facilitate the design of blended learning environments that meet learners' self-regulatory needs. It also raises crucial questions about how blended learning relates to well-established learning theories and provides a basis for future research on self-regulation in blended learning environments.

Keywords

Blended learning, self-regulation, support, instructional design, systematic review

2.1 Introduction

During the last two decades we have seen a steep rise in computer- and web-based technologies, which has led to significant changes in education. Blended forms of learning have become increasingly popular (Garrison & Kanuka, 2004; Garrison & Vaughan, 2008; Graham, 2006; Spanjers et al., 2015). Learning activities within these blended environments are supported by a large variety of online and face-to-face instructional interventions. As a result of this, blended learning environments differ widely in the technologies used, the extent of integration of online and face-to-face instruction and the degree to which online activities are meant to replace face-to-face instruction (Smith & Kurthen, 2007). Despite their popularity, it remains unclear whether these environments are successful, and if they are, which attributes make them successful (Oliver & Trigwell, 2005). An important observation is that blended learning seems to be especially challenging for learners with lower self-regulatory abilities; but the opposite is also true: those who are able to regulate their own learning do well in these environments (Barnard, Lan, To, Paton, & Lai, 2009; Lynch & Dembo, 2004). However, it remains

unclear why this is the case and what can be done to help struggling learners. This is problematic since educational research shows that the effectiveness of a learning environment depends on its design (Piccoli, Ahmad, & Ives, 2001), e.g. the nature of the tasks given to learners and the information provided to help them perform the learning activities (Smith & Ragan, 1999; Sweller, Van Merrienboer, & Paas, 1998). In order to design blended learning environments that support self-regulation and thus make learning more effective, we first need to determine the attributes of such environments. This paper therefore makes a first attempt to identify and define these attributes in the existing literature. After providing a brief overview of existing theories of self-regulation, we explain why the model we used as a framework to reflect upon the results of this review was most appropriate. Subsequently, we review the relevant literature, identify the attributes of effective blended learning environments and define them. This definition is particularly challenging, firstly because an inductive or bottom-up approach was used in this systematic literature review (see: Hart, 2009; Joy, 2007); its aim was to identify attributes rather than validating them. Secondly, numerous studies have already noted (e.g., Petticrew & Roberts, 2008) that conceptual transparency is often lacking in intervention studies within learning and educational sciences. It is likely, then, that while the retrieved studies report on common attributes, they approach them from different perspectives. While this complicates the definition process, such definitions are nonetheless likely to make a key contribution when designing interventions aimed at particular attributes.

2.1.1 Learner variables influencing self-regulation

In this study learning is seen as an activity performed by learners for themselves in a proactive manner, rather than as something that happens to them as results of instruction (Bandura, 1989; Benson, 2013; Knowles, Holton, & Swanson, 2014). Learning is therefore seen as a self-regulated process (Zimmerman & Schunk, 2001). This perception of the abilities of learners to regulate their learning originates from the social cognitive perspective (Bandura, 1977). Over the past three decades, various self-regulated learning theories have been grafted onto this perspective. Five main theories can be identified in the leading reviews written to date (e.g., Baumeister & Heatherton, 1996; Boekaerts, 1999; Boekaerts, Pintrich, & Zeidner, 2005; Puustinen & Pulkkinen, 2001; Zimmerman & Schunk, 2001). These theories describe a cyclic process of self-regulatory phases, often consisting of (a) defining the task, (b) goal-setting and planning, (c) performance and (d) evaluation (e.g. Boekaerts' Model of Adaptable Learning (1992, 1995, 1996a, 1996b, 1997; Boekaerts et al., 2005) and Pintrich's General Framework for Self-regulation (Pintrich, 2000; Pintrich & De Groot, 1990; Schunk, Pintrich, & Meece, 2008)). In total, the five main theories also identify three categories of variables: (1) cognition (e.g. Zimmerman's cyclical Social Cognitive Model of Self-regulation (Zimmerman, 1986, 1990, 1998; Zimmerman, 2000; Zimmerman & Pons, 1986)), (2) metacognition (e.g. Borkowski's Process-oriented Model of Metacognition (Borkowski, Carr, Rellinger, Pressley, & others, 1990; Pressley, Levin, & McDaniel, 1987)) and (3) motivation (e.g., Butler & Winne, 1995; Schraw, Crippen, & Hartley, 2006; Schraw & Moshman, 1995; Zimmerman, 2000).

Although no theory of self-regulation can be considered superior to any other, the Winne and Hadwin (1998) model was selected to facilitate the search for attributes of blended learning environment that support self-regulation since it has a number of characteristics that make it very suitable for the purpose of this study. These characteristics are outlined in more detail below. As the name suggests, Winne's Four-stage Model of Self-regulated Learning (Butler & Winne, 1995; Winne, 1995, 1996; Winne & Hadwin, 1998; Winne & Perry, 2000) describes four stages: (1) task definition, during which learners develop perceptions of the task concerned; (2) goal-setting and planning; (3) enacting the tactics and strategies chosen during goal-setting and planning; and (4) metacognitively adapting studying techniques, keeping future needs in mind. Each of these phases consists of five elements:

Conditions, Operations, Procedures, Evaluations and Standards (COPES). The theory emphasizes that learners whose teachers prompt more effective processing in stage one (task definition) and stage two (goal-setting and planning) are more likely to have accurate expectations of the task (Winne & Hadwin, 1998). At the second level, Winne and Hadwin (1998) describe the conditions that influence each of these phases. First, they provide information about the task conditions (e.g. time constraints, available resources and social context). Secondly, they outline the cognitive conditions (e.g. interest, goal orientation and task knowledge) that influence how the task will be engaged with (Winne & Hadwin, 1998). Cognitive conditions are influenced by epistemological beliefs, prior knowledge (all information stored in the long-term memory) and motivation (Winne & Hadwin, 1998).

As mentioned above, the Four-stage Model of Self-regulated Learning has four key characteristics that suit the purposes of this study very well. Firstly, the model looks beyond the focus on instructional stimuli and their effect on learning, assuming instead that all learners process the stimuli as intended (Winne, 1982). The authors see learners as active agents (Winne, 1982, 1985, 2006) or mediating factors in the instructional process, a perspective on instruction which is largely undocumented and needs consideration (Keller, 2010b; Winne, 1982). The model gives clear indications about which phases should be targeted, namely task definition followed by goal-setting and planning (Winne & Hadwin, 1998). A second consideration is that each phase (one to four) incorporates the COPES process, which when combined make up the cognitive system (Greene & Azevedo, 2007). This cognitive system explicitly models how work is done in each phase and allows for a more detailed look at how various aspects of the COPES architecture interact (Greene & Azevedo, 2007). Thirdly, with monitoring and control functioning as the key drivers of regulation within each phase, Winne and Hadwin's model can effectively describe how changes in one phase can lead to changes in other phases over the course of learning (Greene & Azevedo, 2007). This allows the model to explicitly detail the recursive nature of self-regulation (Greene & Azevedo, 2007). A fourth and final reason for this model's suitability is that it separates task definition and goal-setting and planning into distinct phases, in contrast to the model of Pintrich (2000) for example; this allows more pertinent questions to be asked about these phases than would otherwise be the case when focusing on instructional interventions (Greene & Azevedo, 2007; Winne & Marx, 1989). In this respect the systematic literature review presented here will focus on asking such questions and identifying the attributes of blended learning environments that are deliberately integrated into or added to the environment in order to support self-regulated learning (Zumbrunn, Tadlock, & Roberts, 2011).

2.1.2 Support in blended learning environments

This study focuses exclusively on blended learning environments. In their editorial for the Journal of Educational Media, Whitelock and Jelfs (2003) described three definitions of the concept of blended learning. These definitions were also used as a categorization by Graham (2006) in the handbook of blended learning, and by Ifenthaler (2010) in his book on learning and instruction in the digital age. The first definition (based on Harrison (2003)) views blended learning as the integrated combination of traditional learning with web-based online approaches (Bersin & others, 2003; Orey, 2002a, 2002b; Singh, Reed, & others, 2001; Thomson, 2002). The second one considers it a combination of media and tools employed in an e-learning environment (Reay, 2001; Rooney, 2003; Sands, 2002; Ward & LaBranche, 2003; Young, 2001) and the third one treats it as a combination of a number of didactic approaches, irrespective of the learning technology used (Driscoll, 2002; House, 2002; Rossett, 2002). Driscoll (2002, p. 1) concludes that "the point is that blended learning means different things to different people, which illustrates its widely untapped potential". Oliver and Trigwell (2005) add that the term remains unclear and ill-defined. Taking these observations into account, the definition used in this study is as follows: "Blended learning is learning that happens in an instructional context which

is characterized by a deliberate combination of online and classroom-based interventions to instigate and support learning. Learning happening in purely online or purely classroom-based instructional settings is excluded" (Boelens, Van Laer, De Wever, & Elen, 2015).

A formal definition of learner support in blended learning environments does not yet seem to have been provided in research literature, although a considerable number of researchers (e.g., Kearsley & Moore, 1996; Keegan, 1996; Robinson, 1995; Tait, 2000; Thorpe, 2002) have made valuable contributions by defining similar concepts. Learner support in blended learning environments often refers to meeting the needs all learners have, choices at course level, preparatory tests, study skills, access to seminars and tutorials, and so on. These are elements in systems of learner support that many practitioners see as essential for the effective provision of blended learning (Kearsley & Moore, 1996; Keegan, 1996). Nonetheless Sewart (1993) notes that a review of key areas of the literature dating back to 1978 does not reveal any comprehensive analysis of learner support services (see also Robinson (1995)). It is therefore particularly challenging to address the issue of learner support in blended learning. Tait (2000) describes the central functions of learner support services in non-strictly face-to-face settings most fundamentally, arguing that it should be cognitive, affective, and systemic (Tait, 2000). In this study, 'support' refers to all measures taken to instigate and / or facilitate learning.

A final remark should be made regarding the term 'learning outcome'. This term is often used in the same sense as learning objectives (Melton, 1997), but in our opinion this understanding is too narrow and too focused on an increase in performance. In this study, learning outcomes are defined as changes (due to support) in cognitive, metacognitive or motivational abilities, which together constitute a learner's ability to self-regulate (e.g., Allan, 1996; Popham, Eisner, Sullivan, & Tyler, 1969).

2.1.3 Problem statement

There is a growing realization that the precise design of blended learning environments has different impacts on learning for different types of learners. It has been suggested that blended learning makes high demands of learners' self-regulatory abilities and is therefore a major challenge for those with lower self-regulatory abilities. The opposite is also true: blended learning environments are well suited to learners who work well in environments with e.g. a lot of learner control. We do not yet know why this is the case or what a solution might be for learners who struggle. In particular, little is known about the attributes of blended learning environments that are essential to support learners and how they should guide course design. Winne and Marx (1989) and Keller (2010a) have called for an approach to course design in blended learning that centres more closely around supporting self-regulation. As a consequence, the research question addressed in this systematic literature review is: "What attributes of blended learning environments support learners' self-regulation?" In answering this research question, we identify the attributes of blended learning environments that support self-regulation and define them. This facilitates the design of blended learning environments that meet learners' needs from a self-regulatory perspective.

2.2 Methodology

The methodological approach used to answer the research question was based both on research literature on systematic literature reviews (e.g., Hart, 2009; Joy, 2007) and on the methodologies used in highly valued educational reviews with similar methodological aims (e.g., Bernard et al., 2004; Blok, Oostdam, Otter, & Overmaat, 2002; Butler & Winne, 1995; De Jong & Van Joolingen, 1998; Greene & Azevedo, 2007; Tallent-Runnels et al., 2006; Tinto, 1975). By comparing both methodological sources, it could be observed that most of the reviews suggest a similar design as presented by Hart (2009). His

methodological outline and suggestions will be therefore used to perform the systematic literature review.

First, general searches for background information on the study's main concepts were performed. This resulted in an initial map of related topics, a vocabulary of concepts and a provisional list of key authors. The findings of this phase were reported in the introduction of the systematic literature review and functions as a theoretical basis to reflect upon the results of this study. On the other hand, the focus on the topics to be analysed and the identification of information needs regarding the topic was established, resulting in a clear research question. This research question was reported during the problem statement. To answer this research question relevant data was collected and analysed. These procedures will be described below.

2.2.1 Data collection

To establish a collection of publications to be analysed and synthesized, relevant databases for retrieving publications on instruction and information (and communication) technology were identified (n=5): Web of Science, ProQuest, EBSCOhost, Science Direct and OvidSP. The search terms used to perform the searches derived from a deductive process based on the key concepts of this study as presented in the introduction. The following search string was used: ("blended learning" OR "online learning" OR "hybrid learning" OR "web based learning" OR "distance learning" OR "virtual learning") AND design AND (low OR poor OR inadequate OR negative) AND self-regulat* AND ("prior knowledge" OR "cognitive strategies" OR "learning strategies" OR "motivation") AND (problem* OR solution* OR effects OR issues OR explain*) AND ("adult learner" OR "adult learning" OR postgraduate OR post-graduate OR postsecondary OR post-secondary) NOT (kindergarten OR "primary education" OR "secondary education" OR under-graduate OR undergraduate OR "K-12" OR elementary). A number of additional inclusion and exclusion criteria were specified to select appropriate publications for inclusion in the systematic literature review. To be included in the review, publications had to (a) have been published between January 1985 and February 2015, (b) have no duplicates, (c) include full text, (d) include empirical evidence (research based on, concerned with, or verifiable by observation or experience rather than theory or pure logic (see: Barratt (1971); Mouly (1978)) relating to the impacts and outcomes of blended learning environments; this was to address the perceived lack of empirical evidence concerning blended learning. Finally publications had to (e) include performance measures that reflected individual courses (micro level) or learning tasks, rather than entire programmes.

2.2.2 Data analysis

Following the suggestion of Hart (2009), the publications were first skimmed for structure, overall topic, style, general reasoning, data and bibliographical references. A second more detailed survey followed of the sections of each publication (introduction, theoretical foundations, methodology, etc.). The third step included the creation of a summary of each publication retrieved. This was to ensure the preservation of the rich data and context of each publication. A minimally condensed version of this summary can be found in Appendix 1. The summary includes: (a) the aim of each publication, (b) the dependent and independent variables, (c) the sample (including the characteristics of the participants), (d) the procedure or method used, (e) the measurement instrument(s) used and (f) the results and conclusions. This analysis was performed and managed in QSR NVIVO 10 and summarized in MS Word and Excel documents. Based on this third step, the analysis for common attributes was performed by comparing the different variables, results and conclusions with one another. Once the attributes were identified, a twofold (peer-reviewed by the other author), double check (manual versus bibliometric (Cheng et al., 2014) to ensure inter-coder reliability) was performed to ensure that the attributes identified when synthesizing the summaries were found by both researchers individually

and explicitly retrieved in the consulted publications. Thus, both researchers synthesized a sample of the summaries and compared their findings. A text search query was also used to check whether the attributes identified by analysing the summaries were also found explicitly in the retrieved publications (see for detailed methodology: Cheng et al. (2014); Graddol, Maybin, and Stierer (1994); Popping (2000); Romero and Ventura (2007); Wegerif and Mercer (1997)). Finally, based on the identification of the common attributes and the publications that refer explicitly to these attributes, a detailed analysis of the publications involved was done to determine what decisions and conclusions could be drawn from these publications. The results of this analysis can be found in the results section.

2.3 Results

Using the search string mentioned above, an initial search was performed per database, on title and abstract. In total, 247 publications were retained and imported into Endnote X7. A search for overlap or duplicates was done. The publications retrieved first were retained and the duplicate removed from the database. A total of seventeen publications were deleted and 230 publications retained. The last step was the automatic search, performed in Endnote X7, for the full texts of each abstract. A total of 88 publications were removed from the database due to a lack of full text. The remaining 142 publications were imported into QSR NVivo 10 for further analysis. All 142 publications were scanned for general relevance and empirical evidence. Reviews (n=30) and irrelevant publications (n=17) (see for example: "Community based forest enterprises in Britain: Two organizing typologies" by Ambrose-Oji, Lawrence, and Stewart (2014)) were excluded. This brought the number of publications included to 95. No publications were excluded based on (d) the level of focus (course or curriculum): all the publications retrieved reported on course level.

2.3.1 Descriptive statistics of the publications included

General descriptive statistics say something about the field of blended learning and the inclusion of self-regulation in the discourse. The search included all publications from between January 1985 and February 2015. It is noteworthy that no publications were retrieved from the period 1985 to 2001. Between 2002 and 2009 an annual average of four publications were published relating to the search results of this systematic literature review. Between 2010 and February 2015, an average of eleven publications were published per year. The descriptive results of the systematic literature review also show which journals the majority of retrieved publications originated from. The largest proportion of publications were retrieved from Computers & Education (n=19); Computers in Human Behaviour produced thirteen publications, followed by The Internet & Higher Education (n=10), the International Journal of Human-Computer Studies (n=4), Nurse Education Today (n=3), Learning & Instruction (n=3), Higher Education (n=2), Journal of Computing in Higher Education (n=2) and the International Journal of Educational Research (n=2). These journals accounted for 61% of all the retrieved publications. In total, 61 of the retrieved publications were quantitative; 33 included experimental interventions with pre- and post-tests in controlled conditions; 23 retrieved information using surveys; and 5 reported on quasi-experiments (e.g. no pre- or post-tests). Finally, 13 publications were qualitative in nature and used case studies (n=5), observations (n=1), document analysis (n=2) or interviews (n=5) as their method. In the mixed-method combinations of quasi-experiments and interviews, observations and document analysis were used (n=13). Table 1 shows the number of publications retrieved by type of research and methodology used. The publications retrieved were also analysed by the learning variables taken into account. The majority of the publications (n=57) reported on a mix of learning variables (cognition, metacognition and motivation); 30 publications reported on individual variables. Table 2 shows the number of publications retrieved by learner variable. Both the methodological data and the variables used can be found in the individual summaries presented in Appendix 1.

Table 1: Number of publications retrieved by type of research and methodology used.

Type of research (n=87)	*Quantitative methods*	61		
			Experiment	33
			Quasi-experiment	5
			Survey	23
	Qualitative methods	13		
			Case-study	5
			Observation	1
			Document analysis	2
			Interview	5
	Mixed methods	13		

* Eight exclusions were made due to a lack of explicit reference to attributes.

