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Four key challenges to the design of blended learning: A systematic literature review

Abstract

The design of blended learning environments brings with it four key challenges: (1) incorporating flexibility, (2) stimulating interaction, (3) facilitating students' learning processes, and (4) fostering an affective learning climate. Seeing that attempts to resolve these challenges are fragmented across the literature, a systematic review was performed. Starting from 640 sources, 20 studies on the design of blended learning environments were selected through a staged procedure based on the guidelines of the PRISMA statement, using predefined selection criteria. For each study, the instructional activities for dealing with these four challenges were analyzed by two coders. The results show that few studies offer learners control over the realization of the blend. Social interaction is generally stimulated through introductory face-to-face meetings, while personalization and monitoring of students' learning progress is commonly organized through online instructional activities. Finally, little attention is paid to instructional activities that foster an affective learning climate.

Keywords

Instructional activities, blended learning, educational technology, course design

1. Introduction

Recent work on educational technology generally uses the concept of *blended learning* to refer to a deliberate 'blending' of face-to-face and online instructional activities, with the goal of stimulating and supporting learning (Boelens, Van Laer, De Wever, & Elen, 2015). Yet, the idea of combining face-to-face with online 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).

The main reason for this continued interest in the design of effective blended learning environments, is that combinations of face-to-face and online teaching activities have been found to offer several new opportunities for optimizing learning (Spanjers et al., 2015). As previous research has pointed out, this implies a *redefinition* of instruction, in which technology is used to design instructional activities that were previously hard to organize, rather than *substitution*, in which technology is used for carrying out existing activities, without any functional change in teaching and learning (Ertmer, 1999; Puentedura, 2014; Voet & De Wever, 2016). Although this distinction is certainly useful to the design of blended learning, it does, however, not provide concrete design principles for creating instructional activities in blended learning environments.

As of yet, this kind of detailed framework is unfortunately lacking in the literature (Alonso, López, Manrique, & Viñes, 2005; Graham, Henrie, & Gibbons, 2014). Consequently, researchers and practitioners are still struggling with the implementation of blended learning (Moskal, Dziuban, & Hartman, 2013). As a first step toward resolving this issue, the present study outlines how the literature points toward the existence of four key challenges to designing blended learning, and then investigates how previous studies have designed blended courses in order to deal with these challenges.

2. Four key challenges to designing blended learning

An overview of several influential studies on blended learning is presented in Table 1. This overview includes (1) the three most cited articles and the most cited book chapter from 2000-2011 as presented in the review of Drysdale, Graham, Spring, and Halverson (2013) (i.e. Garrison & Kanuka, 2004; Graham, 2006; Osguthorpe & Graham, 2003; Ruiz, Mintzer, & Leipzig, 2006), (2) the three most cited articles in Web Of Science for the search term “blended learning” during the past 10 years (i.e. Gikandi, Morrow, & Davis, 2011; Ozkan & Koseler, 2009; So & Brush, 2008), (3) three recently published articles about blended learning (i.e. Chen, Wang, & Chen, 2014; Henrie, Halverson, & Graham, 2015; Owston, York, & Murtha, 2013), and (4) two recently published doctoral dissertations (Halverson, 2016; McDonald, 2012). A comparison of the challenges outlined by each of these studies, reveals four key challenges: incorporating flexibility, stimulating interaction, facilitating students’ learning process, and fostering an affective learning climate. In what follows, each of these challenges will be further discussed.

Table 1

Previous research addressing the four key challenges.

	Incorporating flexibility	Facilitating interaction	Facilitating students' learning processes	Fostering an affective climate
Halverson (2016)		Psycho-social relationships (interaction) is a core issue of blended learning design.	Metacognitive strategy use and ability of self-regulation may be particularly important (cognitive engagement).	Emotional engagement (e.g. enjoyment, confidence, confusion, boredom, frustration, anxiety).
Henrie et al. (2015)		Emotional engagement (learners' social connection with others at school).	Learners' self-regulation and metacognitive behavior (cognitive engagement).	Emotional engagement (learners' feelings about their learning experience, e.g. interest, frustration, or boredom).
Chen et al. (2014)	Providing a flexible environment that includes a variety of learning modes, and opportunities for students to choose where and when they learn.	The instructor should be aware of the transactional distance.	Some students may need greater incentives to encourage self-directed home study.	Promoting a positive learning environment (e.g. use of humor, praising student performance), and individualization.
Owston et al. (2013)	Offering students a choice whether to enroll in blended or face-to-face course sections.	Interaction during the course (with other students and the instructor).	Some students may not have the independent study skills that blended learning demands (self-regulation skills, time-management).	Student engagement (e.g. to ask questions, to feel anxious, to be overwhelmed).
McDonald (2012)	The study raises questions about the degree of self-directedness learners experience and about their need for personal control.	Face-to-face interaction with the instructor and peers can assuage the potential sense of isolation.	Students' time-management skills are requisite to succeed in blended courses.	Students' self-motivation skill is a requisite skill to succeed in blended courses.
Gikandi et al. (2011)			Implementing formative assessment strategies (i.e. monitoring of learning and provision of feedback) to support learners.	Motivating learners by implementing authentic learning tasks, designing instruction that caters the diverse learning needs.
Ozkan and Koseler (2009)	Trend towards location-independent education, and course flexibility.	Interaction with other students and teacher is important.	Effective course management (e.g. making announcements, pre-defined evaluation criteria).	Identification of learner characteristics (e.g. motivation, confidence, anxiety, enthusiasm).
So and Brush (2008)		Providing opportunities for both online and face-to-face interaction (social presence).	In blended learning environments, the importance of students' self-regulated learning (e.g. time-management) increases.	The importance of students' self-motivation, emotional support and bonding.
Graham (2006)	Learner choice: the type and amount of guidance that should be provided to learners in making their choices about the blend.	When and why should we consider human interaction (e.g. collaboration and learning communities)?	How can blended learning environments be designed to support increasing learner maturity and capabilities for self-regulation?	
Ruiz et al. (2006)	Learners have control over the content, learning sequence, pace, time, and media.	Enhancing learners' interactions with each other.	The online component provides the teacher with a set of online resources to facilitate the learning process.	The online component allows learning to be individualized (e.g. personalization of content), which enhances learners' motivation.
Garrison and Kanuka (2004)		The sense of community and belonging is essential (social presence).	Managing the environment and facilitating learning experiences (teaching presence).	
Osguthorpe and Graham (2003)	Students need to be given the opportunity to make choices about what they will study and how they will study it (personal agency).	Social interaction as a goal of blended learning: how will community be built during both types of contact?		

