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University students' emotions in virtual learning empirical research in the 21st Century

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University Students' Emotions in Virtual Learning: A Review of Empirical Research in the 21st Century

Practitioner Notes

What is already known about this topic

- Since the year 2000, several meta-analyses of technology integration which include virtual learning have been conducted in higher education
- The studies have primarily focused on technology and its beneficial uses in the virtual learning environment rather than on the experiences of the individual student.
- Similarly, emotions in studying and learning have been a topic of interest to many researchers

What this paper adds

- This review brings together two areas – virtual learning and emotions – in order to synthesise how emotions have been addressed in studies on virtual learning and what these studies contribute overall to the field.

Implications for practice and/or policy

- The majority of the emotion-related concepts identified in our review were emotional state-type concepts and attached to the learning environment or to interaction or to students' motivation or study outcomes.
- Only a few trait- or process-type concepts were found. Students' emotions have been mainly studied through concepts that describe less stable aspects.
- Most studies rely on post-hoc data and treat emotions as traits rather than states.
- Future research in learning should be directed to the study of social interaction and to group dynamics in virtual learning.

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Abstract

This article presents a systematic review of university students' emotions in connection with virtual learning based on 91 articles published between 2002 and 2017 in four international journals that focus on virtual learning and educational technology or on learning in higher education. These journals were considered potential channels for research on emotions in virtual learning and higher education. The objective was to analyse the articles for concepts and theoretical background related to virtual learning and emotions, contextual focus, methodological choice, and/or results. The review showed that the most common emotion-related concept was "satisfaction". The most common context for the articles was a complete non-physical learning environment (e.g. Second Life). Approximately sixty percent of the articles used quantitative methods. The most common design for studying emotions was an explanatory design. Students' emotions were mainly studied through concepts related to emotion (e.g. "satisfaction"). Yet only a few of the studies focused on the fluctuation of emotions in the course of events, relying instead on post-hoc data that treat students' emotions as traits rather than states.

Introduction

The widespread use of digital tools and environments in higher education presents us with new perspectives and forms of learning that benefit from different technologies. In the future, students will be entering universities with high expectations of choice, flexibility, and individualization of learning. The current generations of students have grown up with virtual environments, and expect these to be available for learning. This requires universities to invest in the development of virtual learning opportunities. By virtual learning we understand non-physical learning that utilises digital technology including online and offline solutions.

Increasingly, emotions are being taken into consideration in educational research and are recognized as an important part of student learning (Linnenbrink-Garcia & Pekrun, 2011; Pekrun, Stephens, Harris, & Graham, 2012; Seligman & Csikszentmihalyi, 2000). As a consequence, emotions are no longer seen as incidental phenomena, but are considered instead to be an important part of the learning process (Pekrun et al., 2012; Seligman & Csikszentmihalyi, 2000). Emotions have been found to be related to students' well-being, the quality of learning, productivity, and interaction (Diener, 2000; Pekrun et al., 2012; Seligman & Csikszentmihalyi, 2000). Furthermore, attention, self-regulation and motivation are considered the mediators that influence students' emotions in learning and their pursuit of achievement (Pekrun, Goetz, Titz, & Perry, 2002). Along with motivation, positive as well as negative emotions are considered an integral part of the learning process (Pekrun et al., 2012). Just as in a physical learning environment, in a virtual learning environment students' emotion are influenced by interactions. These interactions play an important role in the learning process (Keltner

& Kring, 1998). By emotions we understand dynamically evolving mental states, which consist of “physiological processes that regulate the body, subjective experience that regulates behaviour, and expressive processes that regulate social coordination” (Hannula, 2012, 143; cf. Buck 1999; Power & Dalgleish 1997).

As education becomes increasingly digital, interaction becomes more diversified. New ways of learning provide opportunities for adaptive, collaborative and situated learning by increasing student control over the learning process, its openness and the choices a person can make during it (Järvenoja & Järvelä, 2005). Since 2000, several meta-analyses of technology integration which include virtual learning have been conducted in higher education (Bayraktar, 2000; Christmann & Badgett, 2000; Hsu, 2003; Larwin & Larwin, 2011; Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014; Michko, 2007; Schenker, 2007; Schmid et al., 2014; Sitzmann, 2011; Sosa, Berger, Shaw, & Mary, 2011; Tekbiyik & Akdeniz, 2010; Timmerman & Kruepke, 2006; Vogel et al., 2006). This means that there is a fairly solid body of knowledge about learning in virtual learning. However, these studies seem to primarily be focused on technology and its beneficial uses in the virtual learning rather than on the experiences of the individual student (Tamin, Bernard, Borokhovski, Abrami, & Schmid, 2011). More recently, emotions have gained attention in research on learning in higher education (Linnenbrink-Garcia & Pekrun, 2011; Pekrun et al., 2012). We found a few published meta-analyses or reviews of research on emotions in virtual learning (Allen, Bourhis, Burell, & Mabry, 2002; D’Mello, 2014; Pradeep et al., 2014). However, each of these meta-analysis is targeted at a specified research question, and they only cover quantitative studies. Therefore, we have conducted this review to bring together the two broader areas – virtual learning and emotions – in order to synthesize how emotions have been addressed in studies on virtual learning and what these studies contribute overall to the field.

We posed the following research questions:

1. What concepts have been used to research on emotions in virtual learning?
2. What designs and methods have been applied to research on emotions in virtual learning?
3. Which key theoretical contributors feature in research on emotions in virtual learning?
4. How is virtual learning applied in the studies that address emotions?
5. What findings about emotions in virtual learning does the set of studies reviewed here bring out?