Table 2: Number of publications retrieved by learner variables used.

Learner variables (n=87)	Cognition, metacognition and motivation	15
	Cognition and metacognition	14
	Metacognition and motivation	20
	Cognition and motivation	8
	Cognition	12
	Metacognition	7
	Motivation	11

* Eight exclusions were made due to a lack of explicit reference to attributes.

2.3.2 Attributes of blended learning for self-regulation

As mentioned above, after analysing the publications' descriptive features and learner variables (cognitive, metacognitive and motivational) a search was performed to identify common attributes of interest in the retrieved publications. Once the attributes were identified, a twofold (peer-reviewed), double check (manual versus bibliometric) was performed to ensure that the attributes identified when synthesizing the summaries were found by both researchers individually and explicitly retrieved in the consulted publications.

The systematic literature review presented here suggests that blended learning environments that foster cognition, metacognition and motivation and thus support self-regulation have seven main attributes. These attributes are (1) authenticity, (2) personalization, (3) learner control, (4) scaffolding, (5) interaction, (6) reflection cues and finally (7) calibration cues. Table 3 shows the number of publications retrieved per attribute: 87 reported on at least one attribute (eight were excluded due to a lack of explicit reference to at least one attribute). It is important to note that 59 articles reported

on at least two attributes, with a maximum of six attributes per publication. This illustrates the interrelatedness of each attribute with the others. The summaries in Appendix 1 report on the attributes identified in each of the publications. Based on these findings the relevant publications were synthesized in more depth. Each attribute is elaborated on in more detail below.

Table 3: Number of publications retrieved per attribute.

Attributes	Authenticity	29
	Personalization	24
	Learner-control	18
	Scaffolding	24
	Interaction	70
	Reflection	19
	Calibration	15

2.3.2.1 Authenticity

In total, 29 publications appear to centre around authenticity (e.g., Ai-Lim Lee, Wong, & Fung, 2010; Artino, 2009b; Chen, 2014; Corbalan, Kester, & van Merriënboer, 2008; Demetriadis, Papadopoulos, Stamelos, & Fischer, 2008; Donnelly, 2010; Gulikers, Bastiaens, & Martens, 2005; Smith, Craig, Weir, & McAlpine, 2008; Ting, 2013) and report its influence on cognitive (e.g., Corbalan et al., 2008; Gulikers et al., 2005), metacognitive (e.g., Chen, 2014; Kuo, Hwang, & Lee, 2012) and motivational (e.g., Kovačević, Minović, Milovanović, de Pablos, & Starčević, 2013; Sansone, Fraughton, Zachary, Butner, & Heiner, 2011; Siampou, Komis, & Tselios, 2014) variables that influence the self-regulatory abilities of learners. The retrieved publications contained several definitions of authenticity, ranging from 'real-world relevance' and 'needed in real-life situations' to 'of important interest to the learner for later professional. In sum, authenticity was treated as the real-world relevance, to the learners' professional and personal lives, of the learning experience. It was described as being manifested in both the learning environment and the task at hand.

The majority of publications retrieved referred to the motivational value of authentic learning tasks. In this respect Ai-Lim Lee et al. (2010) used a survey study and Kovačević et al. (2013) an experimental design to conclude that authentic tasks in an educational context are associated with finding meaning and relevance and therefore associated with higher motivation. In their survey study, Sansone et al. (2011) add that when learners have little pre-existing interest or motivation, tasks that practise skills needed in real-life situations were more motivating. An example is provided in the interview study of Smith et al. (2008), who report that learners wanted to be involved in education as long it proved to have a practical application and relevance to their professional background.

On the metacognitive side, a survey study included in the experimental study of Chen (2014) and Kuo et al. (2012) found that authentic digital learning materials significantly influenced learners' perceptions of learning outcome expectations, learning gratification and learning climate in web-based learning environments. Wesiak et al. (2014) conducted an experiment and analysed log-files of learners. They add to the previous findings that real-world relevance in an online medical simulation improved metacognitive skills. Taken together, these findings suggest that authentic tasks influence

cognitive (e.g. prior knowledge and performance), metacognitive (e.g. learning outcome expectations) and motivational (e.g. enjoyment, intrinsic motivation) learner variables, which in turn influence the self-regulatory abilities of learners. However, Gulikers et al. (2005) conducted an experiment and emphasized that authentic tasks and authentic contexts are two different things and have different impacts on learning (no evidence was found for the superiority of authentic environments). Corbalan et al. (2008) analysed log-files during an experiment and added to this that for novice learners, the acquisition of complex skills by performing authentic tasks is heavily constrained by the limited processing capacity of their working memory and that such tasks can cause cognitive overload and should therefore be adapted to the individual needs of learners.

2.3.2.2 Personalization

We identified 24 publications which address personalization (e.g., Hung & Hyun, 2010; Law & Sun, 2012; Leen & Lang, 2013; Liaw, Hatala, & Huang, 2010; Ma, 2012; Reichelt, Kämmerer, Niegemann, & Zander, 2014; Yu, Chen, Yang, Wang, & Yen, 2007). In these publications, personalization is defined as non-homogenous experiences related directly to the tailoring of the learning environment (both the characteristics and objects) to the inherent needs of each individual learner (topics of high interest value). Examples include elements of name recognition or the integration of name-specific references to the learner, self-description or tailoring of the environment to the individual preferences (content, subject, etc.) of the learner and cognitive-situationing or adapting the environment to the performance level of the learner.

Some of the retrieved publications report on interventions carried out to identify the effect of personalization on a mix of learner variables, whereby Reichelt et al. (2014), using a quasi-experimental set-up including document analysis, and Leen and Lang (2013), using a survey study, found that personalized learning materials, a good fit of learning contexts integrating the personal preferences of the learners and communicative features expressed in a personalized style contribute to enhanced motivation and learning, seem to engage learners in learning processes and provide learning success. Accordingly Ai-Lim Lee et al. (2010) investigated the influence of a desktop virtual reality application's constructivist learning characteristics on learning outcomes. During this investigation they found that options regarding individual preferences relate positively to learning effectiveness and satisfaction.

Other publications reported more generally on the nature of blended learning environments and their suitability with regard to a range of learner variables. Liaw et al. (2010); Ma (2012); Mohammadi (2015); Yu et al. (2007) used survey studies and interviews to evaluate the feasibility of e-learning for continuing education and concluded that diversity, flexibility, adaptability and individualization are catalysts for increasing motivation, user satisfaction, intention to use e-learning and regulating abilities. Law and Sun (2012) did the same with regard to a digital educational game. Here, too, adaptability (to personal preferences) was seen as an influencing factor for the user experience. Although the literature retrieved seems to find a positive influence of personalization on metacognitive and motivational learner variables (e.g., Liaw et al., 2010; Mohammadi, 2015; Yu et al., 2007) personalization itself had no straightforward effect on learning performance (Ai-Lim Lee et al., 2010; Reichelt et al., 2014).

2.3.2.3 Learner control

In total, 18 publications refer to the amount of control learners have in blended learning environments (e.g. (e.g., Artino, 2009a, 2009b; Corbalan et al., 2008; Hughes et al., 2013; Hung, Huang, & Yu, 2011; Leen & Lang, 2013; Lin, Fernandez, & Gregor, 2012; Mohammadi, 2015; Reychav & Wu, 2015; Roca, Chiu, & Martínez, 2006; Ting, 2013; Yu et al., 2007)). These publications consider learner control to be

an inclusive concept that describes the degree of control that learners have over the content and activities within the learning environment. Examples include control over the pace of the course, the content used, learning activities in which the content is presented and content sequencing which allows the learner to determine the order in which the content is provided.

Corbalan et al. (2008) and Hughes et al. (2013) found in their experimental studies, including log-file analysis, that shared (learner and instructor) control has positive effects on learner motivation, and that the choice provided positively influenced the amount of effort invested in learning, combined with higher learning outcomes. In his survey study, Artino (2009b) provided evidence for the positive predictive ability of the task learners choose (rehearsal vs in-depth) on elaboration, metacognition, satisfaction and continuing motivation. During their survey study, Lin et al. (2012) found that the higher the level of control and learning afforded by a virtual-reality-based learning environment, the better the learning outcomes as measured by performance achievement, perceived learning effectiveness and satisfaction would be. While learner control seems to influence cognition (Ai-Lim Lee et al., 2010), metacognition (Artino, 2009b) and motivation (Lin et al., 2012) this influence is not unfailingly positive. Some remarks are made in the publications retrieved. Corbalan et al. (2008) found that learners with lower levels of competence in a domain lack the ability to make productive use of learner control; Artino (2009a) observed, in his survey study on how feelings, and actions are associated with the nature of an online course, that a lack of control on the part of the learner results in boredom and frustration. Leen and Lang (2013) found that older adults had a strong need for a sense of belonging and personal growth, and thus a heightened interest in learner control, whereas younger adults' motives for learning were more competition-related. Learners with a high need for control might tend to adopt e-learning quickly, whereas learners with low self-control abilities tend to reject e-learning (Yu et al., 2007). For individuals with lower self-control abilities, it seems essential to establish user-friendly learning environments in the early stages of development (Yu et al., 2007). Hung and Hyun (2010) conclude as a result of their interview study that learners with low prior knowledge require a learning context provided by the instructors to sustain the learning experience.

2.3.2.4 Scaffolding

The search produced 24 publications related to scaffolding in blended learning environments (e.g., Aleven & Koedinger, 2002; Artino & Jones, 2012; Artino & Stephens, 2009; Chia-Wen, Pei-Di, & Meng-Chuan, 2011; Davis & Yi, 2012; Demetriadis et al., 2008; Govaere, de Kruif, & Valcke, 2012; Kim & Ryu, 2013; Koh & Chai, 2014; Kuo et al., 2012; Niemi, Nevgi, & Virtanen, 2003; Wesiak et al., 2014). These publications define scaffolding as changes in the task or learning environment that assist learners in accomplishing tasks that would otherwise have been beyond their reach. This could involve ongoing diagnosis of the amount of support learners need and the provision of tailored support based on the results of this ongoing diagnosis, both of which result in a decrease in support over time.

Some of the retrieved publications report on interventions done to identify the effect of scaffolding on cognition, metacognition and motivation. Wesiak et al. (2014), for example, found clear indications that the addition of thinking prompts provided by scaffolding services is beneficial to learners, who reported an increasing amount of effort in terms of time spent. These findings imply a positive effect of the refinements of thinking prompts and/or affective element added. This supports the assumption that scaffolding support fosters metacognition and reflection. Aleven and Koedinger (2002) conducted an experiment and concluded that scaffolding of problem-solving practice, using self-explanation, with a computer-based cognitive scaffolding tutor was an effective tool for the support of the acquisition of metacognitive problem-solving strategies and that guided self-explanation adds value to guided problem-solving practice without self-explanation. Demetriadis et al. (2008) and Govaere et al. (2012) found, using an experimental set-up, that learners in a scaffolded group achieved significantly higher

scores, which indicates that explicitly asking scaffolding questions to activate learners has positive effects. Accordingly, Kim and Ryu (2013) showed that, during the assessment of a web-based formative peer assessment system, learners using such a system achieved significantly higher scores for metacognitive awareness. Devised questions, prompts, and peer interaction as scaffolding strategies are shown to facilitate metacognitive skills.

Artino and Stephens (2009), on the other hand, used a survey to investigate the potential developmental difference in self-regulated learning and come up with instructional guidelines to overcome these differences. They suggest that scaffolding for the support of self-regulated learning in online learning environments should ideally be achieved by explicitly providing instructional support, structure and scaffolds of social interaction. Artino and Jones (2012) articulated the benefits of attending to learners' achievement emotions in structuring online learning environments. This way, learning and performance are improved by facilitating learners' use of adaptive self-regulatory learning strategies. Yu et al. (2007) emphasized, in their investigation of the feasibility of the adaption of e-learning for continuing education, that for learners with lower self-regulatory abilities it is essential to scaffold support around strategies of behaviour modification, to increase learners' confidence and self-regulatory abilities while maintaining their participation and improving the learning effect.

2.3.2.5 Interaction

We retained 70 publications that appear to centre around interaction (e.g., Alant & Dada, 2005; Chen, 2014; Clark, Draper, & Rogers, 2015; DuBois, Dueker, Anderson, & Campbell, 2008; Gomez, Wu, & Passerini, 2010; Ho & Dzeng, 2010; Liaw et al., 2010; Lin et al., 2012; Ma, 2012; Siampou et al., 2014; Ting, 2013; Xie, Miller, & Allison, 2013). These publications describe interaction as the involvement of learners with elements in the learning environment, including content (learning materials, object, etc.), the instructor (teacher, coach, trainer, etc.), other learners (peers, colleagues, etc.) and the interface (objects in the online or offline learning environment).

Some of the publications retrieved report on the positive influence of social interaction on self-regulation, whereby Ting (2013) and Reichelt et al. (2014) found in their experiments that communicative features, peer interaction and back-feedback gave learners more control over their learning. Kuo et al. (2012) emphasized in this respect that the method of the integration of collaborative learning mechanisms within an online inquiry-based learning environment has great potential to promote middle- and low-achievement learners' problem-solving ability and learning attitudes. Michinov and Michinov (2007) add to this that paying closer attention to social interaction is particularly useful during transition periods at the midpoint of an online collaborative activity. Liaw et al. (2010) found during a survey study that enriching interaction and communication activities have a significant positive influence on the acceptance of mobile-learning systems. Siampou et al. (2014) investigated whether the type of interaction influences the learners' modelling processes. Their results suggest that the online dyads focused extensively on the analysis and synthesis actions and their learning was higher than their offline counterparts. Lin et al. (2012) identified in a correlation study that the establishment of social interaction to promote intrinsic motivation increased positive affect and fulfilment in web-based environments. Ai-Lim Lee et al. (2010) found that interaction with the desktop virtual reality application only impacted learning effectiveness (positively). Gomez et al. (2010) emphasize the interaction between motivation and social interaction and perceived learning, concluding that when learners value these social interactions, they will enjoy learning more.

Other publications report on the negative influence of the lack of social interaction on a mix of learner variables. Artino (2009a) and DuBois et al. (2008) observed using an experiment that a lack of interaction results in a decrease in engagement and satisfaction and an increase in drop-out risk. In

summary, it can be observed that the publications retrieved report positively on the influence of social interaction for increasing cognitive (e.g., Siampou et al., 2014), metacognitive (e.g., Kuo et al., 2012) and motivational e.g., Lin et al. (2012) learner variables. A negative influence is seen with regard to motivation when there is a lack of social interaction.

2.3.2.6 Reflection

In total, 14 publications appear to focus on cues that increase the reflective practice of learners in blended learning environments (e.g., Aleven & Koedinger, 2002; Anseel, Lievens, & Schollaert, 2009; Ibabe & Jauregizar, 2010; Kim & Ryu, 2013; Martens, de Brabander, Rozendaal, Boekaerts, & van der Leeden, 2010; Mauroux, Konings, Zufferey, & Gurtner, 2014). Reflection cues are defined in these publications as prompts that aim to activate learners' purposeful critical analysis of knowledge and experience, in order to achieve deeper meaning and understanding. The publications describe three main types: first, reflection during action, which takes place while learners are performing a task; second, reflection about action, which is systematic and deliberate consideration of a task that has already been completed; and third, reflection before action, which involves proactive thinking about a task which will soon be performed.

There is some evidence that reflection can be used to increase learner motivation, especially when learners are in a state of low motivation to learn (Ibabe & Jauregizar, 2010). The majority of evidence supporting the influence of reflection on self-regulation-influencing variables relates to cognitive learner variables. Anseel et al. (2009) concluded, in their investigation of reflection as a strategy for enhanced task performance, that reflection combined with feedback has a more positive impact than feedback alone on task performance. Ai-Lim Lee et al. (2010) and Aleven and Koedinger (2002), who used experiments, added to this that engaging learners in reflective thinking is a significant antecedent to learning outcomes and that engaging them in explanation helps learners acquire better-integrated knowledge.

In addition, a substantial number of publications were found that focus on metacognitive variables. Kim and Ryu (2013), for example, found that peer interaction and back-feedback gave learners more control over their learning; these learners scored significantly higher for metacognitive awareness and performance than the traditional peer assessment group, who in turn achieved higher scores for metacognitive awareness than a self-assessment group who received no peer interaction or back-feedback. Based on a survey study, Niemi et al. (2003) suggested that young learners gain new information about their learning strategies and skills through negotiation with peers and that this negotiation also helps more experienced learners strengthen their learning.

In summary, the publications retrieved report positively on the influence of reflection on cognitive (e.g., Anseel et al., 2009), metacognitive (e.g., Kim & Ryu, 2013) and motivational (e.g., Ibabe & Jauregizar, 2010) learner variables. Anseel et al. (2009) emphasize that learners' levels of learning goal orientation, need for cognition and personal importance affect the extent to which individuals engage in reflection positively. Ibabe and Jauregizar (2010) and Mauroux et al. (2014) supplement this claim with the finding that when leaners have low levels of motivation and acceptance of reflection, the only type of reflection tool they will use are self-assessment tools.

2.3.2.7 Calibration

The search identified 15 publications which appear to centre around cues for calibration in blended learning environments (e.g., Anseel et al., 2009; Artino, 2009a; Artino & Stephens, 2009; Brusso & Orvis, 2013). These publications describe calibration cues as triggers for learners to test their perceptions of achievement against their actual achievement. They are used both to overcome

deviations in learner's judgements from the facts by introducing notions of bias and also to address metric issues regarding the validity of cues' contributions to judgements. Two main types of calibration cues were identified in the publications retrieved: prompts that aim to trigger metacognitive monitoring, such as reviewing content, and secondly, checklists and timed alerts to summarize content and practice tests to help learners compare their own perceptions and the facts.