2.1 Challenge 1: How to incorporate flexibility?

Although earlier research has discussed several benefits of blended learning, like a more effective pedagogy (Graham, 2006; Joosten, Barth, Harness, & Weber, 2014), or enhanced cost-effectiveness (Graham, 2006), an often cited rationale for combining face-to-face with online instruction is increased flexibility for learners (Bonk, Kim, & Zeng, 2006; Graham, 2006; Graham, Allen, & Ure, 2005). This increased flexibility implies that learners have some level of control over time, place, path, or pace of learning (Horn & Staker, 2014). The online component of blended learning may offer flexibility in terms of *time*, by using asynchronous instead of synchronous communication, and *place*, as learners can be anywhere in the world, and no longer have to be co-located in classrooms (Osguthorpe & Graham, 2003). Furthermore, learners may have control in terms of *path*, by determining the order in which the content is provided in the course (Van Laer & Elen, 2016), and *pace*, by progressing at their own speed when studying the material (Horn & Staker, 2014). Finally, another type of learner control or flexibility is that learners may have the option to choose between face-to-face or online learning or instructional activities (Owston et al., 2013). In short, the question as to how incorporate flexibility, and which amount of flexibility is desirable, is the first challenge that surfaces during the design of blended learning environments.

2.2 Challenge 2: How to facilitate interaction?

The increased flexibility in terms of time and space in blended learning environments first of all leads to an enlarged psychological and communication space, called the transactional distance (Moore, 1993). As this transactional distance increases, social interaction becomes more difficult. The second challenge therefore revolves around the question of how to facilitate interaction in blended learning environments. When transactional distance is high, instructors cannot immediately notice when learners encounter problems, or they may not have a good idea of what learners have actually learned (Chen et al., 2014). Consequently, there may be some misunderstanding in the input of the instructor(s) and that of the learners (Moore, 1993). The blended learning approach, however, is seen as an effective approach for facilitating interaction (Ausburn, 2004; Rovai, 2003), as the face-to-face component 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, two-way communication between learners and instructor(s) is also important in the online component of blended learning environments (Ausburn, 2004; McDonald, 2014). In other words, 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).

2.3 Challenge 3: How to facilitate students' learning processes?

Due to the increased flexibility and autonomy of learners in blended learning environments, self-regulation becomes a critical factor for success (Barnard, Lan, To, Paton, & Lai, 2009; C.J. Bonk et al., 2006; Van Laer & Elen, 2016). In particular, several self-regulation skills are required for successful participation in blended learning courses: organization, discipline, time management, skill in using technology to support learning, and self-efficacy to exercise control over their own learning processes (McDonald, 2014). As such, several researchers have found that increased flexibility and learner control are especially beneficial for high achievers or students that possess self-regulation skills, while low achievers may not yet possess the required skills for independent learning (Owston et al., 2013; Tsai & Shen, 2009). The third challenge therefore focuses on the question of how to facilitate these students' learning processes in blended learning environments. In this respect, Vermunt and Verloop (1999) provide a framework of instructional activities to assist students in regulating their learning. As shown in Table 2, this framework distinguishes between four categories of regulative strategies: orienting and planning, monitoring, adjusting, and evaluating.

Table 2

Four categories of regulative strategies (Vermunt & Verloop, 1999).

Regulative strategies	Description	Example (instructional activity)
Orienting and planning	Prepare and design the learning process by examining characteristics of the learning task, and determining learning goals, prior knowledge, or time constraints	The instructor introduces the course and activates learners' prior knowledge
Monitoring	Observe whether the learning process progresses according to the plan	The instructor administers regular tests to assess students' competencies
Adjusting	Change the initial learning plan on the basis of the results of the monitoring activity	The instructor gives additional explanations
Evaluating	Judge the extent to which the final learning outcome is in agreement with the initial plan and the degree to which the learning process has proceeded	The instructor provides summative tests and sample exams

2.4 Challenge 4. How to foster an affective learning climate?

Finally, due to the increased transactional distance in online environments, online interaction is often considered to be less spontaneous compared to face-to-face communication (Osguthorpe & Graham, 2003), which might cause feelings of learner isolation (McDonald, 2014). This could result in reduced

motivation to learn (Osguthorpe & Graham, 2003), which can in turn lead to higher drop-out rates (Angelino, Williams, & Natvig, 2007). It is therefore important for blended learning environments to foster a motivating and affective learning climate (Mazer, Murphy, & Simonds, 2007), which makes that learners feel safe, accepted and valued, and promotes positive attitudes towards the course and the instructor (Mazer et al., 2007; Tomlinson & Imbeau, 2013). In relation to this, research has pointed out that a positive affective learning climate may facilitate the learning process (Vermunt & Verloop, 1999), and lead to positive student outcomes such as intrinsic motivation, creativity, and well-being (Haerens, Vansteenkiste, Aelterman, & Van den Berghe, 2016). Some specific ways in which instructors can contribute to a positive affective learning climate are: showing empathy, having a sense of humor, providing encouragements, directing attention to task-relevant aspects, and attending to students' individual differences (Mazer et al., 2007; Plax, Kearney, McCroskey, & Richmond, 1986; Tomlinson & Imbeau, 2013). In summary, a fourth challenge centers around the question of how to foster an affective learning climate in blended learning environments. Drawing again on the work by Vermunt & Verloop (1999), Table 3 distinguishes between five categories of affective strategies: motivating, concentrating and exerting effort, attributing and judging oneself, appraising, and dealing with emotions.

Table 3

Five categories of affective learning strategies (Vermunt & Verloop, 1999).

Affective strategies	Description	Example (instructional activity)
Motivating	Build and maintain willingness to learn, and form expectations about the course and the outcomes of the learning process	The instructor makes students believe in their own capabilities
Concentrating and exerting effort	Direct attention to task-relevant aspects (instead of distracting, task-irrelevant thoughts), and perform thinking activities that require mental effort	The instructor builds in variation and pauses, or recommends not to study too long in succession
Attributing and judging oneself	Attribute learning outcomes to causal factors (e.g. controllable/uncontrollable), and develop judgments about oneself as a learner	The instructor stimulates realistic attributions
Appraising	Attach subjective values to learning tasks resulting in willingness to invest energy	The instructor points out the relevance of a course or task
Dealing with emotions	Build up and maintain feelings of well-being, self-efficacy, and commitment, and cope with negative emotions (e.g. stress, uncertainty, doubt, helplessness)	The instructor reassures learners and ensures that students experience success

3. Aims and research questions

Contrary to previous review studies, which investigated the potential of blended learning to improve education through meta-analyses (Spanjers et al., 2015), focused on identifying opportunities for future research (Drysdale et al., 2013; Halverson, Graham, Spring, & Drysdale, 2012), or provided a synthesis of best practices (McGee & Reis, 2012), the aim of the present review is to offer an overview of how studies on blended learning environments deal with the four key challenges outlined above. The research questions therefore focus on how studies on designing blended learning environments:

- (1) incorporate flexibility;
- (2) facilitate interaction;
- (3) facilitate students' learning processes, and;
- (4) foster an affective learning climate.