Method

The selection of journals and articles

The review was based on articles drawn from four international journals. The journals were chosen to reflect the different areas that we considered to be potential outlets for research on emotions in virtual learning in academia. Two journals, the *British Journal of Educational Technology* (BJET, 2018) and *Interactive Learning Environments* (ILE, 2018), were chosen to represent research on virtual learning. Two other journals, the *British Journal of Educational Psychology* (BJEP, 2018) and *Studies in Higher Education* (SHE, 2018), were chosen as periodicals that publish research on learning in the university context (SHE) and the psychological aspects of learning (BJEP), and thus were possible outlets of research on emotions and affect. There are many more journals that publish research on virtual learning and higher education, but the rationale for choosing these journals was that they are well known, maintain a high level of quality and are potential outlets for research that combines virtual learning, higher education and emotions. Table 1 shows the number of reviewed and selected articles.

BJET and ILE focus on educational technology, and they frequently feature articles on virtual learning. They have relatively high impact factors in the fields of social science and education: in 2016, 2.410 for BJET (H index 71) and 1.674 for ILE (H index 30) (SCImago, 2016; Web Science,

2016). BJEP has a fairly high impact factor of Impact factor: 2.403 (H index 72). SHE has a fairly high impact factor as well, 1.527 (H index 71) (SCImago, 2016; Web Science, 2016), given its specific focus on higher education. Initially, all articles in these journals published between 2002–2017 were considered. The selection resulted in the inclusion of 91 articles for the current review.

Table 1: The number of reviewed / selected articles.

Journal articles	Total number of articles / reviewed articles	Year / number of reviewed articles
<i>British Journal of Education Psychology</i>	446 / 2	2006/1, 2008/1
<i>British Journal of Education Technology</i>	1224 / 48	2003/1, 2008/2, 2009/2, 2010/1, 2011/3, 2012/1, 2013/3, 2014/6, 2015/7, 2016/7, 2017/15
<i>Interactive Learning Environment</i>	819 / 37	2011/1, 2013/2, 2014/6, 2015/6, 2016/12, 2017/10
<i>Studies in Higher Education</i>	1165 / 4	2002/1, 2015/1, 2016/1, 2017/1
Total	3654 / 91	

The articles were chosen to cover research on technology, learning and emotions. It was expected that the chosen scope would be more frequently covered in the more recent journals due to the digitalization of learning. The review continued until the number of articles addressing the designated scope became fewer and fewer, and finally diminished to zero. The earliest article found was published in 2002, and we ended the search after going through the respective journal issues for 1999.

The following criteria were used to define the studies to be included in the review:

1. An empirical study (i.e. research that use empirical evidence, cf. Goodwin, 2005)
2. A focus on non-physical learning
3. A higher education (tertiary education) context
4. Studies related to students' emotions

The articles were chosen through a two-stage process.

1. In the first phase, if the title or abstract of the article did not correspond to criteria 1-3, the article was excluded from the review.
2. In the second phase, if, on further reading, the fourth criterion was not fulfilled, the article was excluded.

We use the concept of “virtual learning” as an umbrella concept to describe non-physical learning that is facilitated by technology and that liberates teachers and learners from spatial or temporal constraints of face-to-face teaching (either partially or completely). In the selection of the empirical studies to be included in the review we included of broad variety of learning solutions where technology is taken advantage of in order to facilitate learning (e.g. blended learning, e-learning, computer-based learning, computer-mediated learning, computer-supported collaborative learning, distance learning, hypermedia learning, mobile learning, online learning, web-based learning and the use of MOOC, flipped programming and technology-enhanced classrooms, blogging, discussion forums, Facebook, games, simulation, Twitter, Café, Second Life, and Wiki for learning) (see Appendix 1).

To be included for further reading we selected articles that included an emotion-related concept either in the title or the abstract, keywords, aims, research questions, hypotheses, or the research results (appearance of the term in the introduction, method, or discussion parts of article did not satisfy this criteria). We had three types of words in our search list of emotion-related words. First, the word “emotion” and the following terms that highly overlap in meaning: “affect”, “feeling”, and “mood”. Second, we included specific emotion concepts: “anxiety”, “attitude”, “enjoyment”, “frustration”, “joy”, and “satisfaction”. Selecting these concepts was informed by a number of theories on emotions in learning, including the Control-Value Theory of Achievement Emotions (Pekrun, 2006), the Social

Learning Theory (Bandura, 1971), a social-cognitive model (Pekrun, 2000), the mood congruency hypothesis (Bower, 1981), and appraisal theories (Moors, Ellsworth, Scherer, & Frijda, 2013). Third, we included terms describing learning behaviour often associated with emotions: “attachment” (e.g. Lavy, 2017), “engagement” (e.g. Goldin, Epstein, Schorr, & Warner, 2011), “flow” (e.g. Nakamura & Csikszentmihalyi, 2014), and “self-regulation” (e.g. Diamond, 2013). However, we excluded papers, where “affect”, “feel”, “engagement”, and “self-regulation” were used only as more general terms.

We use “emotion” as an umbrella concept, as it is more commonly used in scientific research in the behavioural sciences than the term “affect” (cf. facial feedback theory, see Lanzetta, Cartwright-Smith, & Kleck, 1976; theories of achievement-related emotions, see Weiner, 1985; social-cognitive model, see Pekrun, 2000; and Control-Value Theory of Achievement Emotions, see Pekrun, 2006).