Using an experimental design Vighnarajah, Luan, and Abu Bakar (2009) found that learners reported practising different self-regulated learning strategies (intrinsic and extrinsic goal orientation, control of learning beliefs, rehearsal, elaboration, critical thinking, peer learning, and help seeking). The strategies that interested learners the least were task value, effort regulation, and metacognitive self-regulation. Artino (2009a) illustrated the importance of learner goal-setting by showing that learners with career aspirations directly related to the course content would be more likely to report adaptive motivation and academic success than their peers. Using a survey study, Brusso and Orvis (2013) found that learners who experienced a larger goal-performance discrepancy at the beginning of a course performed worse in the subsequent sessions than those whose performance more closely mirrored their goals. The two survey studies conducted by Brusso and Orvis (2013) and Anseel et al. (2009) suggest that a combination of reflection interventions and goal-setting instructions (looking back on past behaviour by means of coached reflection and managing future behaviour by setting goals) appears to be a particularly strong intervention. Artino and Stephens (2009) illustrate this by presenting two instructional strategies for helping learners identify and set challenging, proximal goals and for providing them with timely, honest, explicit performance feedback.

Despite the moderate number of publications retrieved, the evidence indicates the importance of helping learners make a reasonable estimation of the instructors' expectations and their own capabilities. The studies call for appropriate cues for task definition, goal-setting and planning in order to influence the cognitive (e.g., Brusso & Orvis, 2013) metacognitive (e.g.,Artino & Stephens, 2009) and motivational (e.g., Artino, 2009a) learning variables that in turn influence self-regulation.

2.4 Conclusions and discussion

The aim of this systematic literature review was to identify attributes of blended learning environments that support self-regulation. An inductive or bottom-up approach was used. Following the initial literature analysis, seven attributes were identified and defined. First, authenticity was defined as the real-world relevance of the learning experience (both task and learning environment) to learners' professional and personal lives. Secondly, personalization was defined as non-homogenous experiences related directly to the tailoring of the learning environment (name recognition, self-description and cognitive situationing) to the inherent needs of each individual learner. Third, learner control was defined as an inclusive concept which describes the degree to which learners have control over the content and activities (pace, content, learning activities and sequencing) within the learning environment. Fourth, scaffolding was defined as changes in the task or learning environment (support which diminished over time) which assist learners in accomplishing tasks that would otherwise be beyond their reach. Fifth, interaction was described as learners' involvement with elements in the learning environment (content, instructor, other learners and interface). Sixth, reflection cues were defined as prompts that aim to activate learners' purposeful critical analysis of knowledge and experience (before, during and after), in order to achieve deeper meaning and understanding. Finally, calibration cues were described as triggers for learners (forms, timed alerts and practice tests) to test their perceptions of achievement against their actual achievement and their perceived use of study tactics against their actual use of study tactics.

While this systematic literature review has attempted to identify and define the seven attributes as clearly as possible, it remains unclear what the exact relationship is between each attribute and the self-regulatory behaviour exhibited by learners. It is beyond the scope of this review to address this problem directly. In what follows, however, we make a first attempt to explain the relevance of each attribute using the Four-stage Model of Self-regulated Learning developed by Winne and Hadwin (1998). As mentioned earlier, it is the first two phases of this model – task definition and goal-setting and planning – that are most susceptible to instruction, so the main focus will lie on these two phases (Butler & Winne, 1995; Winne & Hadwin, 1998; Zimmerman, 2000).

2.4.1 Attributes and their relation to the Four-stage Model of Self-regulated Learning

In promoting self-regulation, both constructivist and sociocultural theories stress the importance of building on learners' existing knowledge and skills (Harris & Pressley, 1991; Vygotsky, 1978). It has been argued that, rather than providing direct instruction about predefined strategies, teachers should provide support that assists learners to self-regulate their own learning effectively (Butler, 1998; Palincsar & Brown, 1988). Based on this premise, a search for attributes that support self-regulation in blended learning environments was performed. Authenticity and personalization in the environment seem to contextualize and individualize the conditions and standards needed to make appropriate judgements about the task at hand and thus direct goal-setting and planning. Both authenticity and personalization support learners in situating the task in a realistic, familiar context and tailor it to the general preferences of the learner. In doing so, the environment takes into account the cognition, metacognition and motivation of the learners and supports the identification of conditions (how the task at hand will be approached) and standards (criteria against which products will be evaluated) (Butler, 2002; Reeve & Brown, 1985). It is worth bearing in mind, however, that when learners have had negative prior experiences, they will judge the conditions and standards less accurately (Lodewyk, Winne, & Jamieson-Noel, 2009). Similarly, learner control and scaffolding seem to help learners maximize their degree of control over their own learning and evaluate their learning (comparing standards) more accurately (Perry, 1998; Perry, Phillips, & Dowler, 2004) and thus set more appropriate goals and plan further actions. As the learners are allowed to choose how to learn more freely, and as the support provided is tailored and reduced over time, learners experience how products should be evaluated according to the standards they set themselves and thus how to maximize self-regulation. The relation between learner control and scaffolding is worth mentioning, because when learners have low self-regulatory skills, for example, a high degree of learner control in the environment will leave them wandering aimlessly unless they are supported by scaffolds that gradually disappear over time (Lynch & Dembo, 2004). Interaction and cues for reflection expose learners to the various procedures available (e.g. through social interaction, reflection questions, etc.), providing them with self-initiated feedback about their own performance and helping them to select appropriate procedures for tackling the task at hand (Kumar, Gress, Hadwin, & Winne, 2010). This supports learners in identifying the procedures needed to define and execute the task, which influences their planning of the actual performance. While reflection and interaction support practice retrospectively, they do not have an impact on faulty calibration mechanisms. Cues for calibration therefore need to be put in place to make learners with low self-regulatory abilities aware of such problems. Cues for calibration help learners assess their performance correctly and compare it to the standards they initially set and act upon any perceived deficit (Hadwin & Winne, 2001). Involving learners in processes of external feedback (e.g. by taking tests) will provide them with a realistic framework against which to compare themselves (Winne & Jamieson-Noel, 2002).

2.4.2 The attributes and their relation to current learning theories

To consolidate the relevance of the attributes identified for the design of blended learning environment, they were also tested against other well-established learning theories and instructional design models, with positive results. While conceptual transparency is sometimes lacking within and between these models, our results bear striking similarities to the Four Component Instructional Design model of van Merriënboer (1997), which focuses on task execution support. Van Merriënboer's model states that learners will be able to complete a task when there is a degree of (1) authenticity (van Merriënboer, 1997); (2) personalized task selection (Salden, Paas, & van Merriënboer, 2006); (3) learner control in selecting their own learning tasks (Corbalan, Kester, & van Merriënboer, 2009); (4) support for calibrating learners' goal directedness (van Merriënboer, 1997); (5) scaffolding for complex tasks to prevent cognitive overload (van Merriënboer, Clark, & De Croock, 2002); (6) reflection triggered by cues integrated with feedback (van den Boom, Paas, & van Merriënboer, 2007; Wouters, Paas, & van Merriënboer, 2009); and (7) interaction with peers (van Zundert, Sluijsmans, & van Merriënboer, 2010). It can also be observed that the attributes identified by the review presented here are among the basic components of any powerful learning environment (De Corte, Greer, & Verschaffel, 1996; De Corte, Verschaffel, Entwistle, & van Merriënboer, 2003) as well as a typical constructivist learning environment (Jonassen, 1999; Wilson, 1996). These conclusions support the view that the attributes of blended learning environments identified as supporting self-regulation can in fact be seen as basic attributes of any effective learning environment; they can therefore be found in learning theories and instructional design models that are not specifically related to blended learning. This finding contributes to the question raised by certain researchers of whether the concept of blended learning should be reconsidered (Oliver & Trigwell, 2005). Our findings do indeed suggest that the concept of blended learning could be simplified both theoretically and conceptually. The principal value of this review, however, lies in its identification of design features that foster learners' self-regulation. To the best of our knowledge, this is the first study of self-regulation to present such a framework of design attributes.

2.4.3 Limitations of the study

A number of limitations, both of the publications described and the systematic literature review itself, should be acknowledged. The publications retrieved for this contribution demonstrate both theoretical and methodological limitations and inconsistencies. With regard to methodology, we often see a lack of awareness about the studies' reliability issues. In many case, only the group receiving treatment is described; pre- and post-tests are only administered to the experimental group; and/or no control group is included. Such methodological flaws make it difficult to ascertain the exact design of a study and gain insight into its validity. It also remains unclear in some cases which variables are targeted by the study design. A well-thought-out model of variables and their interactions and mediations would be beneficial for reviewing the literature and reflecting upon interactions and common characteristics in the wide-ranging field that is instruction and support in blended learning environments. Furthermore, the literature often reports on multiple related concepts at the same time (e.g. proactive stickiness, learning gratifications, computer self-efficacy, learning outcome expectations, social environment, interaction, learning climate, system characteristics and digital material features). This makes it difficult to ascribe certain effects to specific interventions or variables.

A number of theoretical limitations were also evident in the publications retrieved. First, conceptual transparency, including situating the concepts within a broader theoretical framework or instructional theory, is problematic. Due to a lack of clarity about other potentially influencing variables in the model used, or the learning environment in which the study was conducted, it is sometimes difficult to determine which variable is responsible for which outcome. Secondly, the studies appear to make

minimal use of instructional design approaches. Using such systematic approaches would help give more insight into the interventions and their conditions. Without a detailed description and specific design, however, study replication is impossible. The third and final remark is that the existing literature is often descriptive rather than theoretical or explanatory. Studies frequently reported on observations using surveys, for example, instead of researching the reasons behind these observations by conducting interventions and experiments. This point also influences the nature of the systematic literature review presented in this study. Specifically, the review is unable to describe in great depth which interventions are successful for which variables. In addition, it also describes the attributes that affect cognitive, metacognitive and motivational variables rather than explaining, for example, the precise degree of learner control needed to evoke a change in motivation for learners with low self-regulatory abilities.

While the approach used in this review was as systematically and theoretically sound as possible, the study has certain theoretical and conceptual limitations and therefore presents opportunities for further research. A first limitation is the scope and level of detail provided about each of the attributes identified, which can be seen as a constraint for immediate application in practice (e.g. design of learning environments). The main focus of the review was to identify attributes rather than focus immediately on application; the output therefore remains descriptive. Accordingly, a first suggestion for future research is to undertake a deeper analysis of each of the attributes presented by performing an additional, extended literature review per attribute in order to gain a more profound understanding of the current state of affairs. A second limitation of this review relates to its methodological approach: the development of the search string and the validity of the attribute categorization. The approach combined a theory-driven search string with inclusion and exclusion criteria; a twofold (peer-reviewed), double (manual versus bibliometric) check was also performed, resulting in a robust selection of publications. This contributed to the replicability and validity of the study and the detailed demarcation of attributes. On the other hand, however, a reasonable number of potentially relevant publications (e.g. reviews of different support types, learner variables or attributes) were excluded. Thirdly, considerable effort has been made to interpret the publications correctly and as intended by their authors. Due to the explicit search for concepts relating to self-regulation in blended learning environments, however, other potentially relevant findings may have been overlooked.

Despite the limitations mentioned above, this systematic literature review makes a number of useful contributions. It provides a clear overview of the existing literature by identifying and defining seven attributes that appear to be worth taking into account when designing blended learning environments that support self-regulation, namely authenticity, personalization, learner-control, scaffolding, interaction and cues for reflection and calibration. In addition, one key finding will help further the debate on the relevance of models for designing blended learning environments: attributes of blended learning environments that support self-regulation appear to tie in closely with the attributes of any effective learning environment. Finally, this study has the potential to function as a basis for further research on the attributes of blended learning environments that support self-regulation. It would be useful not only to review existing research further on self-regulation per attribute (as suggested above), but also to obtain more experimental evidence for each attribute. Such studies might involve the following steps: firstly, create a sound basis for comparison using a well-established instructional design model (e.g., Merrill, 2002; van Merriënboer, 1997) for the experimental and control conditions. Secondly, after administering a pre-test for one of the self-regulatory variables, a treatment can be implemented among an experimental group focusing on the attributes of self-regulation; this will help clarify how certain attributes relate to the variable being investigated. A third and final step would be to compare the post-tests of the experimental and control groups and describe any differences found. Using such an approach would enhance the replicability and validity of the study and help to unravel

how and why the attributes identified here impact the variables responsible for learners' self-regulatory abilities.

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2.6 Appendix 1

Summary of publications reported on, including identified attributes and learner variables.

(**IX** = Independent variables, **DX** = dependent variables, **Att.** = attributes and **LX** = Learning variables)

Reference	Aim	Variables & Methodology	Results	Attributes & Learner variables
Ai-Lim Lee et al. (2010)	• To determine whether motivation is positively related to learning outcomes. • To determine whether spatial ability moderates the influence of motivation on learning outcomes.	**IX:** virtual-reality features, interaction experience, usability, learning experience, psychological factors and learner characteristics. **DX:** learning outcomes. **N=**232. **Method:** quant. quasi-experiment + survey.	• Presence, motivation, cognitive benefits, control and active learning, reflective thinking and usability positively influence learning outcomes (performance achievement, perceived learning effectiveness and satisfaction).	**Att.:** authenticity, personalization, learner control, reflection and interaction. **LX:** cognition and motivation.
Alant and Dada (2005)	• To examine issues of syndicate learning in a web-based environment.	**IX:** facilitating discussion, onsite visit, study material, technology, online discussion, feedback and assignments. **DX:** overall evaluation of the course. **N=**19. **Method**: qual. case-study.	• The authentic web-based medium presented seemed to be an effective tool for academic discussion and problem solving. Nonetheless, learners need to be supported in using the web-based medium to enhance academic discourse.	**Att.:** authenticity, personalization, learner control, scaffolding, reflection and interaction. **LX:** motivation.
Aleven and Koedinger (2002)	• To investigate whether self-explanation can be scaffolded effectively in a classroom environment using a Cognitive Tutor.	**IX:** procedural knowledge and declarative knowledge. **DX:** score answer items. **N=**41. **Method**: quant. experiment + pre and post-test.	• Scaffolding with a cognitive Tutor (guided) is more effective when learners explain their steps by providing references to problem-solving principles. • Tutor feedback helped learners improve their explanations.	**Att.:** scaffolding, reflection and interaction. **LX:** cognition and metacognition.
Anseel et al. (2009)	• To determine whether performance will increase more in a group who receive reflection instructions combined with feedback. • To determine whether participants with a high need for cognition will engage more in reflection after feedback during reflection than their counterparts.	**IX:** age, education, tenure, feedback, instructions completed, learning goal orientation, need for cognition, involvement, word count and reflection. **DX:** task performance. Study 1: **N=**640. **Method**: quant. experiment + pre and post-test. Study 2: **N=**488. **Method**: quant. experiment + survey.	• Reflection (written) combined with (external) feedback improved task performance more than when learners received only a feedback report. Reflection only enhanced performance in combination with external feedback. • The reflection strategy proposed may be less effective for individuals low in need for cognition, low in learning goal orientation and low in personal importance as they will be less inclined to write down their thoughts.	**Att.:** calibration, reflection and interaction. **LX:** cognition and metacognition.
Artino (2009a)	• To examine personal factors relating to academic success in an online course.	**IX:** learning strategies, motivational beliefs and achievement emotions. **DX:** overall satisfaction and continuing motivation. **N=**481. **Method**: quant. quasi-experiment + survey.	• Task value beliefs positively predict elaboration and metacognition and satisfaction and continuing motivation. • In autonomous contexts where learners do not interact with an instructor or other learners, adaptive motivational beliefs may be vital for initiating cognitive and metacognitive engagement.	**Att.:** learner control. **LX:** metacognition and motivation.

Artino (2009b)	• To explore the extent to which learners' thoughts, feelings, and actions are associated with the nature of an online course and how that course relates to them personally.	**IX:** motivational beliefs, achievement emotions, self-regulated learning behaviours , prior knowledge of course material. **DX:** academic outcomes. **N=**481. **Method**: quant. quasi-experiment + survey.	• Learners' motivational beliefs and self-regulatory behaviours are related to the nature of the online course and how courses relates to them personally.	**Att.:** authenticity, learner control and interaction. **LX:** cognition, metacognition and motivation.
Artino and Jones (2012)	• To explore the relations between several discrete achievement-related emotions (boredom, frustration, and enjoyment) and self- regulated learning behaviours (elaboration and metacognition) in an online course.	**IX:** cognitive appraisals and achievement emotions. **DX:** self-regulated learning behaviours. **N=**302. **Method**: quant. quasi-experiment + survey.	• Negative achievement emotions are associated with lower levels of self-regulation, whereas enjoyment is associated with higher levels of elaboration and metacognition. • Learning will be improved when negative emotions are minimized and positive emotions are maximized. • The learning task and the technology should be considered in the design of learning environments.	**Att.:** scaffolding and interaction. **LX:** cognition and metacognition.
Artino and Stephens (2009)	• To explore potential developmental differences in self-regulated learning. In particular. • To examine whether there are motivational and self-regulatory differences between undergraduate and graduate learners enrolled in online courses.	**IX:** motivational beliefs, processing strategies and motivational engagement. **DX:** experience and courses completed. **N=**194. **Method**: quant. survey.	• Learners come to online courses with different levels of online experience and exhibit different levels of motivation and self-regulation while learning online. • Instructors have to consider their online audience, adjusting the type and amount of structure, support, and scaffolding they provide during online instruction (provide explicit instructional support and structure, develop learners' self-efficacy and scaffold online discussions).	**Att.:** scaffolding and personalization. **LX:** metacognition and motivation.
Barzilai and Eshet-Alkalai (2015)	• To determine whether epistemic perspectives and viewpoint comprehension predict information source integration. • To explore how epistemic perspectives moderate the impact of conflicts on viewpoint comprehension.	**IX:** viewpoint comprehension, integration of sources, epistemic perspectives. **DX:** ability. **N=**170. **Method:** experiment + survey + log file analysis.	• Learners' epistemic perspectives can be one of the factors that predict comprehension of source viewpoints. • The strength in which an epistemic perspective is endorsed is considered as an indicator of learners' tendency to adopt that perspective in a particular context.	**Att.:** authenticity and scaffolding. **LX:** cognition.
Brusso and Orvis (2013)	• To investigate whether unattainable goal, and subsequently a large goal-performance discrepancy, may negative impact subsequent videogames. • To provide a remedy for mitigating this negative impact on training effectiveness.	**IX:** goal-setting advice and self-regulation. **DX:** subsequent performance, initial performance goal and initial goal-performance discrepancy. **N=**429. **Method:** quant. experiment + survey.	• Unattainable goal-setting early in videogame-based training has a negative impact on subsequent training performance, and that trainees' self-regulation coupled with goal commitment may serve as mechanisms underlying this relationship. • Instructors should be wary of learners setting goals without advice.	**Att.:** learner control, calibration and interaction. **LX:** cognition and metacognition.
Casillas and Gremeaux (2012)	• To explore how medical learners assessed a website dedicated to cardiovascular rehabilitation, and collecting their suggestions in order to	**IX:** medical information and design. **DX:** quality of the website and knowledge improvement. **N=**18. **Method:** quant. experiment + pre- and post-test + interviews.	• Learners do not seem to see the websites as a properly adapted tool to prepare them. This type of learning material appears to be significantly useful for short-term knowledge improvement.	**Attributes:** interaction and scaffolding**. LX:** cognition.