4. Material and methods

4.1 Literature search strategy

Multiple search strategies were used to obtain research papers that fitted within the scope of the present study. First, to identify appropriate studies, the Web of Science database was consulted in February, 2015, using the following search terms: ("blend* learning" or "hybrid learning" or "flipped learning" or "blend* course" or "hybrid course" or "flipped course" or "flipped classroom*" or "e-learning") and (design or model or guidelines). In addition, results were refined by research domain (social sciences) and research area (education educational research, psychology, or social sciences other topics), which resulted in 496 hits. As a second search strategy, we considered the suggested literature in the paper by Halverson, Graham, Spring and Drysdale (2012) on trends in blended learning (75 hits), and in McGee and Reis's (2012) synthesis of best practices of blended course design (69 hits). This helped to ensure that all relevant studies were identified for answering the research questions (Arksey & O'Malley, 2005). Finally, after removing 17 duplicate papers, a database including 623 titles and abstracts was created in EndNote.

4.2 Eligibility criteria

An overview of the search protocol is presented in Figure 1. This protocol is based on 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,

Johnson, & Adams, 2006). The following inclusion criteria were applied: (a) blended learning had to be defined as a combination of face-to-face and online interventions, (b) studies had to focus on the design or development of blended learning activities in educational contexts, and take an instructional point of view, (c) the design had to be done at course level or within units of a course, and (d) studies had to present a detailed and clear indication of their design. The exclusion criteria were set as follows: (a) studies that focused on the design of one specific tool (e.g. discussion fora) or solely on the online activities, (b) short conference papers without clear description of the design, (c) studies where the full text was not available, (d) book (chapter) reviews, and (e) articles published in a language other than English.

After excluding papers based on title and abstract, 28 studies remained. The first author selected relevant studies by judging title, abstract, and/or full text against the criteria for inclusion and exclusion. In case of doubt, the second author independently judged these papers. Afterwards, both authors discussed the eligibility of these publications until consensus was reached. In this way, 21 publications were selected. Next, the relevance of these 21 publications was independently judged by an independent coder (also see section 4.3 Analysis). There was doubt about one research paper, which was excluded after discussion between the first author and the independent coder. As such, 20 studies were included.

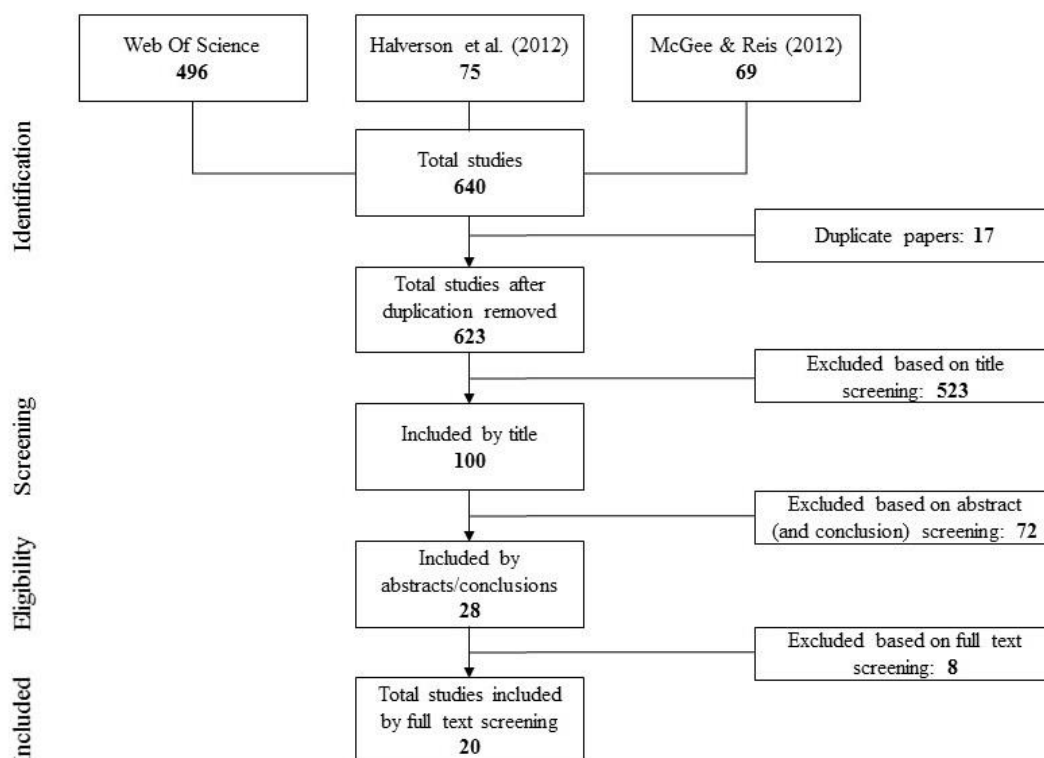


Figure 1. An overview of the search protocol based on the PRISMA statement.

4.3 Analysis

A coding scheme to systematically analyze the retrieved studies was developed in two phases. In the first phase, a first version of the coding scheme was established based on the above-mentioned conceptual framework and research questions. To answer research question 1, we analyzed how face-to-face and online instructional activities were related to each other, and whether students had control over the design of the blend. To examine research question 2, we analyzed whether and how activities for enhancing interaction and community building were included in the selected papers. For research question 3 and 4, the coding scheme was based on the theoretical framework of Vermunt and Verloop (1999). We opted for this framework, as it specifically focuses on aspects that can be dealt with during instruction (for further details on the framework, we refer to section 2.3 Challenge 3: how to facilitate students' learning processes, and section 2.4 Challenge 4: how to foster an affective learning climate). In a second phase, this coding scheme was applied to the selected articles, which resulted in refined codes and sub-codes. Specific instructional activities underlying the four categories to facilitate students' learning processes, were inductively derived during this analysis phase (e.g. peer assessment, tracking learners, teacher assessment, and reminders for the category *monitoring*). Every code was defined in an operational way to be sure that another coder could identify the content that fits with our definition (Miles & Huberman, 1994). The final coding scheme is presented in Appendix A.

Once the coding scheme was finished, the included papers were analyzed based on their description of the instructional activities in the blended learning environment. First, the first author coded all papers. Second, an independent coder received a short training by the first author about the aims of the study, the selection of the publications, and the realization of the coding scheme. The coder and the first author then coded one publication together and openly discussed the coding strategy. The other 19 articles were reviewed independently by both coders. After the operational definitions of three variables (i.e. peer assessment, motivating, and concentrating and exerting effort) were further clarified, percent agreement for all 18 of the variables ranged between 74% and 95% (an overview of percent agreement for each variable is presented in Appendix B). Afterwards, all disparities were discussed by the first author and the independent coder until full agreement was reached on all codes. Important to note is that most of the disagreements were caused by one of the coders overlooking relevant information in the papers, and not by disagreeing about the interpretation.