Analyses

In order to classify the methods and designs used in the studies, a research typology was constructed using two levels, namely method and design (Figure 1). The first included quantitative, mixed, and qualitative methods, while the second consisted of different types of research strategies. Quantitative research was divided into experimental and non-experimental studies; qualitative research was divided into phenomenology, ethnography, case study research, grounded theory, and historical research. Mixed research was divided into mixed method studies (applying qualitative and quantitative methods at different phases) and mixed model studies (a mix of qualitative and quantitative research; e.g. collecting qualitative data, then quantifying these data) (Johnson & Christensen, 2004).

Figure 1. Typology for classifying research methods and designs. (Johnson & Christensen, 2004).

We also classified the articles according to the type of context. The articles were divided into two categories (Appendix 1): completely virtual (E1), i.e. all learning and teaching took place in a non-physical learning environment, and partly virtual (E2), i.e. some learning or teaching took place in a physical, traditional learning environment and the rest in a non-physical learning environment.

In addition, the articles were categorized according to the nature of the studied interaction as follows: student with student (SS), student with teacher / tutor (ST); and student with technology (i.e. social media, simulation, Second Life) / content (SC) (Godwin, Thorpe, & Richardson, 2008, p. 54). Furthermore, we applied a grounded approach to identify different research areas in relation to the emotion-related concepts. Based on the articles, we identified four focus areas: Learning and outcomes (F1); Interaction, peers, learning group (F2); an environment and use of technology (F3); and Emotion recognition (F4) (Appendix 1).

For example, the article “Twitter for teaching: Can social media be used to enhance the process of learning?” (Evan, 2014; see Appendix 1) was classified as follows: the context of the article related

to the media tool Twitter, thus placing the article in the focus area F3 (an environment and use of technology). Furthermore, during the course students used Twitter for learning and to communicate with their tutor and with each other, placing the article in the groups E2 (partly virtual), SC (student with technology/content), SS (student with student) and ST (student with teacher / tutor). In analysing the results of the articles, we have relied on how the researchers themselves described their studies in terms of methodology and theoretical background rather than analysing whether the authors' claims in our view hold true.

Finally, we synthesized the emotion-related research findings of the reviewed articles. We used a bottom-up approach where we accepted the terminology used in the original studies. Emotion theories stem from a variety of traditions, including the evolutionary (Charles Darwin), psychophysiological (William James), neurological (Walter Cannon) and dynamic (Sigmund Freud) traditions (Plutchik, 1984/2009). No single emotion theory would suffice to cover the full spectrum of such a broad variety of concepts and relations. To systematically synthesize these findings, we applied a meta-theory for the affective domain that identifies three dimensions of the theories that address emotions (Hannula, 2012). The first dimension includes three categories of affective constructs: motivation, emotions, and beliefs. The second dimension concerns the development of a fluctuating emotional state into a more stable form, namely a trait, while the third dimension involves the three main levels of theorizing: physiological (embodied), psychological (individual), and social.

Results

Twenty-eight of the articles reviewed had emotions as the main research target (Azran & Ravid, 2016; Baturay, 2011; Cheng & Chau, 2016; Cheng, Hou, Sheng, & Wu, 2014; Chen & Lee, 2011; Cho & Yoo, 2017; Gutierrez-Santiuste & Gallego-Arrufat, 2015; Hew, 2016; Horvat, Dobrota, Krsmanovic, & Cudanov, 2015; Joo, Joung, & Kim, 2014; Kim, Park, & Cozart, 2014; Konradt, Filip, & Hoffmann, 2003; Lin, Huang, & Chuang, 2015; Liu, 2016; Lu & Chiou, 2010; Lu, Huang, Huang, & Yang, 2017; Novak, Johnson, Tenenbaum, & Shute, 2016; Nummenmaa & Nummenmaa, 2008; Rodríguez-Ardura & Meseguer-Artola, 2017; Stott, 2016; Sun & Rueda, 2012; Sun, Wu, & Lee, 2017; Sunderlan, 2002; Teo, 2016; Wang, Anderson, Chen, & Barbera, 2017; Ward, 2016; Witton, 2017; Yilmaz, Gizem, Yilmaz, & Cakmak, 2017). Sixty-three of the articles described investigation of emotions along with other variables, such as student motivation in the learning process (see Appendix 1 "Descriptions of the 91 reviewed articles" and Appendix 2 "References of the 91 reviewed articles and their respective sources used in this review").

The emotion-related concepts in the reviewed articles

In terms of the concepts used in the articles, the most frequent were "satisfaction" (f=32), "enjoyment/joy" (f=26), "engagement" (f=26), and "feeling" (f=25) followed by "attitude" (f=19) and "emotion" (f=19). The concepts of "affect" (f=16) and "self-regulation" (f=12) were used moderately. The less commonly used concepts were "anxiety" (f=10), "flow" (f=7), "frustration" (f=6), "attachment" (f=3), and "mood" (f=3) (Table 2).

The articles in which the most common concepts appeared were mostly published between 2014 and 2017. The concept "satisfaction" appeared for the first time in an article published in 2006 and "enjoyment / joy", in 2011. The concepts "engagement" and "feeling" appeared for the first time in 2002 and for the second time in 2009. Most studies did not focus specifically on emotions, which was often observed as an additional theme or variable. Furthermore, in Figure 2 we illustrate the nature of the relationships among the emotion concepts as indicated by the results regarding the emotion concepts in different studies (cf. Appendix 1 and the main results reported in Table 5).

Table 2: Emotion-related concepts, frequency and percentage of studies in which each concept appears.