	meet their expectations and the goals of second cycle medical studies.		• The immediate impact of this type of multimedia support tool on improving learners' knowledge seems nevertheless relevant and interesting.	
Chen (2014)	• To develop a conceptual model to investigate the determinants of college learners' proactive stickiness with a web-based English learning (WBEL) environment.	**IX:** proactive stickiness, learning gratifications, computer self-efficacy, learning outcome expectations, social environmental, interaction, learning climate, system characteristics and digital material features. **DX:** learning outcomes. **N=**306. **Method**: quant. survey.	• Computer self-efficacy, system characteristics, digital material features, interaction, learning outcome expectations and learning climate are critical affecting factors in determining learner learning gratifications with web-based English learning.	**Att.:** authenticity, personalization, learner control and interaction. **LX:** cognition, metacognition and motivation.
Chia-Wen et al. (2011)	• To explore the effect of a redesigned course, integrating web-enabled self-regulated learning (SRL) with variations in online class frequency on enhancing learners' skills of deploying database management system (DBMS).	**IX:** online class frequency and web-enabled self-regulated learning. **DX:** computing skills. **N=**112. **Method:** quant. experiment + test + survey.	• Self-regulatory interventions helped learners become more responsible for their learning and contribute to further success. • Formal education should also develop learners' informal learning ability for a lifelong learning process. It is suggested that instructors ideally support self-regulatory interventions.	**Att.:** interaction. **LX:** metacognition and motivation.
Cholowski and Chan (2004)	• To explore learners' clinical problem solving based on a model consisting of their motivational orientation, prior knowledge, diagnostic reasoning and diagnostic solutions.	**IX:** motivational orientation, prior knowledge, diagnostic reasoning and diagnostic solutions. **DX:** clinical problem solving. **N=**135. **Method**: quant. survey + test.	• Instructors need to address each contributing component of the problem-solving. Including attention for underlying motivational orientation in undertaking the task and on the way new information is linked with prior knowledge.	**Attributes:** scaffolding**. LX:** cognition, metacognition and motivation.
Clark et al. (2015)	• To identify the processes that key stakeholders perceive to be most important in facilitating a positive impact of continuing professional education on practice.	**IX:** organizational structure, partnership working, a supportive learning environment and changing practice. **DX:** continuing professional education. **N=**31. **Method**: qual. interviews.	• A positive learning culture, effective partnership between learners with understanding of each other's perspectives, aspirations and constraints and a supportive learning environment in both the practice setting and education environment are central to establishing a culture and context that positive influences learning.	**Att.:** interaction. **LX:** cognition.
Corbalan et al. (2008)	• To investigate the influence of difficulty and support of the learning tasks on the learners competence scores. • To investigate whether perceived task load would make learning more effective and efficient. • To assess whether shared control has positive effects on learner motivation.	**IX:** task difficulty, competence, task load, training time and germane load. **DX:** learning outcomes, learning efficiency and task involvement. **N=**55. **Method**: quant. experiment + log-file analysis + survey.	• Learning outcomes of learners who received adaptive training were higher, and they experienced a lower task load during practice than learners who received non-adaptive training. • Learners in the shared-control conditions showed higher task involvement. Choice provided positively influenced the amount of effort invested in learning, combined with higher learning outcomes.	**Att.:** authenticity, personalization, learner control and interaction. **LX:** cognition, metacognition and motivation.
Cox et al. (2006)	• To determine whether web-based and faculty-led learners demonstrated improved knowledge and attitudes about caring for the underserved.	**IX:** faculty-led and web-based course. **DX:** knowledge, attitudes, and skills. **N=**100. **Method**: quant. experiment + pre- and post-test.	• Compared to learners in the established curriculum, both web-based and faculty-led learners demonstrated improved significant knowledge and attitudes. Results also indicate that Faculty-led and web-based curricula can equally improve learner knowledge, attitudes, and skills.	**Att.:** interaction. **LX:** cognition and motivation.

Cramer et al. (2014)	• To determine whether certified education changes learners' empowerment, job satisfaction, and clinical competency over time.	**IX:** empowerment, job satisfaction, intent to turnover, clinical competency, technological skills. **DX:** course satisfaction. **N=**84. **Method**: quant. survey	• Certification significantly improved empowerment, satisfaction, and competence (can reduce persistently high learner turnover rates). • Changes in empowerment and competency did not affect changes in job satisfaction.	**Att.:** interaction. **LX:** cognition and motivation.
Dai and Huang (2015)	• To analyse the effectiveness of three remedial instruction models, including e-learning, blended-learning and traditional instruction.	**IX:** active learning strategy, mathematics learning value, factors of self-awareness, learning method, learning plan and achievement goal. **DX:** learning motivation. **N=**94. **Method**: quant. survey.	• Active learning strategy, mathematics learning value, factors of self-awareness, learning method learning plan and achievement goal influence learning motivation.	**Attributes:** interaction. **LX:** metacognition and motivation.
Davis and Yi (2012)	• To leverage the hierarchical view of traits, to develop a theory-grounded, integrative model of broad personality and IT-specific traits.	**IX:** computer anxiety and computer self-efficacy. **DX:** web utilization. **N=**230. **Method**: quant. survey.	• Links between personal innovativeness and openness, social cues exuding adventurous, creative, and expressive behaviour will be more effective at retention than cues tailored toward reducing anxiety or conscientiousness.	**Att.:** Interaction. **LX:** motivation.
Demetriadis et al. (2008)	• To investigate whether learners' learning and problem-solving performance in ill-structured domains can be improved, whether elaborative question prompts are used to activate learners' context-generating cognitive processes, during case study.	**IX:** scaffolding. **DX:** portfolio score. **N=**32. **Method**: quant. experiment + pre-test + survey.	• Scaffolding treatment had a significant main effect on learners' performance (epistemological beliefs profile and scaffolding treatment interact, learners with complex epistemological beliefs learners benefiting most). • It is possible to improve individual learning in a technology environment, by implementing questioning strategies.	**Att.:** Authenticity and interaction. **LX:** cognition, metacognition and motivation.
Donnelly (2010)	• To investigate, in a tutorial setting, the factors that govern the success of interaction in blended problem- based learning.	**IX:** use of face-to-face PBL tutorials, online journal entries, use of video conferencing, use of asynchronous discussions and use of synchronous chat and international guest collaboration. **DX:** interactions as transactions and interaction in blended problem-based learning. **N=**17. **Method**: qual. observation + quant. log file analysis + interview + self-reflective papers.	• Conditions for the effectiveness of blended learning: the selection of authentic tasks within the problem which demand a division of labour between the face-to-face and the online environments, the maintenance of common goals and motivation, the mutual expectations of learners and tutors, the awareness of the individual role and group leadership, and changes in these and the availability of appropriate communication tools.	**Att.:** authenticity and interaction. **LX:** cognition, metacognition and motivation.
Doo (2006)	• To identify facilitating factors and constraints of skills practice in online learning environments.	**IX:** social self-efficacy, prior knowledge, interview experiences, enjoyment, usefulness, perception about learning, cognitive retention of learning content, verbal interview skills and behaviour based interview skills. **DX:** number of skills practice sessions. **N=**23. **Method**: qual. case-study + interviews.	• Instructors should facilitate learners' skills practice, by: designing an appealing enough course to make learners involved. If learners already have substantial prior knowledge or cognitive knowledge of the interpersonal skills set presented emphasize that cognitive understanding not guarantees successful execution, ensure appropriate learning environments for practicing and use mental practice if learners feel the discrepancies between online learning and offline practice.	**Att.:** interaction. **LX:** cognition.

DuBois et al. (2008)	• To describe the content, format, and outcomes of one of the National Institutes of Health (NIH) courses and share key lessons learned about formats and assessment methods.	**IX:** content and format. **DX:** knowledge of research ethics, ethical problem-solving skills, and levels of confidence in addressing ethical issues in mental health research. **N=**40. **Method:** quant. experiment + pre- and post-test + survey.	• Learners in the distance course were less satisfied and dropped out more easily. This was attributable to technical difficulties, the lack of face-to-face contact and the fact that the course did not offer the flexibility that many distance-learning courses offer. Although they had the opportunity to interact during case discussions, few participants did this. It is concluded that without interactivity, case discussion cannot achieve its aims.	**Att.:** reflection and interaction. **LX:** motivation.
Gerhard, Moore, and Hobbs (2004)	• To provide a theoretical underpinning for understanding the relevance of learner embodiments and co-presence within three-dimensional collaborative computer interfaces.	**IX:** (no-)co-presence, composition and interaction model used. **DX:** experience of immersion, involvement and awareness. **N=**20. **Method:** quant. experiment + pre- and post-test + survey.	• Co-presence simulated by real-life agents can complement avatar technology and potentially achieve permanent presence of all learners by using a hybrid agent model.	**Att.:** authenticity and interaction. **LX:** metacognition and motivation.
Giesbers, Rienties, Tempelaar, and Gijselaers (2013)	• To investigate the relationship between available tools used, learner motivation, participation, and performance on a final exam in an online course.	**IX:** motivation. **DX:** final exam scores. **N=**110. **Method**: quant. experiment + survey.	• Higher levels of autonomous motivation did not have any significant higher participation rate or use of richer communication tools in web- or video-conferences. • Significant effect was found for higher participation rates in the web-and video-conferences with the use of richer tools. Learners who took part in more interactive web-and video-conferences had higher scores on the final exam.	**Att.:** authenticity, personalization and scaffolding. **LX:** cognition and motivation.
Gomez et al. (2010)	• To describes the implementation and evaluation results of a classroom application of a team-based learning process, which was modified to include computer mediation.	**IX:** motivation, perceptions of team members and perceiving of team interactions. **DX:** team interactions, perceived learning, enjoyment, learning outcomes. **N=**73. **Method**: quant. survey.	• Motivation influences the relationship between team interactions and perceived learning. • Enjoyment is affected by motivation and perceptions of team members' contributions, with the implication that learners who perceive that the team interactions are adding value to their education will better enjoy learning and will experience higher-level learning outcomes.	**Att.:** scaffolding and interaction. **LX:** cognition and motivation.
Govaere et al. (2012)	• To determine whether guided use of multimedia learning materials will result in significantly lower levels of cognitive load and higher levels of self-efficacy.	**IX:** conventional classroom, individual DVD use, guided individual DVD use, guided classroom DVD use, cognitive load and self-efficacy. **DX:** knowledge and skills acquisition. **N=**178. **Method:** quant. experiment + pre- and post-test + survey.	• Significant superior impact of studying with the DVD on skills acquisition and higher levels of self-efficacy. In addition, experimental conditions that build on guided usage of the multimedia application, result in superior performance.	**Att.:** authenticity and interaction. **LX:** cognition and metacognition.
Gulikers et al. (2005)	• To explore the effects of an authentic electronic learning environment on learner performance and experiences.	**IX:** perceived authenticity, experienced motivation, perceived as innovativeness, extend of confusion, experienced support and extend of explorative behaviour. **DX:** performance on the final report. **N=**34. **Method:** quant. experiment + test + survey.	• No evidence was found for the expected superiority of the authentic learning environment. The most likely explanation for this finding is that the learning task was identical for both conditions. This is a strong argument for the idea that an authentic task and an authentic context are two different things.	**Att.:** authenticity and interaction. **LX:** cognition and motivation.

Ho and Dzeng (2010)	• To examine the effectiveness of 'safety education to prevent falls' by different learning modes used to assess safety behaviour and learning effectiveness during the education training period.	**IX:** platform function and contents design. **DX:** learning effectiveness. **N=**83. **Method**: qual. interview + test + survey + observation + document analysis.	• An e-learning environment is effective if it motivates the learner, provides the content needed for learning, and creates a learning context. • The smoothness of network, easy operation of platform, affinity of user interface and the test assessment of learning ability are the impressions of learner. Learning satisfaction is essential for learning effectiveness. • Content must include multimedia animation, actual case introduction, self-achievement simulation, and suitability of teaching materials unit, which will influence the learning satisfaction of learning effectiveness and raise performance.	**Att.:** interaction. **LX:** cognition and motivation.
Ho and Swan (2007)	• To examine the actual participation and dynamics that occur in online discussions and their relationship to learner learning outcomes.	**IX:** quantity, quality, relevance, and manner. **DX:** learner participation. **N=**15. **Method:** quant. quasi-experiment + log file analysis.	• Strong correlation was found between learners' Gricean ratings and their final course grades, and between learners' Manner ratings and their conference grades. • An important relationship between the Gricean elements and learner performance was found.	**Att.:** reflection. **LX:** motivation.
Hodges and Murphy (2009)	• To explore the influence of the four traditionally hypothesized sources of self- efficacy on learners' self-efficacy beliefs regarding learning mathematics in an asynchronous environment.	**IX:** mastery experiences, vicarious experience, social persuasion, and physiological / affective states. **DX**: self-efficacy beliefs. **N=**99. **Method**: quant. survey.	• Courses offered using an emporium model should be designed to include elements which provide positive vicarious experiences and support positive affective and physiological beliefs toward the courses.	**Attributes:** calibration**. LX:** metacognition.
Hughes et al. (2013)	• To examine the cognitive and motivational antecedents and outcomes of learner-controlled practice difficulty in relation to learning a complex task.	**IX:** self-efficacy, metacognition, self-evaluation, general mental ability, videogame experience, task knowledge, pre-training skill, practice performance, post-training performance, learner-controlled practice difficulty and adaptive transfer performance. **DX:** task knowledge, performance, and adaptability. **N=**118. **Method:** quant. experiment + survey + log-file analysis.	• Strong direct effects of learner-controlled practice difficulty on both task knowledge and post-training performance. Moreover, practice difficulty was positively related to adaptive performance via its relationships with both task knowledge and post-training performance. • Motivational mechanisms of pre-training self-efficacy and positive error framing also exhibited significant positive relationships with learner-controlled practice difficulty.	**Att.:** learner control and interaction. **LX:** cognition, metacognition and motivation.
Hung and Hyun (2010)	• To examine how East Asian international learners who were enrolled in the 'curriculum and instruction' course reflect upon their learning experiences.	**IX:** learning attitudes, curricular and pedagogic decisions, individual circumstances, epistemological transition and accumulated schemata, situation after arrival, factors affecting learning attitudes and participation, and epistemological transition. **DX:** learning experience. **N=**12. **Method**: qual. interviews.	• Learners with low prior knowledge require an inclusive curriculum and learning context provided by the instructors to sustain the learning experience. • Metacognitive reasoning based on learners' initial circumstance and academic advising arrangement with an advisor played a critical role, starting with the earliest stage of first arrival.	**Att.:** Personalization and interaction. **LX:** metacognition and motivation.