5. Results

In this section, we first provide an overview of the contexts of the selected studies. Afterwards, we describe the results for each of the four research questions. The majority of the selected studies were

conducted in higher education contexts (n=18), while one study was conducted in high school, and one study indicated no educational context. In addition, most of the research reviewed (n=15) concerned intervention studies. The five remaining studies provided a description of a blended learning design without reporting the results of intervention research. In Appendix C, an overview of the included studies with more detailed contextual information (e.g. program and course, number of students, description of the blended learning approach, and duration of the course) is provided.

5.1 How do blended learning environments incorporate flexibility?

A detailed overview indicating how flexibility was incorporated in each study is presented in Table 4. During the analysis of the included studies, a large variation in how flexibility was incorporated in the blended learning environments was found. First, the blended learning practices varied with regard to the sequence of online and face-to-face activities, such as flipped classroom approaches, courses with an introductory face-to-face meeting followed by a series of online activities and finally closing with another face-to-face meeting, or courses with weekly face-to-face meetings in combination with online activities. Second, the blended learning practices varied with regard to the proportion of instruction delivered online versus face-to-face. For instance, some courses consisted of 50% online activities and 50% face-to-face meetings, while other courses contained mainly online activities. Third, in most of the selected studies, the decision or responsibility for the realization of the blend was made by the instructor (n=17). In these cases, the instructor selected the appropriate delivery method (i.e. online or face-to-face) in accordance to the learning goals and course objectives (Kerres & De Witt, 2003; Olapiriyakul & Scher, 2006; Picciano, 2009; Singh, 2003). In these studies, flexibility or learner control was thus limited to time- and place-independent activities. In two studies, the decision about the realization of the blend was completely in hands of the learner. In the study of Beatty (2010), learners were able to choose between weekly or topical participation modes (online or face-to-face). Similarly, 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. Therefore, students could select face-to-face or online learning activities according to their needs and preferences for each module. Finally, in the study of Cooner (2010), the decision about the blend was in hands of both instructor and learner. More specifically, while the instructor scheduled several face-to-face sessions, and other parts of the course were delivered online, learners had the opportunity to request additional face-to-face meetings. Finally, it is important to note that the three studies that offer learner control over the realization of the blend, were situated in higher education, and aimed to develop a distance offer due to the enrolment of a large number of students.

Table 4

How is flexibility incorporated in each study?

Study number	Sequence¹	Proportion²	Who has control?
1	F2F – online – F2F	Mainly online	Instructor
2	Weekly F2F meetings combined with online activities		Instructor
3	Depends on the learner	Depends on the learner	Learner
4	No sequence mentioned		Instructor
5	Depends on the learner	Depends on the learner	Learner
6	Depends on the learner	Depends on the learner	Learner
7	Initial F2F meeting, followed by online & F2F activities	Mainly online	Instructor
8	Flipped classroom		Instructor
9	Weekly F2F meetings combined with online activities	Balanced (50%F2F - 50%Online)	Instructor
10	Initial F2F meeting – online & F2F activities – final F2F exam	Mainly online	Instructor
11	Weekly F2F meetings combined with online activities		Instructor
12	Initial F2F meeting – online presentation of learning content	Mainly online	Instructor
13	Flipped classroom		Instructor
14	F2F – online – F2F	Mainly online	Instructor
15	F2F – online – F2F	Mainly online	Instructor
16	Flipped classroom		Instructor
17	Weekly F2F meetings combined with online activities	Balanced (50%F2F - 50%Online)	Instructor
18	No sequence mentioned		Instructor
19	Online learning activities supplemented with F2F tutorials		Instructor
20	No sequence mentioned		Instructor

Note. In Appendix C an overview is provided of each publication related to its study number.

¹F2F=face-to-face

²An empty cell indicates ‘no proportion mentioned’

5.2 How do blended learning environments facilitate interaction?

To answer the second research question, nine of the studies explicitly reported on interaction in order to enhance community building, or informal and social talk. A detailed overview indicating how interaction was incorporated in each study is presented in Table 5. The other 11 studies did not report explicitly on opportunities for interaction. A notable finding is that, in six studies, an introductory face-to-face meeting was organized in order to meet the other learners and the instructor(s), and to create a sense of community. Afterwards, the online environment was often used to foster additional social interaction, through both synchronous and asynchronous communication. For example, asynchronous communication was promoted by asking students to post personal background information (Kerres & De Witt, 2003), or by stimulating students to use Facebook to support the socialization process (Köse, 2010). In addition, to support synchronous online communication, learners could use the chat function to share information and ask questions (Alonso et al., 2005). Again, it is important to note that four of the six studies with an introductory face-to-face meeting were situated in higher education and

implemented a large number of online learning activities (Alonso et al., 2005; Cooner, 2010; Hoic-Bozic, Mornar, & Boticki, 2009; Martyn, 2005).

Table 5

Which instructional activities to facilitate social interaction are mentioned in each study?

Study number	Support for interaction	Introductory face-to-face meeting?
1	F2F	Yes
2		
3		
4		
5	NC	Yes
6		
7		
8		
9		
10	F2F	Yes
11		
12	F2F/ON	Yes
13	NC	No
14	F2F/ON	Yes
15	F2F/ON	Yes
16		
17	NC	No
18		
19		
20	ON	No
Total	9	6

Notes. F2F: face-to-face, ON: online, F2F/ON: both face-to-face and online, NC: not clear. An empty cell indicates ‘no support mentioned’. In Appendix C an overview is provided of each publication related to its study number.

5.3 How do blended learning environments deal with facilitating students’ learning processes?

Table 6 shows which specific instructional activities to facilitate students’ learning processes were encountered in each study. In general, much attention was paid to the incorporation of regulative instructional strategies in the blended learning designs. In this section, we further discuss how these instructional activities were implemented in the selected studies.

5.3.1 Orienting and planning

Four instructional activities related to the orienting and planning phase were found: measuring prior knowledge, communicating organizational information, communicating expectations, and familiarize

learners with technology. First, learners' prior knowledge was measured by completing (online) tests, (Alonso et al., 2005; Carman, 2005; McKenzie et al., 2013), answering questions related to that week's learning objectives (Cooner, 2010), or an assessment during an introductory face-to-face meeting (Alonso et al., 2005). Second, in order to provide students with organizational information, 10 studies reported about the implementation of an introductory face-to-face meeting to communicate 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 several studies, these activities also took place in the online environment. For instance, instructors posted lesson plans (Köse, 2010) or published information about the course and the learning objectives (e.g. Alonso et al., 2005; Cooner, 2010). Third, and related to the provision of organizational information, instructors clarified expectations during an introductory face-to-face meeting (Antonoglou et al., 2011; Derntl & Motschnig-Pitrik, 2005), or through an online announcement in the beginning of the semester (Karoğlu et al., 2014). In such cases, instructors informed learners about expectations, and communicated what level of performance would be rewarded with which mark (Stubbs, Martin, & Endlar, 2006). Fourth, a frequently occurring activity was the familiarization of learners with the technology used in the online component. In several studies, an introductory face-to-face meeting was organized in order to (a) introduce learners to the 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 this respect, Kim et al. (2014) mentioned no instructional activities to familiarize learners with used technologies, but argued that instructors need to provide technologies that are familiar to students and easy to access.