CONCEPT	f	% OF STUDIES (N=91)
1) Satisfaction	32	35
2) Enjoyment / Joy	26	29
3) Engagement	26	29
4) Feeling	25	27
5) Attitude	19	21
6) Emotion	19	21
7) Affect	16	18
8) Self-regulation	12	13
9) Anxiety	10	11
10) Flow	7	8
11) Frustration	6	7
12) Attachment	3	3
13) Mood	3	3

1) Lu & Churchill, 2014; Papachristos et al., 2014; Park et al., 2014 (2) Gutierrez-Santiuste & Gallego-Arrufat, 2015; Horvat et al., 2015; Jung & Suzuki, 2015 (3) Beth et al., 2015; Chuang, Jou, Lin, & Lu, 2015 (4) Al-Zahrani, 2015; Stepanyan et al., 2014 (5) Garrido-Iñigo & Rodríguez-Moren, 2015 (6) Evan, 2014; Beaumont et al., 2014; Chang & Chang, 2014; Cheng et al., 2014; Cho & Yoo, 2017; Halimi et al., 2014; Huang, 2017; Moreno, Cavazotte, & Alves, 2017; Yukselturk & Top, 2013 (7) Joo, 2014 (8) Kim et al., 2014; Tan, 2017 (9) Lau & Lee, 2015 (10) Gutiérrez-Santiuste & Gallego-Arrufat, 2017; Rodríguez-Ardura & Meseguer-Artola, 2017; Vaughan & Cloutier, 2017; Zhao et al., 2014 (11) Chiang, 2017; Delaval, Michinov, Le Bohec, & Le Hénaff, 2017; Goldwin et al., 2008; Konradt et al., 2000; Liu et al., 2008; Nummenmaa & Nummenmaa, 2008; Sunderland, 2002; Richardson, 2006 (12) Baturay, 2011; Chen & Lee, 2011; Dermo, 2009; Edirisingha et al., 2009; Goldwin et al., 2010; Kim, 2011; Liu, 2017 (13) Chaparro-Peláz et al., 2013; Chen, Xu, Tang, & Chen, 2017; Henderson, Selwyn, & Aston, 2017; Herrington & Parket, 2013; Lu, Huang, Huang, & Yang, 2017; Park & Seo, 2013; Ragusa & Crampton, 2017; Sun, Wu, & Lee, 2017; Sun & Rueda, 2012; Yingxia et al., 2013; Xie & Ke, 2011 (14) Angeli & Schwartz, 2016; Ardura & Artola, 2016; Azran & Ravid, 2016; Bower, Lee, & Dalgarno, 2017; Cheng & Chau, 2016; Cheng, Chu & Ma, 2016; Cheng, Li, Sun, & Huang, 2016; Hew, 2016; Huang et al., 2016; Hung, 2017; Hung & Young, 2017; Jou, Lin & Tsai, 2016; Jou, Lin, & Wu, 2016; Jung-Ivannikov, 2016; Liu, 2016; Maratou et al., 2016; McCarthy, 2016; Nguyen et al., 2016; Phelps, Scott, Chauffet-Manillier, Lenne & Le Jeunne, 2017; Salmon, Pechenkina, Chase, & Ross, 2017; Tirado et al., 2015 (15) Novak et al., 2016; Roozeboom, Visschedijk, & Oprins, 2017; Shin et al., 2016; Stott, 2016; Teo, 2016; Ward et al., 2016. (16) Lin et al., 2015; Magogwe et al., 2015; Stewart & Ivala, 2017; Wang, Anderson, Chen, & Barbera, 2017; Witton, 2017 (17) Makos et al., 2015; Page & Reynolds, 2015 (18) Salmon et al., 2015 (19) Nel, 2017.

Figure 2. The figure shows the nature of the relationships among the identified emotion concepts (An & Kim, 2016; Andu Artola, 2016; Chaparro-Pelaez et al., 2013; Evan, 2014; Gutiérrez-Santiuste & Gallego-Arrufat, 2017; Huang, 2017; Joo e 2014, Liu 2016, Makos, Lee, & Zingaro, 2015; Lu, Huang, Huang, & Yang, 2017; Papachristos et al., 2014, Shin & Teo, 201 Sun & Ruenda, 2012).

The research designs of the reviewed articles

In the articles selected for this review, a quantitative approach was the most commonly used (52) followed by mixed approaches (30), and a qualitative approach (9). Only a few studies were purely qualitative. The research design and methodologies are presented in Table 3. An explanatory (quantitative) design was the type most frequently used, either by itself or combined with another research design. The qualitative studies included five case studies, two phenomenological studies and one design-based and one action inquiry model

Table 3. The research methods and designs of the reviewed articles.

Research method		f
Quantitative research (f = 52)		
Non-experimental (f=28)	(1) Predictive	3
	(2) Predictive, Descriptive	3
	(3) Predictive, Cross-sectional	2
	(4) Predictive, Longitudinal	2
	(5) Predictive, Explanatory	1
	(6) Explanatory	9
	(7) Explanatory, Cross-sectional	2
	(8) Explanatory, Longitudinal	1
	(9) Action research	1
	(10) Descriptive	4
Experimental (f=24)	(11) Pre-Experimental	8
	(12) True Experimental	7
	(13) Quasi-Experimental	9
Mixed research (f = 30)	(14) Mixed method / model	24
	(15) Case study	6
Qualitative research (f = 9)	(16) Case study	5
	(17) Phenomenology	2
	(18) Design-Based	1
	(19) Action inquiry model	1