Hung et al. (2011)	• To investigate the role of the multimedia disclosure method for informed consent and its contribution to higher learning motivation and learning interest, to better remembering, comprehension and satisfaction than the conventional method.	**IX:** disclosure method and psychosocial learning processes. **DX:** learning outcomes. **N=**112. **Method:** quant. survey.	• Different disclosure methods lead to significantly different learning motivation and learning interest and outcomes. • During the psychological learning processes, learning motivation and learning interest were positively correlated with learning outcomes (remembering, comprehension, and satisfaction), and correlations with comprehension and satisfaction were significant.	**Att.:** interaction. **LX:** cognition, metacognition and motivation.
Ibabe and Jauregizar (2010)	• To assess the degree to which learners take advantage of a self-assessment tool. • To explore the relationship between different metacognitive variables and academic performance and/or making use of activities oriented to learning of the relevant material.	**IX:** availability of a self-assessment tool, interactive self-assessment exercises and different metacognitive variables. **DX:** taking advantage, better grades, academic performance. **N=**116. **Method:** quant. experiment + test **+ s**urvey.	• Better academic performance for learners that use interactive self-assessment were measured. • It seems that even learners with low motivation levels made use of these tools. Finally, the need to include self-assessment in the curriculum, with a view to improving learners' metacognitive knowledge.	**Att.:** interaction. **LX:** cognition and metacognition.
Ioannou, Brown, and Artino (2015)	• To evaluate differences in learners' discourse and actions when they used a wiki with discussion vs. a forum with attached MSWord documents for asynchronous collaboration.	**IX:** collaboration, complexity, monitoring & planning, other content, expansion, deletion, content-editing, formatting & spelling. **DX:** wiki and forum use. **N=**34. **Method**: qual. case study.	• Significant differences can be found in the use of a wiki with discussion vs. a forum. This illustrates the expanding nature of a forum and the condensing nature of a wiki. • In a wiki, groups tend to be collaborative, whereas in a threaded discussion, groups tend to be more cooperative.	**Att.:** scaffolding and interaction. **LX:** cognition and metacognition.
Jonas and Burns (2010)	• To undertake a module evaluation which formed part of the universities' teaching and learning strategy.	**IX:** limited IT skills, feeling isolated, lack of perception regarding e-learning, motivation and development of independent learning skills, reduction in travel costs and positive academic support for learning. **DX**: learning outcomes. **N=**13. **Method**: quant. survey.	• Six factors that restricted the achievement of learning outcomes: use of IT skills, feeling isolated, lack of perception regarding e-learning, motivation and development of independent learning skills, reduction in travel costs and positive academic support for learning).	**Att.:** scaffolding and interaction. **LX:** cognition, metacognition and motivation.
Kim and Ryu (2013)	• To assess a web-based formative peer assessment system emphasizing learners' metacognitive awareness for their performance in ill-structured tasks.	**IX:** attitudes toward peer assessment, motivation, identification of the context, clarity of the id process, completeness of the id, justification, critical thinking and creativity. **DX:** metacognitive awareness and performance. **N=**122. **Method:** quant. experiment + survey.	• Sequential metacognitive learning processes help learners monitor their learning and adapt strategies that are not working effectively. • Peer interaction and back-feedback gave learners more control over their learning.	**Att.:** learner control, scaffolding and reflection. **LX:** metacognition.
Kobak, Craske, Rose, and Wolitsky-Taylor (2013)	• To develop a web-based Cognitive Behaviour Therapy training course, to increase accessibility to the training.	**IX:** guidance and feedback. **DX:** effectiveness and user satisfaction. **N=**36. **Method**: quant. experiment + pre- and post-test + survey.	• Feasibility in the form of learner satisfaction is an important factor when developing training. • Learners had high levels of satisfaction with both the clinical content and the technical features of the training. Being able to obtain training online greatly increases accessibility and dissemination. The fact that the training was done by an experienced, but newly trained,	**Att.:** reflection and interaction. **LX:** motivation.

			psychologist gives promise for increased dissemination of the applied training as well.	
Koh and Chai (2014)	• To employ cluster analysis to categorize teachers into groups based on their self-reported technological pedagogical and content knowledge before they were engaged in lesson design activities as part of their professional development.	**IX:** pre-technological knowledge, pre-pedagogical knowledge, pre-content knowledge, pre-pedagogical content knowledge, pre-technological content knowledge, pre-technological pedagogical knowledge and pre-technological pedagogical content knowledge. **DX:** effectiveness and user satisfaction. **N=**266. **Method:** quant. experiment + survey.	• For in-service teachers who were already familiar with curriculum, the transformation of content with technology-based approaches needs to be emphasized in design activities. • Both pre-service and in-service teachers, regardless of their cluster membership, it seemed clear that the design process was inherently complex and could be better scaffolded with distributed intelligence.	**Att.:** authenticity, scaffolding and interaction. **LX:** cognition and motivation.
Koke and Norvele (2008)	• To determine whether the encouragement of learners to use learning strategies can be a design-purpose of study materials. • To determine whether a component that explicitly teaches learning strategies is a key element of the study process.	**IX:** metacognitive strategies, all strategies, except for metacognitive, inferencing, using of context for comprehension transfer, practicing different contexts, all cognitive strategies, communicative and social strategies. **DX:** strategy awareness. **N=**222. **Method**: quant. quasi-experiment + survey + qual. interview.	• Direct teaching components for learning strategies in a distance learning course improve the learners' strategy awareness. They may contribute to the empowerment of learners as autonomous learners, by reducing their anxiety, by fostering reflection, metacognition and by providing a sense of achievement. • Comprehension of learning strategies in distance learning form can be fostered by the implementation of a direct learning strategy. While providing opportunities for practicing these strategies in authentic learning situations and encouraging awareness of the metacognitive strategies during the study process can be directed towards the sustainable use of the acquired strategies.	**Att.:** authenticity, personalization and calibration. **LX:** cognition and metacognition.
Kovačević et al. (2013)	• To provide plausible information about the effect of educational game design on improving general knowledge and results.	**IX:** exam grades, learned by designing computer games, traditional learning circumstances. **DX:** learning outcomes and self-reported experience. **N=**125. **Method:** quant. experiment + survey + qual. interview.	• Learners were interested in alternative ways of learning because it enabled them to learn in a different way, to show their creative skills and not the last, the concept of fun proved to be exceptionally important. • Content of learning (programming game) as well as context (game design) could be defined in terms of relevance and curiosity evoking.	**Att.:** authenticity, personalization, calibration and interaction. **LX:** cognition.
Kuo et al. (2012)	• To propose a hybrid learning mechanism for improving learners' web-based problem-solving abilities via the combination of the cognitive apprenticeship model and the collaborative learning strategy.	**IX:** interest in learning social studies, immersion in learning social studies, capability of learning social studies, usefulness of learning social studies and attitude toward problem-solving. **DX:** problem-solving ability and learning attitude. **N=**58. **Method:** quant. experiment + survey.	• The method integrating cognitive apprenticeship and collaborative learning mechanisms in an online inquiry-based learning environment has great potential to promote middle- and low-achievement learners' problem-solving ability and learning attitudes. • Hybrid approaches could ease their learning anxiety via the inspection of high- achievement peers, while think aloud is essential for these learners when conducting the cognitive apprenticeship process.	**Att.:** authenticity, scaffolding and interaction. **LX:** cognition and metacognition.

Lafuente Martínez, Álvarez Valdivia, and Remesal Ortiz (2015)	• To explore the role of e-assessment in making the learning process more visible to the instructor, while revealing its impact on the adjustment of ensuing feedback.	**IX:** e-assessment. **DX:** learning process visibility. **N=**73. **Method:** qual. document analysis + interview.	• Promote peer-to-peer communication which can be recorded by a wide range of technological tools throughout the activity. Use asynchronous text-based communication as it is still a highly effective device to enable high learning transparency. • Consider formative assessment activities as a means for gathering information to improve feedback, and not only to control and grade learners. Engage learners in dialogic-guidance feedback formats. Learners expect support, they must receive it. In case of overburden, focus on the monitoring of collaborative activities as they provide an open window to the learners' learning process.	**Att.:** authenticity, personalization, learner control, reflection and interaction. **LX:** metacognition and motivation.
Law and Sun (2012)	• To develop a four-dimension evaluation framework and apply it to an empirical study with digital educational games in geography.	**IX:** learning experience, gaming experiences, usability. **DX:** learning efficiency. **N=**16. **Method:** quant. experiment + pre- and post-test.	• Activity theory can be used to describe user experiences in digital educational games. Four dimensions were identified: gaming experience, learning experience, adaptively and usability.	**Att.:** Learner control and interaction. **LX:** cognition.
Leen and Lang (2013)	• To explore motives of young and old learners to participate in two ICT-course settings: e-learning and face-to-face courses. • To exploring individual differences in learning motivation between young and older learners in the field of computer based learning.	**IX:** belonging, instrumentality, personal growth, and competition. **DX:** learning motivation and personality. **N=**211. **Method:** quant. survey.	• Older learners expressed stronger motives of belonging and personal growth, and thus expressed a stronger interest in self-determined and intrinsic learning and social motives. Young learners, in contrast, strongly endorsed competitive-related motives of learning. • Older learners showed higher instrumentality when the difference between chronological age and subjective age is big.	**Attributes:** interaction**. LX:** motivation.
Liaw et al. (2010)	• To explore positive factors for the acceptance of m-learning systems.	**IX:** learners' satisfaction, learners' autonomy, system functions, interaction and communication activities. **DX:** acceptance toward mobile learning. **N=**152. **Method:** quant. quasi-experiment + survey.	• Enhancing learners' satisfaction, encouraging learners' autonomy, empowering system functions, and enriching interaction and communication activities have a significant positive influence on the acceptance of m-learning systems. • A classification for m-learning affordances is presented: educational content and knowledge delivery application, adaptive learning application, interactive application, collaborative application and individual application.	**Att.:** personalization, calibration, scaffolding and interaction. **LX:** motivation.
Lin (2011)	• To explore the determinants of the e-learning continuance intention of learners with different levels of e-learning experience. • To examine the moderating effects of e-learning experience on the relationships among the determinants.	**IX:** frequency of negative critical incidents, perceived ease of use and attitude. **DX:** continuance intention. **N=**83. **Method**: quant. survey.	• Five exogenous constructs have a direct or indirect effect on the learners' continuance decision, namely negative critical incidents, perceived ease of use, perceived usefulness, quality attributes cumulative satisfaction, and attitude. • Negative critical incidents and attitude are the key drivers of continuance intention in the e-learning environment,	**Att.:** calibration and interaction. **LX:** metacognition and motivation.

			irrespective of the user's prior level of e-learning experience.	
Lin et al. (2012)	• To identify characteristics of a website encourage enjoyable online learning. • To identify what design guidelines lead to websites that support enjoyable online learning experiences.	**IX:** engagement, affect and fulfilment. **DX:** web enjoyment experiences. **N**=615. **Method**: quant. survey.	• Identification of characteristics: novelty, harmonization, no time constraint, proper facilitations and associations. • Identification of guidelines: designing multisensory learning experiences, creating a storyline, mood building, fun in learning, and establishing social interaction.	**Att.:** learner control and interaction. **LX:** motivation.
Lin, Zimmer, and Lee (2013)	• To identify perspectives of teachers and learners of podcasting acceptance on campus.	**IX:** individual differences, facilitating conditions and social influences. **DX:** behavioural intent. **N=**99. **Method**: quant. survey.	• There is a positive relationship between performance expectancy and behavioural intention and between effort expectancy and behavioural intention. • Individual difference factors for the learner showed significant paths to effort expectancy for only personal innovativeness and self-efficacy. Finally the relationship between personal innovativeness and performance expectancy was significant.	**Att.:** interaction. **LX:** cognition and metacognition.
Ma (2012)	• To identify the advantages and disadvantages of computer-aided online distance learning for college teachers.	**IX:** conception on learning (metacognition and cognitive strategies). **DX:** learning outcomes and academic performance. **N=**118. **Method**: qual. case-study + interview.	• Advantages of online distance learning: resourcefulness and adaptability or flexibility were identified. • Disadvantages of online distance learning: limited interaction (lack of interaction causes problems), little instructional variation, the metacognitive and cognitive strategies needed, self-regulation needed and IT-skills needed were identified.	**Att.:** personalization and interaction. **LX:** cognition and metacognition.
Makoe, Richardson, and Price (2008)	• To investigate whether learners' approaches to learning via online peer assessment will show a stronger relationship to learning outcomes than their respective conceptions of learning.	**IX:** self-conceptions of learning. **DX:** learning outcomes and approach to learning. **N=**163. **Method**: quant. experiment + qual. interview.	• At the main level there was a significant association between conceptions and approaches. • Learners embarking on distance education seem to hold distinctive conceptions of learning, which suggests that conceptions of learning are culturally and contextually dependent.	**Att.:** interaction. **LX:** cognition and metacognition.
Martens et al. (2010)	• To determine what the effects of positive, neutral or negative feedback presented to collaborating teams of learners, on learners' intrinsic motivation, performance and on group processes are.	**IX:** positive, neutral or negative feedback. **DX:** learners' intrinsic motivation, performance and group processes. **N=**138. **Method:** quant. experiment + survey.	• Significant positive effect of feelings of autonomy and competence on report of interest. They reduce the interest variance between sessions substantially. • More autonomous learners gain more interest than their peers from positive respectively negative feedback. The relative interest gain of autonomous learners from negative feedback is striking. Feelings of competence also facilitate the effects of positive and negative feedback.	**Att.:** authenticity, calibration, reflection and interaction. **LX:** cognition, metacognition and motivation.

Mauroux et al. (2014)	• To develop a mobile and online learning journal to support reflection on workplace experiences.	**IX:** attitude toward using technologies, motivational support, response to changes, perceptions of the work environment, feedback / support / guidance (prompts), attitude toward reflection and intention to use. **DX:** usage behaviour. **N=**16. **Method:** quant. quasi-experiment + log file analysis + qual. interview + survey.	• Three influencing factors: interest, acceptance and the need for participation and feedback from instructor. • Implications: stimulation of reflection is important, strong guidance and feedback about reflection, relevance of the mobile and online learning journal and use of the mobile and online learning journal. • The use of reflective online learning journals, without the incentive of marks, is relevant and feasible.	**Att.:** reflection. **LX:** metacognition and motivation.
Michalsky (2014)	• To develop and test the self-regulated learning-profession vision scheme for assessing pre-service teachers' integration of professional vision considerations while analysing two delivery modes for teaching of self-regulated learning: direct and indirect teaching.	**IX:** cognition, metacognitive and motivational strategies. **DX:** self-regulation. **N=**26. **Method:** qual. case-study + pre- and post-analysis.	• Active management of motivational processes is essential. • This by using causal attribution, action control and feedback.	**Att.:** authenticity, learner control, scaffolding, reflection and interaction. **LX:** metacognition and motivation.
Michinov and Michinov (2007)	• To investigate group development during an online learning session among learners involved in lifelong learning.	**IX:** use of various modes of communication, need for physical contact, motivation, feelings experienced during the online learning session, perceived cohesion, group development and affect. **DX:** learner satisfaction, perceived learning outcome and evaluation. **N=**7. **Method**: qual. case-study + log file analysis + survey.	• A transition period at the midpoint of the collaborative activity shows a decline of task-oriented communications, motivation and positive mood in this period. Stronger attention is particularly useful during a transition period at the midpoint of an online collaborative activity.	**Att.:** interaction. **LX:** cognition, metacognition and motivation.
Mohammadi (2015)	• To examine an integrated model of technology acceptance model and DeLone & McLean's model for predicting learners' actual use of e-learning. • To explore the effects of quality features, perceived ease of use, perceived usefulness on learners' intentions and satisfaction, along-side the mediating effect of usability towards use of e-learning in Iran.	**IX:** satisfaction (educational quality, service quality, technical system quality, content and information quality) and intention to use (educational quality, service quality, technical system quality, content and information quality, perceived ease of use and perceived usefulness). **DX:** actual use. **N=**390. **Method**: quant. survey.	• Providing an application which is aesthetically satisfying, user-friendly, structurally designed, flexible, environmentally attractive, reliable, and secure which optimizes response time and provides interactive features are recommended. • Appropriate arrangement of time and application environment, possibility of content printing and transferring by the way of application without being detached, possibility of controlling all aspects of the system while working, the presence of a fixed available menu for users, supporting content and information with images, videos, and sounds, evolving e-learning communication towards voice communication and video conference, and expanding requisite IT infrastructure are alternatives in this regard.	**Att.:** authenticity, personalization, learner control and interaction. **LX:** motivation.

Mohammadyari and Singh (2015)	• To understand the role of digital literacy the effect of e-learning on learners' performance.	**IX:** performance expectancy, effort expectancy, social influence, individuals social influence, organizational support and intent to continue using IT. **DX:** performance. **N=**34. **Method**: quant. survey.	• Significant influence of: digital literacy on learners' performance and effort expectations, performance expectations on learners' intentions to continue using Web 2.0 tools, and continuance intention on performance. • Individual digital literacy facilitates the use of e-learning, and should be considered when examining the impact of the latter on performance.	**Att.:** calibration and interaction. **LX:** cognition.
Mulder, Lazonder, and de Jong (2011)	• To determine whether gradually introducing learners to increasingly more sophisticated or comprehensive subject matter was expected to enhance performance success. • To determine whether the progression of model order was predicted to yield higher performance success than model elaboration progression.	**IX:** time on task, perspective, degree of elaboration, and order. **DX:** performance success. **N=**84. **Method**: quant. experiment + pre- and post-test + log file analysis.	• The model order progression enhanced learners' task performance, a comparison among the two model progression conditions confirmed the predicted superiority of the model order progression condition. • Comparison of learners final models indicated that model order progression and model elaboration progression learners were equally proficient in identifying which elements are relevant to their models, whereas model order progression participants more accurately modelled the relations between these elements.	**Att.: authenticity**, scaffolding and interaction. **LX:** cognition.
Niemi et al. (2003)	• To report how learners use the tutoring tool and learn self-regulation skills.	**IX:** learning skills, keywords and advance organizers, application of theories and self-assessment. **DX:** overall satisfaction and continuing motivation. **N=**256. **Method**: quant. survey.	• The tool presented is the most useful for learners who have difficulties in learning or who do not have stable learning strategies and skills, or who are at an early stage of their studies. • Tutoring towards self-regulation is highly needed. There is too little guidance for study skills and learning strategies in both campus-based and virtual studies.	**Att.:** calibration, reflection and interaction. **LX:** metacognition and motivation.
Obura, Brant, Miller, and Parboosingh (2011)	• To determine whether resident learners participating in an Internet based e-mentoring course would form a community of learners and hold regular community meetings. • To determine whether resident learners' and faculty perceptions of community of learners and Internet sessions are effective as learning experiences.	**IX:** self-regulation, peer mentoring and collaborative problem solving. **DX:** participation community of learners. **N=**10. **Method**: quant. quasi-experiment + log file analysis + survey + qual. interviews.	• Learner adoption of community of learners behaviours was observed, including self-regulation, peer mentoring and collaborative problem solving. High learner enthusiasm and value for community of learners. • High levels of acceptance of Internet learning experiences were observed, although there was room for improvement in audio-visual transmission technologies. The study demonstrated learner acceptance of community building and collaborative learning as valued learning experiences.	**Att.:** personalization and interaction. **LX:** metacognition.
Oosterbaan, van der Schaaf, Baartman, and Stokking (2010)	• To explore the relationship between the occurrence of reflection (and non-reflection) and thinking activities (e.g. orientating, selecting, analysing) during portfolio based conversations.	**IX:** reflection. **DX:** orientating on the task, orientating on one's own portfolio, judging negatively, attributing to oneself , attributing to others and circumstances intending. **N=**21. **Method:** quant. quasi-experiment + coding schemes.	• Thinking activities comparing, analysing and concluding occurred significantly more often during reflection than during non-reflection. Orientating on the task, selecting and describing, occurred significantly less often during reflection.	**Att.:** authenticity, reflection. **LX:** metacognition.