5.3.2 Monitoring

Four instructional activities related to the monitoring phase were found: organizing peer assessment, tracking learners, formative teacher assessment, and providing reminders. In particular, these monitoring activities were mostly incorporated in the online environment, and never exclusively incorporated in the face-to-face environment. First, with respect to peer assessment, a discussion forum was frequently used to discuss course content with peers (Antonoglou et al., 2011; Köse, 2010; Olapiriyakul & Scher, 2006; Picciano, 2009), to provide each other with comments and share opinions (Derntl & Motschnig-Pitrik, 2005; Picciano, 2009; Wong, 2008), or to evaluate and discuss other peers' projects or work (Gedik et al., 2013; Hoic-Bozic et al., 2009). Second, in order to monitor learners' progress, nine studies used specific tools such as online tracking systems. Logs of students' behavior were used to determine success and ascertain the learning product quality (Alonso et al., 2005), for example, by examining learners'

presence and activities within the learning management system (Antonoglou et al., 2011; Gedik et al., 2013; Picciano, 2009). Other strategies to track students' learning were: (a) regular (e.g. biweekly) learner 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 teacher assessment, three kinds of formative assessments to measure learning transfer were found: (a) (unspecified) assignments, (b) tests/quizzes, and (c) presentations. Five studies organized online tests (e.g. quizzes) on a regular basis (Antonoglou et al., 2011; Galway, Corbett, Takaro, Tairyan, & Frank, 2014; Hoic-Bozic et al., 2009; Kim, Kim, Khera, & Getman, 2014; Martyn, 2005). Furthermore, five 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; Karoğlu et al., 2014; Picciano, 2009). Fourth, two of the selected studies implemented reminders via the online learning platform to remind students of upcoming deadlines, assignments, or events.

5.3.3 Adjusting

Most of the studies (except four) reported instructional activities that aimed to adjust the learning process. Two different activities were found in the selected studies: the provision of (a) feedback, and (b) clarifications. These activities were implemented in both face-to-face and online modes. First, in the online environment, instructors provided automated feedback immediately after completing online tests (Antonoglou et al., 2011; Martyn, 2005; McKenzie et al., 2013), responded to each exercise within 48 hours (Cooner, 2010), evaluated papers using an online grading system (Hoic-Bozic et al., 2009), provided personal feedback through email (Karoğlu et al., 2014; Stubbs et al., 2006), or posted group feedback on the forum, wiki, or blog (Karoğlu et al., 2014; Köse, 2010). Second, instructors provided face-to-face feedback on learners' individual and group work (Kim et al., 2014), for instance when learners gave classroom presentations (Derntl & Motschnig-Pitrik, 2005), or in relation to previous online discussions (Karoğlu et al., 2014; McKenzie et al., 2013). Third, with respect to clarifications in the online environment, instructors provided email support (Carman, 2005), or learners could ask questions to clarify aspects of a task by using video conferencing, chat, or a forum (Köse, 2010; Martyn, 2005). Furthermore, in the face-to-face environment, instructors provided opportunities for learners to ask questions about exercises, raise concerns and seek clarification (Antonoglou et al., 2011; Cooner, 2010; Galway et al., 2014; Martyn, 2005; Stubbs et al., 2006).

Table 6

Which instructional activities to facilitate students' learning processes are mentioned in each study?

Study number	Orienting–planning				Monitoring			Adjusting		Evaluating		
	Prior knowledge	Organizational information	Expectations	Used technology	Peer assessment	Tracking learners	Teacher assessment	Reminders	Feedback	Clarifications	Summative assessment	Final exam
1	F2F/ON	F2F/ON		F2F		ON				ON		F2F
2		F2F	F2F	F2F	ON	ON	ON		ON	F2F/ON		NC
3		ON	F2F/ON	NC			F2F/ON					
4	NC		ON		ON		NC	ON		ON		
5	NC	F2F/ON		F2F/ON	F2F/ON		ON		ON	F2F		
6		F2F/ON									F2F/ON	
7		F2F/ON	F2F	F2F	ON		F2F/ON		F2F/ON		ON	
8							F2F/ON		F2F	F2F		NC
9	NC	F2F		F2F	ON	ON	F2F/ON		F2F		F2F	
10		F2F		F2F	NC	ON	ON		ON		F2F/ON	F2F
11		F2F/ON	NC		ON	ON	F2F/ON	ON	F2F/ON			
12		F2F		F2F			ON				F2F	F2F
13	ON	NC					ON		F2F			
14		F2F/ON		F2F	ON	ON	ON		ON	ON		F2F
15		F2F	F2F/ON	F2F/ON			ON		ON	F2F/ON		F2F
16	ON	ON				ON	ON		F2F/ON		ON	F2F
17		ON		F2F/ON	ON		ON			ON		
18					ON	ON	ON					
19			F2F/ON		ON				F2F/ON	F2F/ON	F2F	
20			F2F		ON	ON			F2F/ON			
Total	6	15	8	11	12	9	16	2	13	9	7	8

Notes. F2F: face-to-face, ON: online, F2F/ON: both face-to-face and online, NC: not clear. An empty cell indicates 'no support mentioned'. In Appendix C an overview is provided of each publication related to its study number.

5.3.4 Evaluating

In the evaluation phase, a distinction was made 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 face-to-face environment. In the online environment, instructors implemented quizzes (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 face-to-face environment, instructors organized assignments (De George-Walker & Keeffe, 2010), presentations of group work (Hoic-Bozic et al., 2009; Kerres & De Witt, 2003), or demonstrations of realized projects, such as own designed web pages (Stubbs et al., 2006). Second, in six of the eight studies that included a final examination, this was organized during a face-to-face session. However, most cases supplemented the final grade of the exam with other assessments, such as online (formative) test results, contributions to forum discussions, and papers (Hoic-Bozic et al., 2009; Martyn, 2005).

5.4 How do blended learning environments deal with fostering an affective learning climate?

For all selected studies in this review, it was indicated which specific instructional activities were related to the five categories that foster an affective climate (i.e. motivating, concentrating and exerting effort, attributing and judging oneself, appraising, and dealing with emotions). The category ‘attributing and judging oneself’ was not addressed in the present study, because no examples of this instructional strategy were encountered in the selected studies. A detailed overview is presented in Table 7. In general, most attention was paid to motivating, and concentrating and exerting effort, while only few studies paid attention to appraising, and dealing with emotions.