1) Lu & Churchill, 2014; Papachristos et al., 2014; Park et al., 2014 (2) Gutierrez-Santiuste & Gallego-Arrufat, 2015; Horvat et al., 2015; Jung & Suzuki, 2015 (3) Beth et al., 2015; Chuang, Jou, Lin, & Lu, 2015 (4) Al-Zahrani, 2015; Stepanyan et al., 2014 (5) Garrido-Iñigo & Rodríguez-Moren, 2015 (6) Evan, 2014; Beaumont et al., 2014; Chang & Chang, 2014; Cheng et al., 2014; Cho & Yoo, 2017; Halimi et al., 2014; Huang, 2017; Moreno, Cavazotte, & Alves, 2017; Yukselturk & Top, 2013 (7) Joo, 2014 (8) Kim et al., 2014; Tan, 2017 (9) Lau & Lee, 2015 (10) Gutiérrez-Santiuste & Gallego-Arrufat, 2017; Rodríguez-Ardura & Meseguer-Artola, 2017; Vaughan & Cloutier, 2017; Zhao et al., 2014 (11) Chiang, 2017; Delaval, Michinov, Le Bohec, & Le Hénaff, 2017; Goldwin et al., 2008; Konradt et al., 2000; Liu et al., 2008; Nummenmaa & Nummenmaa, 2008; Sunderland, 2002; Richardson, 2006 (12) Baturay, 2011; Chen & Lee, 2011; Dermo, 2009; Edirisingha et al., 2009; Goldwin et al., 2010; Kim, 2011; Liu, 2017 (13) Chaparro-Peláz et al., 2013; Chen, Xu, Tang, & Chen, 2017; Henderson, Selwyn, & Aston, 2017; Herrington & Parket, 2013; Lu, Huang, Huang, & Yang, 2017; Park & Seo, 2013; Ragusa & Crampton, 2017; Sun, Wu, & Lee, 2017; Sun & Rueda, 2012; Yingxia et al., 2013; Xie & Ke, 2011 (14) Angeli & Schwartz, 2016; Ardura & Artola, 2016; Azran & Ravid, 2016; Bower, Lee, & Dalgarno, 2017; Cheng & Chau, 2016; Cheng, Chu & Ma, 2016; Cheng, Li, Sun, & Huang, 2016; Hew, 2016; Huang et al., 2016; Hung, 2017; Hung & Young, 2017; Jou, Lin & Tsai, 2016; Jou, Lin, & Wu, 2016; Jung-Ivannikov, 2016; Liu, 2016; Maratou et al., 2016; McCarthy, 2016; Nguyen et al., 2016; Phelps, Scott, Chauffet-Manillier, Lenne & Le Jeunne, 2017; Salmon, Pechenkina, Chase, & Ross, 2017; Tirado et al., 2015 (15) Novak et al., 2016; Roozeboom, Visschedijk, & Oprins, 2017; Shin et al., 2016; Stott, 2016; Teo, 2016; Ward et al., 2016. (16) Lin et al., 2015; Magogwe et al., 2015; Stewart & Ivala, 2017; Wang, Anderson, Chen, & Barbera, 2017; Witton, 2017 (17) Makos et al., 2015; Page & Reynolds, 2015 (18) Salmon et al., 2015 (19) Nel, 2017.

The key theoretical contributors of the reviewed articles

In terms of theoretical background, we identified key researchers based on how many of the articles referred to theorists in total and how many times they appeared in the references of the selected 91 articles as a primary or secondary author. In order to apply some level of selection, but at the same time provide a sufficiently broad view of the theoretical background of the research, we included the nine most cited virtual learning, affective domain, and learning theorists. Affective domain theorists Deci and Ryan were exceptionally treated together and they represent a single affective domain theorist in this research. (Table 4).

Learning theorists featuring in relation to our umbrella concept of virtual learning (reference numbers 1 to 9, Table 4)

Nine theorists were identified, namely Arbaugh (e.g. web-based learning), Barab (e.g. games and virtual worlds), D.R. Garrison (e.g. online learning), Gunawardena (e.g. distance education), Kim (e.g., social presence), Kreijns (e.g. social presence), Rourke (e.g. computer conferencing), Rovai (e.g. blended learning), and Salmon (e.g. digital learning). Ninety-nine of their publications were referenced in one hundred and five of the articles we reviewed and cited a total of 203 times. D.R. Garrison was the most frequently cited theorist. Twenty-eight of his articles were cited seventy-four times in the twenty-five articles. For example, Garrison was cited as exploring student learning and collaboration in online groups (Liu, Magjuka, & Lee, 2008; Zhao et al., 2014).

Affective domain theorists (reference numbers 10 to 18, Table 4)

Nine key theorists were identified in the affective domain, namely Ajzen (e.g. behavior theory), Bandura (e.g. self-efficacy), Frida (e.g. emotion and mood), Csikszentmihaly (e.g. flow, anxiety), Deci / Ryan (e.g. motivation and self-determination), Pekrun (e.g. emotion) Pintrich (e.g. motivation, self-regulation), Schunk (e.g. academic achievement, self-regulation), and Zimmerman (e.g. Motivation, self-regulation). Ninety-three of their publications were referenced in seventy-one of the articles we reviewed and cited a total of one hundred and thirty-five times. The most cited theorists in this group were Csikszentmihaly (referenced in nine of the reviewed articles) and Pintrich (referenced in seventeen of the reviewed articles). For example, Csikszentmihaly was cited as exploring students' challenges and skills in the context of flow and anxiety (Konradt et al., 2003). Moreover, Pintrich was cited as exploring social cognitive processes in the context of self-regulation (Sun & Rueda, 2012).