			• The outcomes show that the occurrence of certain thinking activities can be an indication of reflection.	
Raupach, Munscher, Pukrop, Anders, and Harendza (2010)	• To examine whether participation in an online module on 'the differential diagnosis of dyspnoea' impacts on learner performance in a multiple choice examination.	**IX:** interest, perceived ability to use a computer and perceived knowledge. **DX:** learner satisfaction, perceived learning outcome and evaluation of the online module. **N=**74. **Method**: quant. experiment + pre- and post-test + survey.	• Learners using an online module scored higher in a test than learners not included in the study, despite comparable achievement levels before entering the study. • The online module is likely to have increased learners' motivation to learn, and subsequent learning was not restricted to the content of the online module.	**Att.:** personalization and interaction. **LX:** cognition, metacognition and motivation.
Ream, Gargaro, Barsevick, and Richardson (2015)	• To investigate the adapted delivery by telephone for the 'beating fatigue programme'.	**IX:** interest, perceived ability to use a computer and perceived knowledge. **DX:** learner satisfaction, perceived learning outcome and evaluation of the online module. **N=**64. **Method**: quant. experiment + qual. interview.	• Motivational interviewing appeared key to the intervention's success. • Effects of the telephone-delivered version were similar to those generated by the in-person intervention. Helping learners explore benefits of maintaining / enhancing activity establishing attainable goals and facilitating their attainment of them.	**Att.:** calibration and interaction. **LX:** metacognition and motivation.
Regan et al. (2012)	• To explore the emotional experiences of instructors in online learning environments. • To explore how instructors attempt to regulate their challenging emotions when participating in online learning environments.	**IX:** online learning environments. **DX:** regulation of emotions and feelings. **N=**6. **Method**: qual. interview.	• Overarching themes included emotions of feeling restricted, stressed, devalued, validated, and rejuvenated. • A consensus among all instructors is that continuous dialogue in a community of practice about strategies to enhance online learning environments is imperative.	**Attributes:** interaction**. LX:** metacognition.
Reichelt et al. (2014)	• To investigate the effectiveness of multimedia design principles for different target groups, to match learners' profiles.	**IX:** receiving personalized computer-based programme and receiving a formal version. **DX:** performance on transfer and retention. **N=** 127. **Method:** quant. quasi-experiment + survey + qual. document analysis.	• Personalized learning materials promote motivation and learning regardless of the target population. Mean effect sizes and evidence that personalized learning material positively influences retention. • An practical implication for design is that communicative features expressed in a personalized style seem to engage learners across different educational settings in active learning processing.	**Att.:** personalization, learner control and interaction. **LX:** cognition.
Reychav and Wu (2015)	• To understand the role of five different dimensions of cognitive absorption in training outcomes and how affective and cognitive involvements leverage this learning process.	**IX:** enjoyment, immersion, dissociation, curiosity and control. **DX:** affective and cognitive involvement. **N=**501. **Method**: quant. experiment + pre- and post-test.	• Cognitive absorption plays a significant role in affecting learners' deep involvement, which in turn impacts training outcomes. • Heightened enjoyment, focused immersion, temporal dissociation, and control are crucial to leverage learning but indirectly by increasing the cognitive involvement of the trainee. The results further indicate a direct effect of heightened enjoyment, focused immersion, temporal dissociation and curiosity on perceived usefulness.	**Att.:** interaction. **LX:** cognition, metacognition and motivation.

			• Moreover, perceived usefulness has a direct effect on perceived learning.	
Roca et al. (2006)	• To propose a decomposed technology acceptance model in the context of an e-learning service.	**IX:** satisfaction, confirmation and perceived quality. **DX**: e-learning continuance intention. **N=**172. **Method**: quant. survey.	• Learners continuance intention is determined by satisfaction, which in turn is jointly determined by perceived usefulness, information quality, confirmation, service quality, system quality, perceived ease of use and cognitive absorption. • Instructors can increase learners' usage intention by improving their beliefs of how the e-learning system can enhance their performance and effectiveness.	**Att.:** interaction. **LX:** metacognition and motivation.
Sansone et al. (2011)	• To examine whether individual interest in computers moderated the effect of adding usefulness information predicting higher engagement levels, which in turn predicted motivation and performance outcomes.	**IX:** individual interest, anticipated usefulness, anticipated interest. **DX:** engagement, motivation, performance outcomes, regulation of interest and learning online. **N=** 108. **Method:** quant. experiment + survey.	• Individual interest in computers did not directly affect motivation and performance outcomes, nor did it directly affect learners' patterns of engagement during the lesson. • When there was little pre-existing interest, the explicit connections to how individuals could use the skills in real life were more motivating when framed in terms of potential work applications.	**Att.:** authenticity, personalization. **LX:** cognition, metacognition and motivation.
Sansone, Smith, Thoman, and MacNamara (2012)	• To examine learners' self-reported use of strategies to motivate studying for the first exam.	**IX:** self-grades importance, persuade self to work, real life application, enjoyment of game, enjoyment of other learners, enjoyable links, interest and first exam grades. **DX:** final interest and final grades. **N=** 110. **Method:** quant. experiment + survey.	• Learning online did not differ with learning in the on-campus context in the degree to which learners reported using motivational strategies that emphasized the value of potential studying-related outcomes. • Strategies aimed at enhancing or sustaining motivation to reach learning outcomes may be more defined in terms of strengthening why learners should exert effort and persist in the learning task, and these kinds of strategies may be less dependent on the learning context. • Discouraging exploration of the Internet may negatively impact learners' ability to sustain interested engagement while learning on their own.	**Att.:** scaffolding and interaction. **LX:** cognition, metacognition and motivation.
Siampou et al. (2014)	• To examine the differences between online synchronous and offline face-to-face collaboration in the context of a computer-supported modelling task.	**IX:** collaboration type. **DX:** modelling processes, interactions and learning outcomes. **N=**16. **Method:** quant. quasi-experiment + qual. observation.	• Learners who worked online in pairs emphasized analysis and synthesis, they also demonstrated a higher learning gain. Offline pairs needed the instructors' support and demonstrated stronger social interaction. • Actions of offline dyads were more numerous, the dyads that worked online seemed to present more task oriented actions.	**Att.:** authenticity, calibration, scaffolding and interaction. **LX:** cognition and metacognition.

Smith et al. (2008)	• To examine what registered care home nurses' and senior care home assistants' educational priorities regarding stroke care are and how they conceive stroke care will be delivered.	**IX:** preferred type of delivery and reasons to undertake further training. **DX:** perceived need for stroke training. **N=**134. **Method:** qual. interview + survey.	• Senior care assistants needed more information on multidisciplinary team working while care home nurses were more concerned with ethical decision-making, accountability and goal setting. • Both the care home nurses and senior care assistants are clear that stroke education should be to the benefit of their resident population.	**Attributes:** personalization**.** **LX:** metacognition and motivation.
Strang (2011)	• To determine whether knowledge articulation dialogue increases online university science course outcomes.	**IX:** teaching method. **DX:** final grades. **N=**52. **Method:** quant. quasi-experiment + test.	• When the knowledge articulation dialogue online facilitation method was applied, learners went through a learning curve effect, but thereafter, their knowledge articulation was be strengthened. • If the questioning approach was used, this may result in favourable scores early on, but overall the remaining deliverables and final marks may be lower. • It is suggested this knowledge articulation dialogue method would better suit quantitative subject matter courses.	**Att.:** reflection and interaction. **LX:** cognition.
Tan and Richardson (2006)	• To investigate the writing of short messages, using a sociocultural perspective of literacy as a social discursive practice that implicates identity construction.	**IX:** SMS messages, messages in class and online messages. **DX:** out-of-school practices. **N=**31. **Method:** qual. document analysis + interviews.	• In assigned school writing, the activity was one of language study and practice entailing the maintenance of school values and academic and examination discourse. School writing, done within the examination-oriented and often teacher-centred class, consisted of set text types that fit examination genres. • In learners informal interactions, learners wrote freely to maintain friendship ties, to overcome boredom, and basically to fulfil their need for meaningful communication. Content in learners' messages was unguarded and uncensored, revolving mainly around relationships, school and social life.	**Att.:** authenticity, personalization and interaction. **LX:** metacognition and motivation.
Tao (2008)	• To comprehend the teachers' and learners' perceptions on concerns toward e-learning issues.	**IX:** learning effect, administrative challenges, customization, geographic and content integration and instructional design challenges. **DX:** perception on institutional e-learning issues **N=**145. **Method**: quant. survey.	• Learners have black-or-white perceptions on the use of e-learning, they see learner and administrative support as crucial and rather feel a lack of competitive awareness on the professional market.	**Att.:** personalization and interaction. **LX:** metacognition.
Taplin, Kerr, and Brown (2013)	• To analyse the monetary value learners place on having access, via the internet, to recorded lectures in a blended learning context.	**IX;** university fixed price for iLectures to maximize revenue and learner demographics. **DX:** learner choice to purchase iLectures at a fixed price and learner perceptions of iLectures and face-to-face lectures. **N=**1932. **Method:** quant. survey.	• It is necessary to be cautious of qualitative valuations of iLectures. • It appears that some learners may agree that something is worthwhile if they perceive it to be free.	**Attributes:** interaction**. LX:** motivation.

Ting (2013)	• To proposes a notion for helping instructors design an innovative mobile learning practice in specific subject domain. • To determine whether learners accept the proposed learning activity and perceive the claimed learning benefits	**IX:** relationship, perception and attitude toward learning technology. **DX:** willingness to use learning technology. **N=**57. **Method**: quant. experiment + pre- and post-test + survey.	• Mobile technologies add new dimensions to learning activities, both the personal and portable nature of the devices, as the kinds of learning interactions they can support. Mobile learning enables learners to interact and capture experiences in both physical and social realms, and makes learning more experiential and multifaceted. • Guidelines: mapping subject content onto social interactions, recording social interactions, synthesis of group behaviours and subject content and delivery of instructional information and visualization of the design framework.	**Att.:** authenticity, learner control, scaffolding, refection-evoking and interaction. **LX:** metacognition and motivation.
Tseng and Kuo (2010)	• To propose and validate a self-regulation model that explores the effects of social capital and social cognitive factors on knowledge-sharing behaviour.	**IX:** community identity and interpersonal trust. **DX:** social awareness, knowledge-sharing behaviour and knowledge-sharing self-efficacy. **N=**?. **Method**: quant. survey.	• Knowledge-sharing behaviours in the online community exhibit a triadic interplay among the community identify, interpersonal trust, social awareness, learners' perception of self-efficacy, and knowledge-sharing behaviour in the online environment.	**Att.:** interaction. **LX:** metacognition.
Verhagen, Feldberg, van den Hooff, Meents, and Merikivi (2012)	• To fill the research gap between the growth and commercial potential of virtual worlds and the relatively little knowledge about users' motivations to engage in them.	**IX:** perceived usefulness, entertainment value, economic value, perceived ease of use, escapism and visual attractiveness. **DX:** attitude towards using a virtual world, entertainment value, perceived usefulness. **N=** 846. **Method:** quant. survey.	• Strong direct effects of the extrinsic motivation perceived usefulness and the intrinsic motivation entertainment value on the attitude towards virtual world usage. • Higher levels of economic value, perceived ease of use and escapism contribute to the perceived entertainment value and usefulness of virtual world systems. • Visual attractiveness did not contribute to the perceived usefulness of virtual worlds.	**Att.:** personalization, calibration and interaction. **LX:** metacognition and motivation.
Vighnarajah et al. (2009)	• To investigate learners' perception on participation in a discussion platform, on the importance of practicing self-regulated learning strategies and on the development of self-regulated learning strategies through participation in the discussion platform.	**IX:** intrinsic goal orientation, extrinsic goal orientation, control of learning beliefs, self-efficacy for learning and performance, metacognitive self-regulation, time and study environment, effort regulation, peer learning and help seeking. **DX:** overall development of self-regulated learning strategies. **N=**50. **Method:** quant. experiment + survey.	• Learners acknowledged practicing self-regulated learning strategies. Frequent strategies appear to be intrinsic and extrinsic goal orientation, control of learning beliefs, rehearsal, elaboration, critical thinking, peer learning, and help seeking. • Strategies that interest learners the least are task value, effort regulation, and metacognitive self-regulation.	**Att.:** calibration, scaffolding and interaction. **LX:** metacognition.
von Bastian and Oberauer (2013)	• To examine the impact of working memory training on a broad set of transfer tasks.	**IX:** working memory training. **DX:** transfer tasks. **N=**137. **Method:** quant. experiment + pre- and post-test.	• Degree of improvement in the training tasks correlated positively with the magnitude of transfer. • Differential effects of training different functional categories of working memory and executive functions could explain why previous studies yielded mixed results.	**Att.:** authenticity**. LX:** cognition.

Weaver, Oji, Ettienne, Stolpe, and Maneno (2014)	• To assess the impact of a hybrid teaching methodology on improving critical thinking in an health policy elective course.	**IX:** hybrid teaching methodology. **DX:** critical thinking. **N=**8. **Method**: quant. quasi-experiment + pre- and post-test + qual. interview	• Learners reported that their ability to effectively participate improved significantly although the assessment showed mixed findings. • The course benefited from being new and giving the learners a broad view. • Critical thinking was improved among the learners.	**Att.:** personalization, scaffolding, reflection and interaction. **LX:** cognition and metacognition.
Wesiak et al. (2014)	• To determine whether scaffolding services support self-regulated learning in an augmented simulator.	**IX:** scaffolding service, training in the simulator and augmented simulator. **DX:** relevance for real life experiences, self-regulated learning, and enhanced learning experience. **N=** 113. **Method:** quant. experiment + log-file analysis + survey.	• Addition of thinking prompts by the scaffolding service was beneficial. Time spent with the simulation increased. • Positive effect of the refinements of thinking prompts and / or affective element added to the scaffolding service. • The type of notes taken by the learners, during the think aloud method, supports the assumption that scaffolding support fosters metacognition and reflection.	**Att.:** authenticity, personalization, learner control, calibration, scaffolding and interaction. **LX:** metacognition and motivation.
Xie et al. (2013)	• To determine how social conflict evolve in an online class and what the relations between social and learning interactions in an online social learning environment are.	**IX:** social interaction. **DX:** learning interaction. **N=**18. **Method**: qual. case-study + interviews.	• A model of social conflict evolution within the learning community is identified consisting of five general phases: cultural initiation, social harmonization cycle, escalation of conflict, intervention and stabilization, and adjourning. • Strong relationships between social and learning interactions during these five phases of social conflict development.	**Att.:** authenticity and interaction. **LX:** motivation.
Yang and Tsai (2010)	• To investigate college learners' conceptions of and approaches to learning via online peer assessment (PA).	**IX:** online peer assessment. **DX:** conceptions of and approaches to learning. **N=** 163. **Method:** quant. quasi-experiment + qual. interviews.	• Conceptions emphasizing on fragmented and cohesive learning tended to be associated with approaches focusing on surface and deep learning. • Approaches to learning via online peer assessment were less related to the learning outcomes than conceptions of learning. • Support for deep learning is advisable.	**Att.:** scaffolding and reflection. **LX:** metacognition and motivation.
Yu et al. (2007)	• To investigate the feasibility of developing e-learning. • To examine reasons for adopting or rejecting e-learning as an alternative way to conduct continuing education for public health nurses.	**IX:** age, education level, marital status, job position and previous experience in web-based learning. **DX:** feasibility of adopting e-learning as an alternative way of continuing education and reasons for adopting or rejecting e-learning. **N=**233. **Method**: quant. survey.	• Asynchronous e-learning courses are suitable for individuals with high self-control, it allows them to learn in remote locations according to their own needs and pace. • Needs assessment is strongly recommended in the programme preparation stage. Only by fulfilling learners; individual needs, reducing learning barriers, increasing their motivation and self-controlling ability, can this approach be successful.	**Att.:** personalization and learner control and reflection. **LX:** metacognition and motivation.

3 How To Design Blended Learning? A Review Study

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ABSTRACT

Although many instructors in education are increasingly being required to incorporate technology-enhanced learning in their instruction, the research on blended learning remains fragmented across different studies and the literature does not explicitly put forward an overarching framework for designing blended learning environments. Therefore, this study reviews 19 co-existing studies on the design and development of blended learning environments in order to investigate which design features were used until now. The following research questions were addressed: How do blended learning environments deal with (1) learner flexibility, (2) interaction, (3) guiding students' learning processes, and (4) fostering an affective climate? The results showed that few studies provide opportunities for learners to choose between online or classroom-based activities. Second, designers often implemented an initial face-to-face meeting, together with a number of online features, to facilitate a good interpersonal relationship. Third, the most common regulative teaching activities were familiarizing students with technology, and providing online quizzes, organizational information, and feedback. Fourth, clarifying expectations and fostering learners' motivation received attention to foster an affective climate, while dealing with emotions and appraising were often neglected. Finally, we noticed that most of the selected studies only provided little explanation about the assumptions underlying their specific design, and suggest that this should be explained explicitly in future studies.

Keywords

Blended learning, Design, Instructional methods, Review study

3.1 Introduction

The idea of combining face-to-face with computer-mediated instruction in education is not new (see e.g., Garrison & Kanuka, 2004; Graham, 2006; Osguthorpe & Graham, 2003). Since the rise of ICT in education, this approach to teaching and learning has been implemented and studied repeatedly (Drysdale, Graham, Spring, & Halverson, 2013). Recent work commonly uses the term blended learning, which emphasizes the deliberate blending or combination of classroom-based and online activities to instigate and support learning (Boelens, Van Laer, De Wever, & Elen, 2015). Over the past few years, there has been a growing interest in studies on how to design effective blended learning environments. The main reason is that research has demonstrated that, when blended learning environments are designed, several transformations are required. Among other things, the design of courses has to be rethought, new learning activities have to be created, and online and face-to-face components have to be integrated (Joosten, Barth, Harness, & Weber, 2014). In this respect, an increasing number of studies have focused on models that guide the design of blended learning environments (Graham, Henrie, & Gibbons, 2014).

However, previous research did not provide us with clear theoretical guidelines articulating the core pedagogical or psychological aspects of such an environment (Alonso, López, Manrique, & Viñes, 2005; Graham et al., 2014). For instance, the Substitution Augmentation Modification Redefinition (SAMR) model created by Puentedura (2014) provides interesting insights in how we can transform learning and teaching with technology. On the one end, substitution stands for the fact that technology can be used for the same task as was done before the use of computers, which means that there is no functional change in teaching and learning. On the other end, redefinition means that technology enables to design new tasks that were previously unimaginable. Although such models are necessary when designing blended learning activities, these are rather broad models describing how technology can transform teaching and learning. They do not provide us with specific guidelines that guide the design and practical implementation of blended learning activities. In addition, institutions are still struggling with the implementation of blended learning (Moskal, Dziuban, & Hartman, 2013), and it remains difficult to make decisions about a blended course design (Drysdale et al., 2013; Graham et al., 2014).