Table 7

Which instructional activities to foster an affective learning climate are mentioned in each study?

Study number	Motivating	Concentrating/ exerting effort	Appraising	Dealing with emotions
1		ON		
2	ON	ON		
3		ON		
4	ON		ON	
5				
6				
7				
8		ON		
9	ON		F2F	
10		ON		
11	ON	F2F/ON		
12				
13		ON	NC	

14		ON		
15	ON			
16	ON	ON		
17				
18				F2F
19				
20	F2F/ON			
Total	7	9	3	1

Notes. F2F: face-to-face, ON: online, F2F/ON: both face-to-face and online, NC: not clear. An empty cell indicates ‘no support mentioned’. In Appendix C an overview is provided of each publication related to its study number.

5.4.1 Motivating

With respect to motivating students, instructional strategies 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). Gedik et al. (2013) argued that quizzes on topics that were covered earlier motivated learners for the next session. Other motivating activities in the online environment were posing thought-evoking questions to learners (Carman, 2005), or publishing successfully completed assignments (Karoğlu et al., 2014). Finally, four studies fostered students’ motivation by other means than instructional activities, such as providing more responsibility to learners (Beatty, 2010; De George-Walker & Keeffe, 2010; Hoic-Bozic et al., 2009), encouraging active participation of learners (Derntl & Motschnig-Pitrik, 2005), or developing a problem-based learning approach (Hoic-Bozic et al., 2009).

5.4.2 Concentrating and exerting effort

For the variable concentrating and exerting effort, a distinction was made between efforts of the instructor to (1) provide tasks that require mental effort, and (2) build in variation. First, two manners that instructors used to provide tasks that require sufficient mental effort were found. On the one hand, five authors mentioned the adaptation of tasks or content based on the learner’s prior knowledge and capabilities. 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). On the other hand, students could prepare in-class activities during online (personalized) activities to make sure all students enter class with similar prior knowledge (Kim et al., 2014). Second, to build in variation, instructors provided students with (a) multiple forms of resources or learning materials, 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; Beatty, 2010;

Galway et al., 2014), or (b) individualized activities in the online environment, such as a blog to share additional resources about topics of the course (Köse, 2010).

5.4.3 Appraising and dealing with emotions

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 that are familiar to the learners. For instance, Gedik et al. (2013) stated that experts who share their experience in a face-to-face session can show the relevance of their knowledge. In addition, Kim et al., (2014) argued that it is important to provide learners with clear connections between face-to-face activities and out-of-class activities to avoid students' distraction from successfully achieving learning goals. Second, only the study of Picciano (2009) explicitly 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.

6. Discussion

In this section, the four major findings from this study are highlighted: (1) only few studies offer learners control over the realization of the blend, (2) slightly less than half of the selected studies explicitly include support for social interaction, (3) much attention is paid to facilitating students' learning processes, but (4) when it comes to building an affective learning climate, studies particularly focus on stimulating students' motivation and providing tasks that require mental effort or create variation in the online learning environment, and pay little attention to appraising and dealing with emotions. Afterwards, the limitations of the present study and implications for educational practice and future research are discussed.

6.1 Summary of findings and discussion

The first research question examines how flexibility is incorporated in designs of blended learning. The results reveal three important aspects related to the development of flexibility in blended learning environments: (a) the sequence of the online and face-to-face activities, i.e. when are the online and face-to-face activities planned, (b) the proportion of instruction delivered online versus face-to-face, and (c) learner versus instructor control over decisions whether to acquire or complete activities online or face-to-face. A remarkable finding is that only in a small number of studies, learners had the control over the realization of the blend. This is not in line with the prediction of Bonk et al. (2006), who argued that, in the future, decisions about the type and format of blended learning will be made by learners

themselves to address their individual needs. A possible explanation for this finding is that instructors may often find that learners do not yet possess the self-regulation and self-direction skills that are usually associated with a high degree of learner control and autonomy (Barnard et al., 2009; Van Laer & Elen, 2016), such as determining the learning goals, gathering the required information, and judging the appropriateness of the newly learned skills (Moore, 1973). This therefore appears to be a first important issue for future research. Further work is required to gain more insight in the tension between providing maximum flexibility and autonomy for students (in terms of time, place, path, space, and control over the realization of the blend) on the one hand, and carefully taking into account the need for structure and guidance of (certain) students on the other hand.

With respect to the second research question, slightly less than half of the reviewed studies explicitly mention the implementation of instructional strategies to foster interaction and stimulate a learning community. This finding is in part surprising, as learners themselves have argued that encouraging familiarity and interaction in blended learning environments results in improved learning processes (Joosten et al., 2014; Voegele, 2014). Most of the studies that did include support for social interaction organized an introductory face-to-face session for meeting the other students and the instructor(s). In particular, especially studies in higher education with a large number of online activities incorporate such an introductory meeting. This appears to be a promising approach to stimulating interaction, as previous research in the domain of distance education shows that an introductory face-to-face meeting can facilitate the formation of informal study groups, and help students to become part of the social life of the school (Rovai, 2003; Workman & Stenard, 1996). Next to face-to-face interaction, additional support for synchronous and asynchronous interaction in the online environment is implemented in most of the studies that mentioned strategies to foster interaction. This is also promising, as previous research points out that learners appreciate both face-to-face and online interaction (Ausburn, 2004; McDonald, 2014). Overall, promoting social interaction in blended learning is thus a second important issue that deserves more attention in future research on blended learning.

Looking at the third research question, the blended learning environments described by the studies generally include several types of support to facilitate students' learning processes. Most importantly, it becomes clear that the face-to-face and online components of blended learning environments are generally used for different purposes. On the one hand, introductory face-to-face meetings are often implemented to provide students with organizational information, to clarify expectations, and to explain the used technologies. This use of face-to-face meetings is also stressed in previous research, finding that learners value an initial orientation session to introduce the course and familiarize them with its technology and tools (Rovai, 2003; Workman & Stenard, 1996). On the other hand, monitoring students' learning process is frequently carried out through the online environment. In such cases, the learning

management system is not only used for tracking learners progress and presence, but also for implementing formative peer- and teacher assessment. In line with this, previous research has also endorsed the use of regular online assessments (Spanjers et al., 2015). Such assessments provide learners with information about their learning process, help them to better remember the content, and spread their work, while instructors are informed about the learning process of their students and stumbling blocks in the course (Spanjers et al., 2015). Building on the finding that the face-to-face and online components are generally used for different purposes, future research should not only focus on investigating which instructional activities to facilitate students' learning processes are successful, but also in which mode (online, face-to-face, both), or in which sequence.