Learning theorists (reference numbers 19 to 27, Table 4)

The learning theorists cited were Biggs on constructive alignment, Chickering on conversation framework, Fredricks on engagement, Johnson on cooperation, Lave on situated learning, Laurillard on conversational framework, Topping on peer assessment, Ramsden on higher education teaching and learning, and Vygotsky on socio-cultural processes in learning. For example, Biggs was cited in an exploration of whether social media (Twitter for teaching) can be used to enhance the learning process (Evan, 2014). All in all, forty-two of the reviewed articles cited 32 studies of these theorists a total of 56 times.

The analysis of identifying the most-cited theorists also identified references to sources on methodological issues. These were omitted as not being specific to theory formation on emotions or virtual learning.

Table 4. Key theoretical contributors, their main research objects and their references in the 91 articles.

	Theorists	No. of articles that referred to theorist in total	No. of times theorist is referred as a primary author	No. of times theorist is referred to as a secondary author	No of works by theorist cited in the reviewed articles	Main research object
Virtual learning theorists						
(1)	Garrison	25	49	25	28	- Blended and online learning (community), distance education (computer conferencing, critical thinking, presence). e-learning
(2)	Rourke	13	15	4	5	- Computer conferencing (social presence). distance learning (groups)
(3)	Gunawardena	12	16	0	5	- Distance education, computer conferencing (social presence), online learning
(4)	Rovai	10	13	0	9	- Blended learning (community), distance -, online – perceived -, virtual learning
(5)	Arbaugh	12	14	4	11	- Online-learning (community), virtual learning, web-based learning
(6)	Salmon	9	24	6	17	- Digital learning (learning design), MOOC, online learning, Second Life
(7)	Kim	9	9	2	8	- Social presence
(8)	Kreijns	8	11	1	7	- Social aspects, sociability, social presence, social space
(9)	Barab	7	9	1	9	- Games, virtual worlds
Affective domain theorists						
(10)	Pintrich	17	17	9	17	- Motivation, self-regulation
(11)	Csikszentmihalyi	9	19	1	10	- Anxiety, flow, experience
(12)	Deci / Ryan	9	13	2	10	- Motivation, self-determination theory
(13)	Zimmerman	8	19	2	16	- Motivation, self-regulation,
(14)	Bandura	8	14	2	12	- Self-efficacy theory, social cognitive theory, self-motivation, self-regulation
(15)	Schunk	7	7	5	10	- Academic achievement, metacognition, motivation, self-regulated learning
(16)	Ajzen	6	6	4	5	- Planned behavior theory
(17)	Frijda	4	4	0	4	- Emotion, mood
(18)	Pekrun	3	8	3	9	- Academic emotions, control-value theory of achievement emotions
Learning theorists						
(19)	Vygotski	8	8	0	2	- Socio-cultural processes in learning
(20)	Laurillard	5	5	0	3	- Conversational framework
(21)	Lave	5	5	0	2	- Cognition, situated learning
(22)	Ramsden	4	8	3	9	- Academic learning and teaching
(23)	Biggs	4	6	0	6	- Constructive alignment
(24)	Topping	4	6	0	4	- Formative peer assessment
(25)	Chickering	4	6	0	3	- Undergraduate education
(26)	Fredricks	4	5	0	1	- School engagement
(27)	Johnson	4	4	0	2	- Active learning, cooperation

(1) Garrison, 1993, 1997, 2007; Garrison & Akyol, 2014; Garrison & Anderson, 2003; Garrison, Anderson, & Archer, 2000, 2001a, 2001b, 2010; Garrison & Arbaugh, 2007; Garrison & Archer, 2003; Garrison, Cleveland-Innes, & Fung, 2004, 2010; Garrison & Cleveland-Innes, 2005; Garrison, Cleveland-Innes, Koole, & Kappelman, 2006; Garrison & Kanuka, 2004; Garrison, & Vaughan, 2008 AND Akyol & Garrison, 2008, 2011a, 2011b; Akyol, Garrison, & Ozden, 2009; Akyol, Vaughan, & Garrison, 2011; Anderson, Rourke, Garrison, & Archer, 2001; Arbaugh et al., 2008; Rourke, Anderson, Garrison, & Archer, 2000, 2001; Swan, Garrison, & Richardson, 2009; Vaughan & Garrison, 2005.

(2) Rourke, Anderson, Garrison, & Archer, 1999; 2001; Rourke & Anderson, 2004 AND Anderson & Rourke, 2002; Anderson, Rourke, Garrison, & Archer, 2001.

(3) Gunawardena, 1995; Gunawardena, Carabajal, & Lowe, 2001. Gunawardena, Lowe, & Anderson, 1997; Gunawardena & Zittle, 1997; Gunawardena & McIsaac, 2004.

(4) Rovai, 2001, 2002a, 2002b; 2003, 2007; Rovai & Baker, 2005; Rovai & Barnum, 2003; Rovai & Jordan, 2004; Rovai, Wighting, Baker, & Grooms, 2009.

(5) Arbaugh, 2000, 2001, 2005a, 2005b, 2007; Arbaugh et al., 2008; Arbaugh & Hornik, 2006; Arbaugh & Hwang, 2006; Arbaugh & Stelzer, 2003 AND Garrison & Arbaugh, 2007; Hwang & Arbaugh, 2009.