Through a review of previous work focussing on models or guidelines for the design of blended learning environments, the present study aims to crtitically analyze a number of features concerning the design of blended courses. By this, we aim to furthen the theoretical discussion and provide an overview for designers and practitioners about the design of such environments. In what follows, we provide a short overview of the literature on reasons for designing blended learning and resulting challenges, in order to define themes for further analysis.

3.1.1 Increased flexibility as a reason to blend

Although earlier research has discussed several benefits of blended learning, such as a more effective pedagogy (Graham, 2006; Joosten et al., 2014) or enhanced cost-effectiveness (Graham, 2006), a frequently reported and important benefit of combining classroom-based with online instruction is increased flexibility for learners (Bonk et al., 2006; Graham et al., 2005; Graham, 2006). In particular, the online component offers flexibility both in terms of time (synchronous/asynchronous) and place (co-located/anywhere) (Norberg, Dziuban, & Moskal, 2011; Osguthorpe & Graham, 2003). In addition to flexibility in terms of time and place, blended learning also offers flexibility in terms of learner choice for a certain instruction mode. In this respect, learners have the choice to enroll in a face-to-face or online course section, depending on their own preferences (see e.g., Owston, York, & Murtha, 2013).

However, this increased flexibility also poses two major challenges for instructors: (1) many learners want the flexibility offered by the blended learning method, but do not want to lose the social interaction and human touch they are used to in a face-to-face environment (Graham, 2006), and (2) more flexibility means more responsibility for learners, which appeals to self-regulatory skills or self-directedness of learners (Bonk, Kim, & Zeng, 2006).

3.1.2 Challenges when designing blended learning: interaction and self-regulation

Online instruction methods do not only separate learners from instructors geographically, but also lead to an enlarged psychological and communication space, called the transactional distance (Moore, 1993). Consequently, online instruction methods may limit human interaction, and if there is interaction, it is often considered less spontaneous than face-to-face communication (Osguthorpe & Graham, 2003). This can result in feelings of learner isolation (McDonald, 2014), which can in turn reduce the motivation to learn (Osguthorpe & Graham, 2003). The blended learning approach is seen as an effective alternative for distance education (Ausburn, 2004; Rovai, 2003), as it brings learners (geographically) together and enables both verbal and non-verbal communication during certain parts of the course (Osguthorpe & Graham, 2003). Still, as learners themselves have reported, a two-way

communication between learners and instructor(s) is important in both online and the classroom-based activities (Ausburn, 2004; McDonald, 2014).

Another concern is that, due to the increased autonomy of learners in online learning environments, self-regulation becomes a critical factor for success (Barnard, Lan, To, Paton, & Lai, 2009; Bonk et al., 2006; Lynch & Dembo, 2004). In this respect, it has been found that increased flexibility was mainly beneficial to high achievers. These students were more engaged in their studies, and appeared to learn key concepts better (Owston et al., 2013). On the other hand, it has been argued that low achievers may not have the required skills for independent learning (Montrieux, Vangestel, Raes, Matthys, & Schellens, 2015; Owston et al., 2013). In this respect, learners need several (self-regulatory) skills in order to control their own learning process, such as time-management, the ability to self-motivate, and the appropriate use of the technology to support learning (McDonald, 2014). Training in the above mentioned skills may therefore be necessary (Barnard et al., 2009; McDonald, 2014; Steffens, 2006), and blended learning environments should implement features that support students' learning processes and motivation.

3.1.3 Aim of the present study

The purpose of this paper is to review research that focusses on models or guidelines that guide the design of blended learning environments. Based on our identification of a number of aspects in the introduction above, we formulated the following research questions: In blended learning environments, how is dealt with (1) learner flexibility, (2) interaction, (3) guiding students' learning processes, and (4) fostering an affective learning climate?

3.2 Method

The present study is a qualitative literature review that integrates individual studies and provides a conclusion and discussion of the findings derived from systematic methods (Green, Johnson, & Adams, 2006).

3.2.1 Literature search strategy

Multiple search strategies were used to obtain research articles that fitted within the scope of the present study. First, to identify appropriate studies, the Web of Science database was consulted in February, 2015. The search terms that were used were: ("blend* learning" or "hybrid learning" or "blend* course" or "hybrid course" or "e-learning") and (design or model or guidelines). This resulted in 1016 hits. These results were refined by research domain (social sciences) and research area (education educational research, psychology, or social sciences other topics), which resulted in 479 hits. Articles published in a language other than English were excluded. As a second search strategy to identify appropriate literature, we considered the suggested literature in Halverson, Graham, Spring, and Drysdale's (2012) analysis paper of trends in blended learning (6 studies added) and in McGee and Reis's (2012) synthesis of best practices of blended course design (3 studies added). Finally, after removing one duplicate paper, a database including 487 titles and abstracts was created using EndNote.

3.2.2 Eligibility criteria

An overview of the search protocol is presented in Figure 1, according to the recommendations of the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) statement (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2010). Inclusion and exclusion criteria were employed to select appropriate studies and keep the review focused (Green et al., 2006). The following inclusion

criteria were applied: (1) blended learning had to be defined as a mix of face-to-face and online interventions, (2) studies had to focus on the design or development of blended learning activities, (3) the design had to be done at course level or within units of a course, and (4) studies had to present a detailed and clear indication of their design. The exclusion criteria were set as follows: (1) studies that focused on the design of one specific tool (e.g., discussion fora), (2) short conference papers, (3) studies were the full text was not available, and (4) book (chapter) reviews. Finally, 19 studies were selected and analyzed.

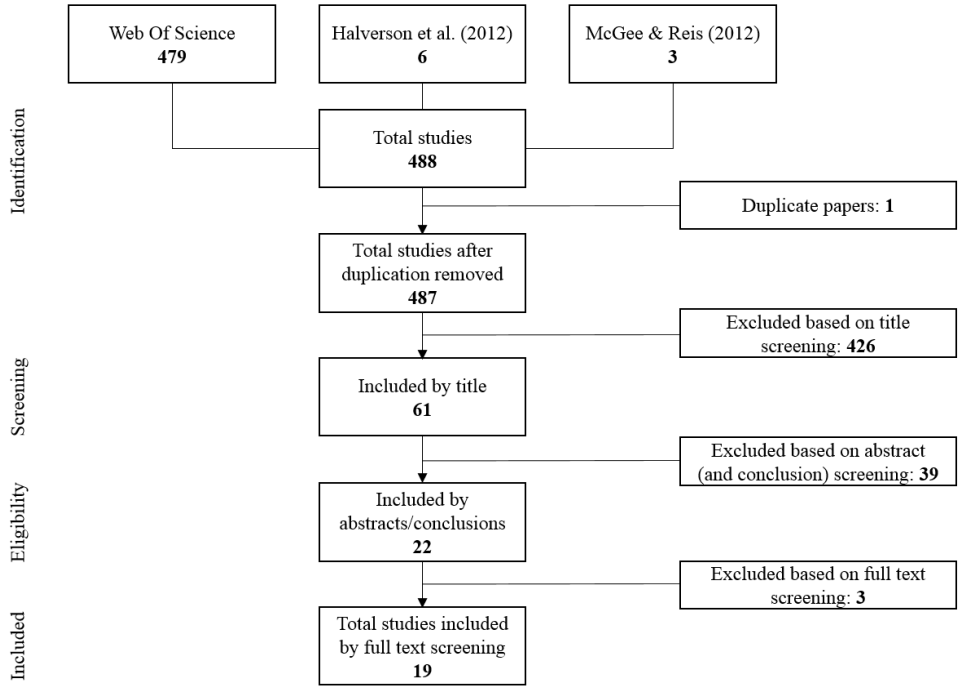

Figure 1. An overview of the search protocol according to the PRISMA statement

3.2.3 Analysis framework

In order to conduct a systematic analysis, a framework was constructed which defined categories of analysis according to each research question. This framework is provided below:

RQ1 – Flexibility:

- Who is responsible for the blend? (1) instructor, (2) learners, or (3) shared responsibility
- Reasoning for this approach

RQ2 – Interaction:

- Types of interaction

RQ3 – Guiding students' learning processes:

Reported support for

- orienting and planning
- monitoring and testing
- adjusting
- evaluating and reflecting

RQ4 – Creating an affective climate:

Reported support for

- motivating and expecting
- concentrating and exerting effort
- attributing and judging oneself
- appraising
- dealing with emotions

First, in order to identify how the selected studies dealt with learner flexibility, we investigated who was responsible for the blend and what was the reasoning for this approach. Second, in order to provide an overview of the interaction possibilities in blended learning environments, the types of interaction were analyzed. With respect to the third and fourth research question, we applied the framework of Vermunt and Verloop (1999), focusing on affective, metacognitive, and cognitive learning functions. These learning functions are psychological functions that have to be fulfilled in order for learning to occur (Shuell, 1988). We opted for this framework, since it is specifically focusing on teaching activities rather than on learning activities. In addition, the framework provides us a comprehensive lens to analyze features of the selected designs. However, we focus not so much on their upper level categorization of cognitive, metacognitive, and affective learning functions, first of all, since the authors themselves have argued that these categories are not mutually exclusive (Vermunt & Verloop, 1999), and secondly, since we are interested in the their underlying classification of instructional activities. Due to the nature of the research questions, we particularly were interested in the classification underlying metacognitive and affective learning functions.

3.3 Results and discussion

3.3.1 How is learner flexibility dealt with in blended learning environments?

The selected studies differed in this area, although the decision for the blend was in most of the studies made by the instructor. In this respect, the instructor selected the appropriate delivery method in accordance to the course objectives (Olapiriyakul & Scher, 2006; Picciano, 2009; Singh, 2003), or based on the pedagogical decisions (Kerres & De Witt, 2003). In two studies, the decision about the blend was completely in hands of the learner. In the study of Beatty (2010), learners were able to choose between participation modes (online or offline) weekly or topically. Related to this, De George-Walker and Keeffe (2010) argued that there are many successful combinations, and that it is not the role of the instructor to decide on the blend. According to these latter authors, instructors have to provide their courses in multiple participation modes, and support their learners in the creation of their individualized blend according to their learning needs and preferences. Finally, in one study, the decision about the blend was in hands of both instructor and learner (Cooner, 2010). In this case, the instructor scheduled several face-to-face sessions, and the other parts of the course were delivered online, while learners had the opportunity to request additional face-to-face meetings.

With respect to the first research question, it was found that learner flexibility was present to a certain extent in all selected studies, because of the implementation of time- and/or place-independent activities, which puts learners in control of when and where to carry out the activity, as well as how much time they choose to spend on it. However, only in a small number of studies, learners had the flexibility to decide whether they wanted to acquire or complete activities online or face-to-face. In this respect, some authors have argued that, in the future, decisions about the type and format of blended learning will be made by learners (Bonk et al., 2006), which means that learners will have

more responsibility and learning trajectories will be individualized. On the other hand, the ability of learners to outline their own trajectory depends on their self-regulatory skills and self-directedness, for example, students' ability to estimate their own needs. When students lack these skills, the teacher has to propose a model trajectory or guide students through the course. In this respect, individual learning differences are an important area to consider when providing blended instruction (Lim & Morris, 2006).

3.3.2 How is interaction dealt with in blended learning environments?

To answer the second research question, we focused on eight of the studies, which explicitly reported on interaction in order to enhance community building, or informal and social talk. Three of the selected studies reported that this aspect was implemented solely in the face-to-face mode, and in one study this was solely designed in the online mode. In addition, three studies offered interaction possibilities in both modes. Finally, one study did not explicitly mention in which mode this interaction aspect was implemented. The other 11 studies did not report explicitly on opportunities for interaction. A detailed overview of each study's approach to supporting interaction is presented in Appendix 1.

A notable finding is that in six studies an initial face-to-face meeting was organized in order to meet the other learners and the instructor(s), and to create a sense of community (Alonso et al., 2005; Cooner, 2010; Hoic-Bozic, Mornar, & Boticki, 2009; Kerres & De Witt, 2003; Köse, 2010; Martyn, 2005). Afterwards, the online environment was often used to foster additional social interaction. For instance, learners posted personal background information (Kerres & De Witt, 2003), or communicated through Facebook (Köse, 2010). This way of approaching interaction in blended learning environments is in line with the recommendations of Joosten et al. (2014), who emphasized the importance of both instructors and learners connecting with each other, and building a learning community. In addition, learners themselves have argued that encouraging familiarity and interaction between learners leads to improved learning (Joosten et al., 2014; Voegele, 2014).

3.3.3 How is dealt with guiding students' learning processes in blended learning environments?

For all selected studies in our review, we indicated which specific teaching activities were related to the four categories that regulate students' learning processes (Vermunt & Verloop, 1999). The classification of the specific teaching activities underlying the four categories was inductively derived during the analysis phase. Figure 2 shows in which mode (online or face-to-face) these teaching activities were implemented. In addition, a detailed overview indicating which specific activities were encountered in each study is presented in Appendix 1.

Three teaching activities related to the *orienting and planning* phase were found: measuring prior knowledge, communicating organizational information, and familiarize learners with technology. First, the prior knowledge of (a) individual learners was measured by completing an online test (Alonso et al., 2005; Carman, 2005; McKenzie et al., 2013), or (b) the group was assessed during an initial face-to-face meeting (Alonso et al., 2005). Second, in order to provide students with organizational information, 10 studies reported an initial face-to-face meeting to communicate about learning objectives, tasks to be completed, and course material (Alonso et al., 2005; Antonoglou, Charistos, & Sigalas, 2011; Cooner, 2010; Derntl & Motschnig-Pitrik, 2005; Gedik, Kiraz, & Ozden, 2013; Hoic-Bozic et al., 2009; Karoğlu, Kiraz, & Ozden, 2014; Kerres & De Witt, 2003; Köse, 2010; Martyn, 2005). In addition, a significant part of these activities (also) took place in the online environment. Examples included: publishing learning objectives and information about the course (Alonso et al., 2005; Cooner, 2010; Derntl & Motschnig-Pitrik, 2005; Olapiriyakul & Scher, 2006), giving online instructions (Beatty, 2010), making announcements (De George-Walker & Keeffe, 2010), or posting lesson plans (Köse,

2010). Third, a frequently occurring activity was the familiarization of learners with the used technology and tools, and eliminating technical barriers (n = 10 studies). In several studies, an initial face-to-face meeting was organized in order to (a) familiarize learners with the used technology (Köse, 2010; Martyn, 2005), (b) inform learners about the online tools and features of web 2.0 (Alonso et al., 2005; Antonoglou et al., 2011; Kerres & De Witt, 2003; Köse, 2010), and (c) show learners how to navigate in the learning platform (Antonoglou et al., 2011; Cooner, 2010; Derntl & Motschnig-Pitrik, 2005; Gedik et al., 2013; Hoic-Bozic et al., 2009; Kerres & De Witt, 2003; Martyn, 2005; Olapiriyakul & Scher, 2006). In addition, when technical issues arose, these were discussed either face-to-face or online (Antonoglou et al., 2011; Martyn, 2005; Olapiriyakul & Scher, 2006).

Four teaching activities related to the *monitoring* phase were found: organizing peer assessment, tracking learners, formative assessments, and providing reminders. First, learners assessed or monitored each other's work most of the time (n = 7 studies) online. A discussion forum was frequently used to discuss course content with peers (Antonoglou et al., 2011; Köse, 2010; Olapiriyakul & Scher, 2006; Picciano, 2009) and to provide each other with comments and share opinions (Derntl & Motschnig-Pitrik, 2005; Picciano, 2009; Wong, 2008). Second, in order to monitor learners' progress, seven studies used specific tools such as online tracking systems. Logs of students' behavior can help to determine success and ascertain the learning product quality (Alonso et al., 2005), for example, by recording learners' presence and activities within the e-platform (Antonoglou et al., 2011; Gedik et al., 2013). Other strategies to track students' learning were: (a) learners published systematically (e.g., biweekly) reports about advances and tasks performed (Hoic-Bozic et al., 2009; Köse, 2010), (b) the use of email messages for student tracking (Karoğlu et al., 2014), and (c) providing statistical results to learners about their learning progress (Wong, 2008). With respect to the third teaching activity, formative assessment, three kinds of formative assessments were found: (a) assignments (unspecified), (b) tests/quizzes, and (c) presentations. In general, assignments were often implemented in both the online and the face-to-face learning environment. Some studies gave no further explanation about the nature of the assignment, while other studies referred to quizzes and presentations. Four studies organized online tests (e.g., quizzes) on a regular basis (Antonoglou et al., 2011; De George-Walker & Keeffe, 2010; Hoic-Bozic et al., 2009; Martyn, 2005). Furthermore, seven studies used online or face-to-face presentations to share and demonstrate students' learning experiences with their peers (Cooner, 2010; Derntl & Motschnig-Pitrik, 2005; Gedik et al., 2013; Hoic-Bozic et al., 2009; Karoğlu et al., 2014; Kerres & De Witt, 2003; Picciano, 2009). Fourth, two of the selected studies implemented reminders via the online learning platform to remind students of upcoming deadlines, assignments, or events (Carman, 2005; Karoğlu et al., 2014).

With respect to *adjusting* the learning process, two kinds of activities were found in the selected studies: the provision of (a) feedback, and (b) additional explanations or clarifications. These activities were implemented in both face-to-face and online environments. First, with respect to providing feedback in the online environment, instructors (a) provided automated feedback immediately after completing online quizzes/tests (Antonoglou et al., 2011; Carman, 2005; Martyn, 2005; McKenzie et al., 2013), or (b) responded to each exercise within 48 hours (Cooner, 2010), evaluated uploaded papers using an online grading subsystem (Hoic-Bozic et al., 2009), provided personal feedback through email (Karoğlu et al., 2014; Stubbs, Martin, & Endlar, 2006), or posted group feedback on the forum, wiki, or blog (Karoğlu et al., 2014; Köse, 2010). Second, instructors provided face-to-face feedback when learners gave classroom presentations (Derntl & Motschnig-Pitrik, 2005), or in relation to online discussions (Karoğlu et al., 2014; McKenzie et al., 2013). With respect to additional explanations, instructors implemented these in the online environment as follows: (a) providing email support (Carman, 2005), (b) learners could ask questions to clarify aspects of the task (Antonoglou et al., 2011; Olapiriyakul & Scher, 2006; Stubbs et al., 2006), for instance via video conferencing (Köse,

2010), chat, or forum (Martyn, 2005), and (c) the instructor announced additional material on his blog when needed (Köse, 2010). Furthermore, in the classroom-based environment instructors provided opportunities for learners to (a) refer to difficulties and constraints (Antonoglou et al., 2011), (b) ask questions about exercises, raise concerns and seek clarification (Cooner, 2010; Martyn, 2005), and (c) consult the instructor during hands-on sessions (Stubbs et al., 2006).