Moving on to research question 4, there are three remarkable findings. First of all, the results point out that mainly online instructional strategies are implemented to motivate learners. This makes sense, since feelings of learner isolation and reduced motivation often arise during the online component (McDonald, 2014; Osguthorpe & Graham, 2003), and motivating instructional activities might stimulate learners to persist in the course (Angelino et al., 2007). In comparison, the face-to-face component is generally motivating by itself, by bringing learners together and ensuring spontaneous interaction (Osguthorpe & Graham, 2003). Second, bearing in mind that technology provides increased opportunities for personalizing learning (Brodersen & Melluzzo, 2017; Wanner & Palmer, 2015; Watson, 2008), it is rather unexpected that only five studies report about the adaptation of content or tasks based on individual differences between students. In these five cases, the online learning environment is often used to individualize the learning process. More specifically, both teacher-directed and computer-adaptive differentiation is designed, where respectively the teacher or the software aligns the content and difficulty level to match learners' needs (Brodersen & Melluzzo, 2017). Except for these five studies, the results show that individualization was rather limited in the blended learning designs. Therefore, further research is recommended to determine how blended learning environments may contribute to personalized learning and differentiated instruction. Third, the selected studies often neglect teacher behavior that points out the relevance of a course or task, and deals with learners' emotions. On the other hand, support that takes into account learners' emotions may be organized by other means than proactively planned instructional activities. For instance, this may occur spontaneously or reactive, when emotional support is required (Tomlinson et al., 2003). Even so, it can still be argued that more attention should be paid to the important issue of organizing instructional activities that take into account learners' emotions in blended learning environments. Moreover, strategies to foster an affective learning climate should be considered in both instructional modes, since previous research has found that learners experience emotional engagement differently in the online and the face-to-face component (Halverson, 2016).

6.2 Limitations

A first limitation is that, during the analysis of the publications included in the review, large differences are noticed in how much details each study provided on the design of its blended learning environment, with some particular studies indicating only a small number of instructional activities. Although this likely means that other activities were not implemented in the design, it is still possible that there were other activities that were not mentioned in the publication. For instance, it might be possible that face-to-face activities are described in less detail because the focus of the studies generally lies on the development of the online component which is often newer, or because some activities, such as monitoring and fostering an affective learning climate, occur more spontaneously or informally in a face-to-face setting. Next to this, it became clear that, while most of the studies indicated their underlying theoretical framework (e.g. constructivism), it was often unclear how this theory was then translated into actual design principles. As such, future research on blended learning environments should be more explicit about both the design of these environments, as well as the rationale for selecting particular online or face-to-face activities. In doing so, the framework presented in this study provides a set of core attributes that might be used for articulating blended learning designs across researchers (Graham et al., 2014). Finally, another limitation is that, by focusing on the four key challenges to designing blended learning to systematically analyze the studies, other dimensions, such as which educational objectives (e.g. understanding, applying, evaluating, creating) are targeted in the online or face-to-face component, are excluded. For instance, some studies especially focus on the application of knowledge and skills in the face-to-face component (McKenzie et al., 2013). However, the main reason why this particular framework was adopted, was that the literature marks these four key challenges as the most important issues in the design of blended learning.

6.3 Implications

This study presents a framework that is based on four key challenges to the design of blended learning: incorporating flexibility, stimulating interaction, facilitating students' learning processes, and fostering an affective learning climate. This framework can help both researchers and practitioners to (1) design new blended learning environments, (2) communicate about and share blended learning designs, and (3) evaluate existing blended learning practices. Furthermore, an investigation of previous research on blended learning, based on the framework, reveals several points of attention for future research. First, the results indicate that, when designing blended learning, more attention should be paid to increasing learner control, stimulating social interaction, and fostering an affective learning climate. Research topics that are central to this undertaking include: (a) the tension between incorporating learner control, and facilitating and structuring students' learning processes, and (b) the tension between a growing

number of students within blended learning courses, and the need for (b1) personalized learning and differentiated instruction on the one hand, and, on the other hand, (b2) an affective and safe learning climate, with plenty of opportunities for social interaction. Finally, future research should provide more information on the concrete design of blended learning environments (Graham et al., 2014), as well as the rationale for selecting particular online or face-to-face activities.

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Appendix A. Coding scheme

Variable number	Main category	Operational definition	0	1	2	3	4
			No	Yes			
1		<p>Flexibility: who makes the decision or is responsible for the realization of the blend (learner – instructor – shared responsibility)? Yes = learner choice (learner’s or shared responsibility) No = no learner choice (instructor’s responsibility)</p>					
			No	Yes, F2F	Yes, online	Yes, both F2F and online	Yes, unclear in which mode
2		<p>Interaction in order to enhance community building, or informal and social talk. This interaction needs to have a social function and not only a cognitive function. (Excluded: interaction in collaborative assignments)</p>					
3	Orienting / planning	<p>Prior knowledge: giving introductions, activating prior knowledge</p>					
4		<p>Organizational information: informing learners about the learning objectives, content, learning activities</p>					
5		<p>Expectations: the instructor clarifies expectations</p>					
6		<p>Used technology: familiarization with technology and used tools</p>					
7	Monitoring	<p>Peer assessment: students monitor or assess each other’s process or work, students provide each other with comments and/or share opinions</p>					
8		<p>Tracking learners: the use of (online) tracking systems to monitor students’ progress</p>					
9		<p>Teacher assessment: to monitor students’ learning, such as assignments, test/quizzes, presentations...</p>					
10		<p>Reminders: the instructor reminds students of upcoming deadlines, assignments, or events</p>					
11	Adjusting	<p>Feedback: the instructor provides students with feedback after tests, exercises, papers...</p>					
12		<p>Clarifications: the instructors gives additional explanations or clarifications, he/she change tasks when needed/necessary</p>					
13	Evaluating	<p>Summative assessment: to evaluate students’ learning, such as summative tests (quizzes, questionnaires, evaluations of group projects, assignments, presentations)</p>					
14		<p>Final exam: an examination that leads to a certificate or diploma</p>					
15		<p>Motivating: generating interest, make students believe in their own capacities,</p>					

		give students responsibility, present the learning content in a captivating way (only when explicitly stated in the publication)
16	Affective learning climate	<p>Concentrating and exerting effort: directing attention to task-relevant aspects, building in variation and/or pauses (e.g. the provision of multiple resources), give tasks that require mental effort (e.g. the adaptation of assignments and/or content based on students' levels of understanding or prior knowledge)</p> <p>Attributing and judging oneself: giving realistic attributions, ascribing failure to controllable factors</p> <p>Appraising: pointing out the relevance of a course or task</p> <p>Dealing with emotions: reassuring learners, reducing fear and/or anxiety, let students experience success</p>
17		
18		
19		