(6) Salmon, 2000a, 2000b, 2002, 2004, 2009, 2011, 2013, 2014a, 2014b; Salmon & Hawkrig, 2008; Salmon, Nie, Edirisingha & Wheeler, 2009; Salmon, Ross, Pechenkina, & Chase, 2015 AND Jaques & Salmon 2007; Gregory & Salmon, 2013; Lokuge, Gregory, Salmon, & Pechenkina, 2014; Wheeler & Salmon, 2008a, 2008b.

(7) Kim, 2010, 2011, 2013; Kim & Gorman, 2005; Kim, Kwon, & Cho, 2011; Kim et al., 2014 AND Joo, Joong, & Kim, 2014; Kang, Kim, & Park, 2008.

(8) Kreijns, 2004; Kreijns, & Kirschner, 2004; Kreijns, Kirschner, & Jochens, 2003; Kreijns, Kirschner, & Vermeulen, 2013; Kreijns, Kirschner, & Jochens, 2003; Kreijns, Kirschner, Jochens, & Van Buuren, 2004, 2007.

(9) Barab, Dodge, Tuzun et al., 2007; Barab, Gresalfi, & Ingram-Goble, 2010; Barab & Squire, 2004; Barab, Thomas & Merrill, 2001; Barab, Hay, Barnett, & Keating, 2000; Barab, Hay, Barnett, & Squire 2001; Barab, Thomas, Dodge, Carteaux, & Hakan, 2005; Barab, Zuiker, Warren al., 2000 AND Steinkuehler & Barab, 2012.

(10) Pintrich, 1999; 2003, 2004; Pintrich & De Groot, 1990; Pintrich, & Garcia, 1994; Pintrich & Schunk, 2002; Pintrich, Schunk & Meece, 2008; Pintrich, Smith, Garcia & McKeachie, 1991 AND Andersson et al., 2001; Linnenbrink & Pintrich, 2004; Schunk, Meece, & Pintrich, 2013; Schunk, Pintrich, & Meece, 2008; Wolters & Pintrich, 1998; Wolters, Pintrich, & Karabenick, 2005; Zeidner, Boekaerts, & Pintrich 2000; Zimmerman, Boekarts, Pintrich, Zeidner, 2000; Zusho, Pintrich & Coppola, 2003.

(11) Csikszentmihalyi 1975a, 1975b, 1990, 1991, 1997; Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005; Csikszentmihalyi & Larson, 1987; Csikszentmihalyi & Lefevre, 1989; Csikszentmihalyi, Rathunde, & Whalen, 1997 AND Moneta, & Csikszentmihalyi, 1996.

(12) Deci & Ryan 1985, 1987; Deci, Vallerand, Pelletier, & Ryan, 1991; Ryan & Deci, 2000a; 2000b; Ryan, Connell, & Grolnick, 1992; Ryan & Connell, 1989 AND Fitzgerald et al., 2009; Gagne & Deci, 2005; Rigby, Deci, Patrick, & Ryan, 1992.

(13) Zimmerman, 1989, 1990a, 1990b, 1998, 2000, 2002, 2008, 2011; Zimmerman, Bandura, & Martinez-Pons, 1992; Zimmerman, Boekarts, Pintrich, & Zeidner, 2000; Zimmerman, Greenberg, & Weinstein, 1994; Zimmerman & Martinez-Pons, 1986, 1990; Zimmerman & Schunk, 2001; AND Schunk & Zimmerman, 1994; Stephenson, Holbert, & Zimmerman, 2006.

(14) Bandura, 1977, 1982, 1986a, 1986b, 1988, 1989, 1997, 1998, 2001, 2004, 2006 AND Zimmerman & Bandura, 1994.

(15) Schunk, 1991, 1994, 2008; Schunk, Meece & Pintrich, 2013; Schunk, Pintrich, & Meece, 2008; Schunk & Zimmerman, 1994 AND Pintrich & Schunk, 2002; Pintrich, Schunk, & Meece, 2008; Zimmerman & Schunk, 2001, 2011.

(16) Ajzen, 1991, 2002; Ajzen & Fishbein, 1980; Ajzen & Manstead, 2007 AND Fishbein & Ajzen, 1975.

(17) Frida 1986, 1993; Frijda, Kuipers, & Schure, 1989; Frijda & Mesquita 1994

(18) Pekrun, 1992, 2006; Pekrun et al., 2004; Pekrun, Elliot, & Maier, 2009; Pekrun, Goetz, & Frenzel, 2007; Pekrun, Goetz, Titz, & Perry, 2002 AND Frenzel, Thrash, Pekrun, & Goetz, 2007; Goetz, Pekrun, Hall, & Haag, 2006; Kim & Pekrun, 2014.

(19) Vygotsky 1987, 1988.

(20) Laurillard 1979, 2002, 2013.

(21) Lave, 1988, 1991.

(22) Ramsden 1979, 1984, 1988, 1989, 1991, 1992; Ramsden & Entwistle, 1981 AND Entwistle & Ramsden, 1983; Wilson, Lizzio, & Ramsden, 1997.]

(23) Biggs, 1987, 1970, 1993, 1999, 2003; Biggs, Kember, & Leung, 2001.

(24) Topping, 1996, 1998, 2005 AND Topping, Smith, Swanson & Elliot, 2000.

(25) Chickering & Ehrmann, 1996; Chickering & Gamson, 1987; 1999.

(26) Fredricks, 2004.

(27) Johnson & Johnson, 1999; Johnson, Johnson, & Smith, 1991.

The way of applying virtual learning in the reviewed studies

The use of the learning environment was analysed from two perspectives: 1) whether the environment

was blended or virtual, and b) the nature of the interpersonal context of the environment, i.e. students' interactions with a teacher, peers or technology. Fifty-two of the 91 studies reviewed focused on a fully virtual learning environment, and thirty-nine focused on a blended learning environment (Appendix 1).