In the *evaluation* phase, we made a distinction between summative assessments, and final examinations that lead to a certificate or diploma. First, instructors designed summative assessment activities in both the online and the classroom-based environment. In the online environment, instructors implemented quizzes (Antonoglou et al., 2011; De George-Walker & Keeffe, 2010; McKenzie et al., 2013), questionnaires (Derntl & Motschnig-Pitrik, 2005), or evaluations of group projects (Hoic-Bozic et al., 2009). In the classroom-based environment, instructors organized assignments (De George-Walker & Keeffe, 2010), presentations of group work (Hoic-Bozic et al., 2009), or demonstrations of realized projects, such as own designed web pages (Stubbs et al., 2006). Second, in seven of the eight studies that included a final examination, this was organized during a face-to-face session to avoid problems of cheating and identity (Wong, 2008). However, most cases supplemented the final grade of the exam with other formative and/or summative assessments, such as online test results, contributions to forum discussions, and papers (Hoic-Bozic et al., 2009; Martyn, 2005).

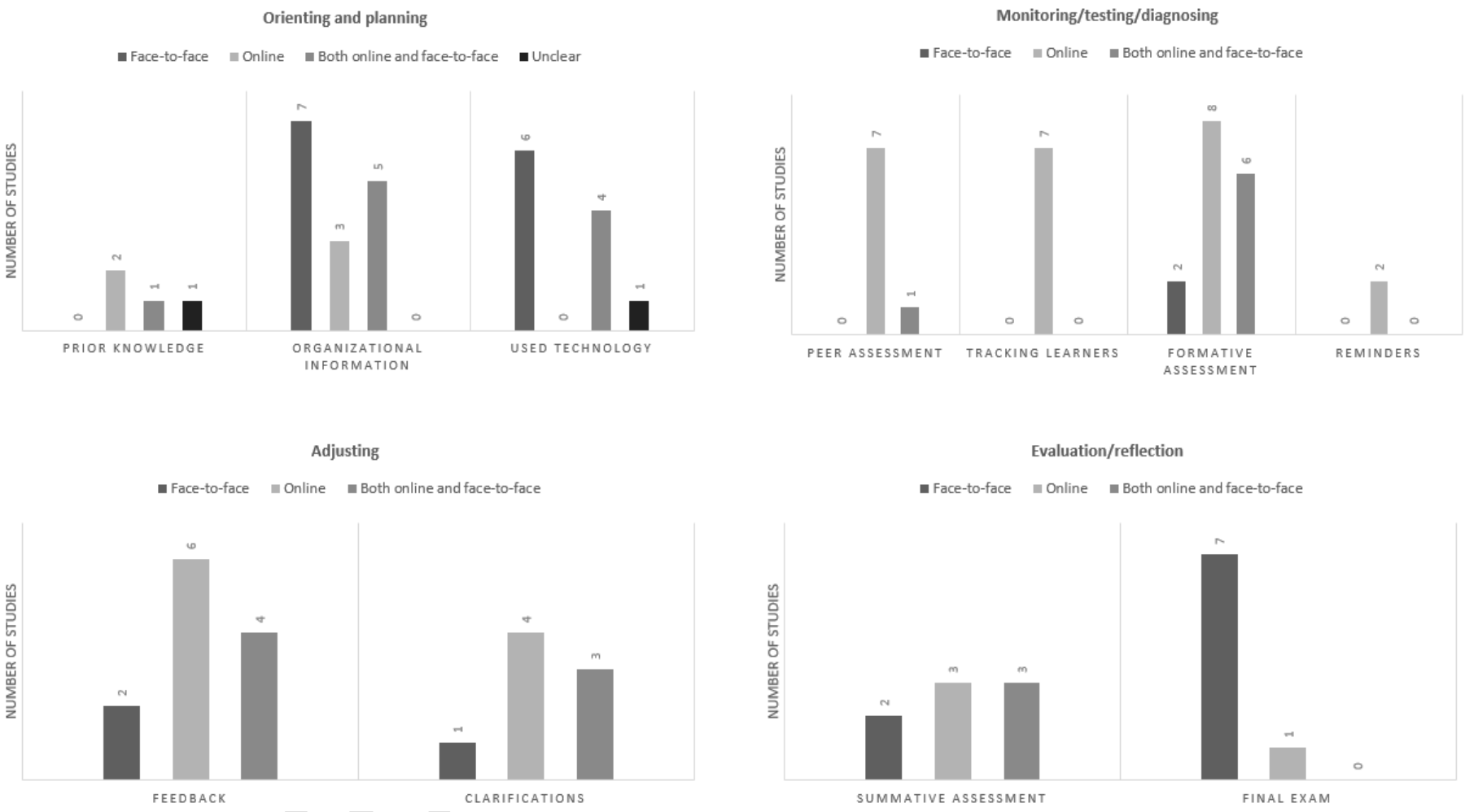

Figure 2. Teaching activities that guide students' learning processes (*n* = 19 studies)

With respect to the third research question, we found several teaching activities that guided students' learning processes. The most common regulative teaching activities were: providing organizational information (n = 15), familiarization with technology (n = 11), formative assessments (n = 16), and providing feedback (n = 12). For some teaching activities there was a clear indication to the classroom-based environment. Examples include: to familiarize students with the technology, build social relationships, provide organizational information, and to examine students. In contrast, studies emphasized especially the online environment when tracking students' learning progress. Finally, most of the other instructional activities were not strictly assigned to online or classroom environments. It is thereby important to notice that one delivery method does not necessarily exclude the other. For instance, online tasks could be adjusted by both online feedback and classroom-based feedback.

We are presenting an overview of specific instructional activities implemented in different blended learning environments, however, without making any judgements which instructional activities are actually necessary and/or effective, since there are no clear guidelines. Although, it seems advisable to consider at least teaching activities that guide students' learning processes. The above stated results are in line with other research, finding that learners value an initial orientation session to familiarize with technology and tools used (Rovai, 2003; Workman & Stenard, 1996). In addition, other researchers also endorse the use of online quizzes/tests, because regular assessments have as advantages that learners remember the content better, and spread their work (Spanjers et al., 2015; Spanjers et al., 2014). Another benefit of online quizzes is the immediate feedback: learners get information about their learning process, while instructors are informed about the learning process of their students and stumbling blocks in the course (Spanjers et al., 2014). In addition, Butler and Roediger (2008) have found that immediate (and delayed) feedback of multiple-choice testing increased the proportion of correct responses on a delayed recall test.

3.3.4 How is dealt with fostering an affective learning climate in blended learning environments?

Vermunt and Verloop (1999) discussed five categories of learning functions that create an affective climate: (1) motivating and expecting, (2) concentrating and exerting effort, (3) appraising, (4) dealing with emotions, and (5) attributing and judging oneself. The latter category was not addressed in the present study, because no examples of this learning function were encountered in the selected studies. An overview of 16 studies that report about teacher behavior that fosters an affective climate is presented in Figure 3, indicating in which mode (i.e., online or face-to-face) those specific activities are encountered. A detailed overview indicating which specific activities were encountered in each study is presented in Appendix 1. The other three studies did not report explicitly on the above mentioned affective learning functions.

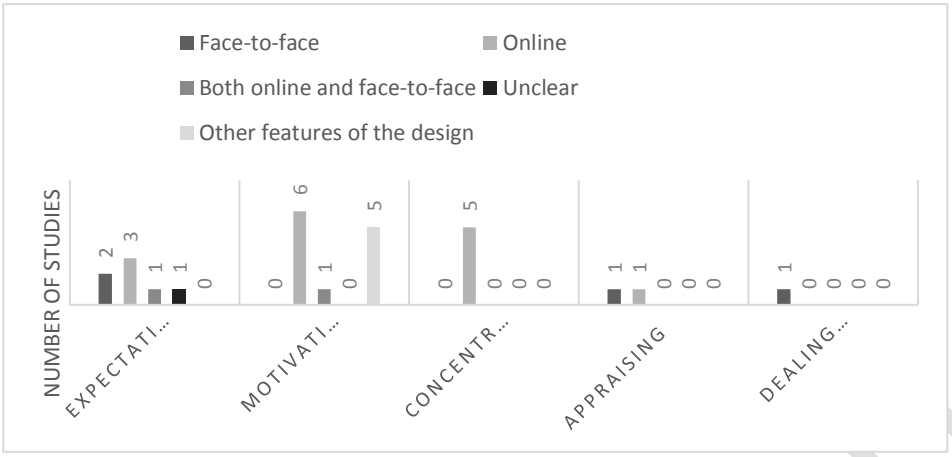

Figure 3. Teaching activities that foster an affective learning climate (*n* = 16 studies)

In seven studies, instructors clarified expectations during an initial face-to-face meeting (Antonoglou et al., 2011; Derntl & Motschnig-Pitrik, 2005), and/or through an online announcement in the beginning of the semester (Karoğlu et al., 2014). Instructors informed learners about expectations, and communicated what level of performance will be rewarded by what mark (Stubbs et al., 2006).

With respect to *motivating* students, several strategies were found (n=12). First, activities that aimed to foster students' motivation were often implemented in the online mode. Examples included the implementation of interactive online activities, such as quizzes (Antonoglou et al., 2011; Gedik et al., 2013; McKenzie et al., 2013), games, puzzles and flash exercises (Wong, 2008). An additional motivator to complete such activities was the presence of a deadline (Antonoglou et al., 2011). Gedik et al. (2013) also argued that quizzes on topics that were covered earlier motivate learners for the next session. Other motivating activities in the online environment were (a) posing thought-evoking questions to learners (Carman, 2005), (b) telling a joke during an online live event (Carman, 2005), (c) publishing successfully completed assignments to inspire and motivate students (Karoğlu et al., 2014), and (d) obliging learners to prepare before chat sessions (by e.g., reading texts or online quizzes) (Martyn, 2005). Second, some other features in the designed environment aimed to foster students' motivation in the selected studies. Learners can be motivated by giving them more responsibility, for example, by letting learners choose the topic for their assignment (Hoic-Bozic et al., 2009), or by cross-referencing between the two delivery modes (Beatty, 2010; De George-Walker & Keeffe, 2010; Wong, 2008). In addition, hands-on exercises (Carman, 2005), active participation of learners during the course (Derntl & Motschnig-Pitrik, 2005; Păuleţ-Crăiniceanu, 2014), and problem-based learning approaches (Hoic-Bozic et al., 2009) are considered as motivating aspects of the blended learning environment. Finally, other activities that are assumed to motivate learners are: giving awards by points (Hoic-Bozic et al., 2009), and implementing familiar activities such as games and blogs in both modes (Wong, 2008).

To provide tasks that require sufficient *mental effort*, several authors mentioned the adaptation of tasks or content based on the learner's prior knowledge and capabilities (n=5). Based on a prior knowledge test (a) learners got different instruction methods (but the same course documentation) during the self-paced learning process (Alonso et al., 2005), (b) a personal study plan was established for the learner (McKenzie et al., 2013), or (c) the teacher created homogeneous groups for group work (Hoic-Bozic et al., 2009). In two studies, there was room for more learner choice. This is done through (a) multiple forms of resources

in different ways and locations, allowing learners to select and utilize the materials that are most suitable to them and to work on their own pace (Antonoglou et al., 2011), or (b) individualized activities in the online environment, such as a blog to share additional resources about the topics of the course (Köse, 2010).

Finally, *appraising* and *dealing with emotions* were less present in the selected studies. First, in order to point out the relevance of a task, Carman (2005) argued that the instructor may use examples or analogies that are familiar to the learners during online live events. In addition, Gedik et al. (2013) stated that experts who share their experience in a face-to-face session can show the relevance of their knowledge. Second, only the study of Picciano (2009) reported on dealing with emotions, and recommended to provide social and emotional support, such as advice on professional opportunities, in a face-to-face mode.

Regarding the fourth research question, especially the clarification of expectations and fostering learners' motivation received attention in the design of blended learning environments. Expectations were clarified in the beginning of the semester, either online or face-to-face. Teachers fostered learners' motivation by giving a certain amount of learner responsibility, interactive online activities, a learner-centered active learning pedagogy (e.g., problem-based learning approach), or by implementing other additional features such as giving awards, the use of familiar tools, and telling a joke. With respect to the modification of tasks and/or content to suit a particular learner, especially the online learning environment was used to individualize the learning process. This is not surprising, as technology provides us with increased opportunities to personalize learning for students (Wanner & Palmer, 2015). Finally, the selected studies often neglected teacher behavior that appraised or assessed the value of learning contents, and provided emotional support for students. Future research should therefore concentrate on these affective functions in blended learning environments.

3.4 General discussion and conclusion

The present study was designed to investigate the current state of research into the design and development of blended learning environments. The results show that (1) few studies offered opportunities for learners to make choices about the blend, (2) slightly less than half of the selected studies explicitly included support for interaction, (3) frequently occurring actions to guide students' learning process were: familiar learners with the used technology, provide organizational information, implement formative assessments, and provide feedback, and (4) regarding the stimulation of an affective climate, studies particularly reported about how teachers clarified their expectations and fostered students' motivation, and less about dealing with emotions and appraising.

During the analysis of the selected studies, we noticed that it is often unclear why researchers or designers opted for the online or classroom-based environment. In most of the selected studies, only little explanation is given about the reasons and assumptions underlying the specific design. In this respect, we agree with other authors that course goals and objectives should guide the selection of an appropriate teaching method and technologies used (Picciano, 2009; Singh, 2003). For instance, when a class discussion is implemented as a teaching method, the designer decides whether this has to be synchronous or asynchronous, depending on the objectives of the discussion (e.g., change ideas or an in-depth discussion). We further support the idea of Graham (2006), that the designer should list both strengths and weaknesses that influence of an instructional method (e.g., class discussion) and use this these to

make decisions whether to use the online, face-to-face, or both learning environments. With respect to this previous remark, future research should therefore concentrate on the investigation of the potential of several instructional methods according to learning objectives in the design of blended learning environments. For instance, by uncovering strengths and weaknesses of asynchronous online discussions versus synchronous class discussions (see e.g., De Wever, Schellens, Valcke, & Van Keer, 2006; Garrison & Kanuka, 2004), or by pointing out the potential of web-based lectures for several pedagogical intentions (see e.g., Montrieux et al., 2015).

A first limitation of this study is that by focusing on several aspects (i.e., flexibility, interaction, regulation of learning processes and support for an affective climate) in the selected studies, other instructional activities may have been overlooked. However, we are confident that using a specific analysis framework was the most appropriate way to perform a systematic and in-depth analysis of the design of blended learning environments. A second weakness of this study is that all analyses were done by one researcher, meaning that there is no inter-rater reliability. Nevertheless, the researcher analyzed the retrieved studies in a systematic way (e.g., the search string was carefully considered to make sure that no things were overlooked, we made use of the PRISMA statement because of the importance of transparent reporting of systematic reviews, and each study was systematically indexed).

Notwithstanding these limitations, this study has both implications for practice and research. First, this study provides an overview and a critical analysis of issues to consider when designing blended learning courses. Instructors can consider to implement several of the above stated findings or recommendations. Second, we agree with the idea of Wu et al. (2013) that more intervention studies regarding technology-supported instructional activities should be carried out and clearly describe their strategies used. We suggest that the assumptions and reasons underlying the design should be explicitly explained in future studies: why and how certain learning and teaching activities were designed, and in which delivery mode (online or face-to-face).

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3.6 Appendix 1

A detailed overview indicating which specific activities were encountered in each study

References	Flexibility – learner choice	Interaction	Guiding students' learning processes*										Affective learning climate*				
			Orienting/planning*			Monitoring*				Adjusting*		Evaluating*					
			Prior knowledge	Organizational information	Used technology	Peer assessment	Tracking learners	Formative assessment	Reminders	Feedback	Clarifications	Summative assessment	Final exam	Expectations*	Motivation*	Concentrating and exerting effort*	Appraising*	Dealing with emotions*
Alonso et al., (2005)																		
Antonoglou et al., (2011)																		
Beatty (2010)																		
Carman (2005)																		
Cooner (2010)																		
De George-Walker & Keeffe (2010)																		
Derntl & Motschnig-Pitrik (2005)																		
Gedik et al., (2013)																		
Hoic-Bozic et al., (2009)																		
Karoğlu et al., (2014)																		
Kerres & De Witt (2003)																		
Köse (2010)																		
Martyn (2005)																		
McKenzie et al., (2013)																		

Olapiriyakul & Scher (2006)																		
Păuleţ-Crăiniceanu (2014)																		
Picciano (2009)																		
Stubbs et al., (2006)																		
Wong (2008)																		

*Classification of instructional activities by Vermunt and Verloop (1999)

Face-to-face (horiz)	
Online (vertic)	
Both online and face-to-face	
Unclear	
Other features of the design	
Not explicitly mentioned	

4 Epilogue

The study of Van Laer and Elen identified seven attributes of blended learning environments, namely authenticity, personalization, learner-control, scaffolding, interaction and cues for reflection and calibration. These results may (a) serve to facilitate the design of blended learning environments that meet learners' needs from a self-regulatory perspective and (b) raise crucial questions about how blended learning relates to well-established learning theories and instructional design models. The study by Boelens and De Wever investigated how blended learning environments deal with (1) learner flexibility, (2) interaction, (3) guiding students' learning processes, and (4) fostering an affective climate. The findings of this study provide an overview and a critical analysis of issues to consider when designing blended learning courses.

Both studies contribute to the mapping of the current state of research on blended learning. They illustrate strengths and weaknesses of current research and uncover gaps. This current state will function as a basis to further develop the description framework and design guidelines presented in the second phase (deliverable 2.2) of the project.

For further information on these studies please contact the corresponding authors:

In Search of Attributes That Support Self-Regulation in Blended Learning Environments.

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How To Design Blended Learning? A Review Study

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