Appendix B. Percent agreements for each variable

Variable	Percent agreement
1 Flexibility	0.95
2 Interaction	0.84
3 Prior knowledge	0.89
4 Organizational information	0.89
5 Expectations	0.89
6 Used technology	0.89
7 Peer assessment	0.79
8 Tracking learners	0.74
9 Teacher assessment	0.74
10 Reminders	0.79
11 Feedback	0.84
12 Clarifications	0.84
13 Summative assessment	0.79
14 Final exam	0.79
15 Motivating	0.74
16 Concentrating & exerting effort	0.74
17 Attributing and judging oneself	1.00
18 Appraising	0.89
19 Dealing with emotions	0.84

Appendix C. Overview of the included studies with relevant contextual information

(Study number) Author details	Year	Country	Educational context	Type of study	Program/course/domain	Number of students	Description of the blended learning approach or design principles	Duration of the course / unit
(1) Alonso, López, Manrique, Viñes	2005	Spain	Higher education	Description (and example)	Master in Information and Communications Technologies Management	-	This instructional model is composed of seven phases: analysis, design, development, implementation, execution, evaluation, and review. The model includes a series of psychopedagogical prescriptions that further the learning process	Eight weeks
(2) Antonoglou, Charistos, Sigalas	2011	Greece	Higher education	Intervention	Chemistry Management system: Molecular symmetry and Group theory	Groups of min. 30 and max. 39 students	Each course implementation involved twelve scheduled two-hour class meetings at the Department's computer lab in combination with the online study packs distributed by Moodle.	One semester
(3) Beatty	2010	USA	Higher education/adult education	Description	Master in Instructional Technologies	-	Principles for hyflex course design: learners choice, equivalency, reusability, accessibility	-
(4) Carman	2005	USA	Adult education and corporate training	Description	-	-	Five ingredients: live events, online content, collaboration, assessment, reference materials	-
(5) Cooner	2010	UK	Higher education	Intervention	Social work (diversity in social work practice)	81 students	One obligatory face-to-face meeting (and students were free to request additional face-to-face meetings) and access to online lectures, communications tools, a workbook (to record learning development) and online video case studies	Nine weeks
(6) De George-Walker & Keeffe	2010	Australia	Higher education	Intervention	Teacher education program: Course in human development	450 students	Self-determined blended learning: learners choose for online/distance or face-to-face meetings and activities	One semester
(7) Derntl & Motschnig-Pitrik	2005	Austria	Higher education	Intervention	Business Informatics: Web Engineering Course	355 students	BLESS model as framework for mining, applying, evaluating, and improving blended, person-centered scenarios. Five layers: (0) learning	One semester

(8) Galway, Corbett, Takaro, Tairyan, Frank	2014	Canada	Higher education	Intervention	Master of Public Health: Environmental and occupational health course	11 students	theory and didactic baseline, (1) blended learning courses, (2) course scenarios, (3) blended learning patterns, (4) web templates, (5) learning platform	Flipped classroom (eight in-class sessions for two hours)	13 weeks course
(9) Gedik, Kiraz & Ozden	2013	Turkey	Higher education	Intervention	Teacher education: A foundational, educational technology course	-	50% online components (reading materials/resources, forum discussions, sample links) and 50% face-to-face components (traditional lectures, group work, group discussions, expert seminars)	The main activities for the course were performed mostly in the online environment. There was an initial face-to-face meeting, face-to-face presentations of students, and a final exam in the classroom environment	13 weeks
(10) Hoic-Bozic, Mornar, Boticki	2009	Croatia	Higher education	Intervention	Undergraduate program in a Mathematics and Information Science major: Teaching Methods in Information Science	30 students for two academic years	7 principles: student-faculty contact, cooperation, active learning, prompt feedback, time on task, communicates high expectations, respects diverse talents and ways of learning	The main activities for the course were performed mostly in the online environment. There was an initial face-to-face meeting, face-to-face presentations of students, and a final exam in the classroom environment	Two terms
(11) Karoglu, Kiraz, Ozden	2014	Turkey	Higher education	Intervention	Undergraduate teacher education program	47 pre-service teachers	communicates high expectations, respects diverse talents and ways of learning	Three components of a blended learning arrangement: content, communication, construction	One semester
(12) Kerres & De Witt	2003	Germany	Unknown	Description	-	-	Three components of a blended learning arrangement: content, communication, construction	-	-
(13) Kim, Kim, Khera, & Getman	2014	USA	Higher education	Intervention	(1) Engineering, (2) Social Studies, (3) Humanities	115 students (enrolled in three separate classes, 13 students in the humanities class, number of students in others classes is unknown)	Flipped classroom	Fixed sequence per subject: face-to-face lecture, online personal/classroom activities. After two or three subjects: examination	One semester
(14) Köse	2010	Turkey	High school	Intervention	Mathematics	150 students	Fixed sequence: first and last class: face-to-face, online learning activities in between	Fixed sequence per subject: face-to-face lecture, online personal/classroom activities. After two or three subjects: examination	Two terms
(15) Martyn	2005	USA	Higher education, adult education,	Intervention	-	107 students in eight hybrid online courses	Fixed sequence: first and last class: face-to-face, online learning activities in between	Fixed sequence per subject: face-to-face lecture, online personal/classroom activities. After two or three subjects: examination	-

			corporate training						
(16) McKenzie, Perini, Rohlf, Toukhsati, Conduit, & Sanson	2013	Australia	Higher education	Intervention	Psychology (introductory psychology unit)	1710 students		Learning cycle: first the completion of a diagnostic test with immediate access to formative (pre-class) online activities, then a face-to-face lecture, followed by an online summative assessment task, with feedback on class performance to address misconceptions in a second face- to-face lecture	One semester
(17) Olapiriyakul & Scher	2006	USA	Higher education	Intervention	-	-		Hybrid learning classes are designed for students to meet face-to-face for half of the time (normally 1.5 h) and involved in instructor-organized formal online activities for the balance of the time	-
(18) Picciano	2009	USA	Higher education	Description	-	-		Blending with purpose: connect pedagogical objectives and activities (content, social/emotional, dialectic/questioning, synthesis/evaluation, collaboration, and reflection) with the appropriate approach/technology (CMS, F2F, discussion board,...)	-
(19) Stubbs, Martin, & Endlar	2006	United Kingdom	Higher education	Intervention	The business school (emerging technologies and issues)	230 in first year, 180 in second year of the implementation		Two core design principles: pursue intended outcomes through careful attention to the axes of structuration (communication, power, and sanction), design IT and work routines with an acute sense of audience and be ready to encourage/discourage unanticipated behavior	15 weeks
(20) Wong	2008	Hong Kong	Higher education	Intervention	A general education course: Information Technology and Modern Life	-		5i design framework: initiative, interaction, independent, incentive, improvement	-