The different interactions were mainly studied in relation to the interaction amongst students (68), but also according to the amount of interaction between students and tutors or teacher (54) and between students and technology or content (51). In five articles, the information was not available. However, several types of interactions often appeared simultaneously in a single study. In some cases, it was not explicitly stated whether the learning environment was blended or virtual, but we could deduce that from information in the article. Our categorization of studies according to the nature of interaction is reported in Appendix 1.

Four focus areas were identified, namely Learning and outcomes (F1); Interaction, peers and learning group (F2); Environment and use of technology F3); and Emotion recognition (F4). Areas 1 (in 36 articles) and 2 (in 43 articles) appeared more often. Area 3 appeared in 29 articles, whereas area 4 appeared only in two articles (Appendix 1). The focus areas and their connection to the study outcomes are described in Table 5.

The research results of the reviewed articles

The research results were divided according to the research focus areas and the relations between variables. First, we explored whether the author claimed to have identified causal relationships. Second, we identified claims of correlational relationships, and finally, we looked at associations, i.e. possible interdependencies (including predictors) that had not been more specifically defined. Expressions considered to be unclear, such as “tend to”, were not taken into consideration in analysing the results, but they are indicated in the Additional Findings section in the Appendix 1. The causal relations, correlations and associations have been summarized in Table 5 and Figure 3.

Table 5. Summary of relationships between variables reported in the reviewed articles' main results related to students' emotions (Appendix 1).

Reported associations	Reported correlations	Reported causal relations
Focus 1: Learning and outcomes		
Anxiety - time (ID0036) / cohesiveness, task orientation (ID0038) Attitude - achievement (ID0038) / behaviour, experience, self-esteem (ID0051) / intention (ID0056) Emotion - learning performance (ID0066) Engagement - motivation (ID0022) / relatedness (ID0056) Enjoyment - behavioral intention (ID0079) / motivation (ID0030) Feeling (positive) - e-assessment (ID0025) Flow - academic performance (ID0063, ID0065) Mood - training success (ID0026) Satisfaction - course, learning (ID0021) / material (ID0054) / outcomes (ID002, 0024) / task (ID0052) Self-regulation - achievement, out-degree (ID0039) / engagement (ID0081) / feedback (ID0074) / learning (gender) (ID0030)	<ul style="list-style-type: none"> Affect - training success (before/during training) (ID0026) (content (0.03/0.28), transfer (0.06/0.20), structural knowledge (0.23/0.13), composite (0.19/0.33)) Motivation - emotions (achievement) (ID0028) (anger (0.56), boredom (0.43), enjoyment (0.38)) Satisfaction - material (0.47) (ID0055) Self-regulation - engagement (ID0027) (behavioural (0.39), emotional (0.56), cognitive (0.59)) Perceived learning - satisfaction (0.74) (ID0024) 	<p>Self-regulation - flow ($\beta = 0.42$) (ID0029) Flow - satisfaction ($\beta = 0.83$) (ID0029) Flow / satisfaction - learning persistence (ID0029) ($\beta = 0.46 / 0.35$) Flow <- Perceived didactic resources quality (PDRQ) ($\beta = 0.13$) (ID0065)</p> <p><i>Predictors:</i> Emotion (anger, boredom, enjoyment) -> achievement ($\beta = 0.56/0.43/0.38$) (ID0028) Enjoyment -> satisfaction (ID0024)</p>
Focus 2: Interaction, peers and learning group		
Affect / affective communication - participation (ID0014) / satisfaction (ID0075) Attitude - e-collaboration, experience (ID0051) Emotions - collaboration (ID0019) Enjoyment - collaboration, sharing, participating (ID0059), social presence (ID0079) Engagement - social presence (ID0012, 0078), socialization (ID0012) / learning community trust and affirmation (ID0043) / interaction (ID0093) Feeling - communication (ID0050) / tutor, group belonging (ID0012) Satisfaction - group (ID0017) / activity (ID0044) / communication (ID0050) / professor (ID0054), tutor (ID0044) / collaboration (ID0057) / interaction (ID0095) Self-regulation - asking for help (ID0039, 0090)	<p>Engagement - experience (ID0011)</p> <ul style="list-style-type: none"> ease of attending lectures (0.58) ease of actively participating (0.48) pleasurableness of the activity (0.59) <p>Engagement - interest (ID0027)</p> <ul style="list-style-type: none"> behavioural engagement (0.22) emotional engagement (0.76) cognitive engagement (0.35) <p>Satisfaction - participation (0.31) (ID0055) Satisfaction - social presence (0.60) (ID0016)</p>	<p>Participation - attitude (γ -value: 0.28) (ID0014)</p>
Focus 3: Learning environment and use of technology		
Anxiety - multitasking (ID0058) / games (ID0063) Attitude - usefulness (ID0078, 0079) Attitude / Enjoyment - Facebook (ID0045) Attitude / Engagement - Twitter (ID004) Engagement - online quizzes, simulations, games (ID0055) / blended reality, hybrid lessons (ID0070) Enjoyment - design (ID0032) / ease of use (ID0078, 0079) / attitude towards using (ID0079) / discussion boards, wikis, digital badges (ID0059) / messaging service (ID0078)) Feeling of isolation - use of tags (ID008) / feeling of freedom - use of learning environment (ID0032) / feeling free to make mistakes - use of nicknames (ID0078) / feeling of connectedness / commitment - live webcast (ID0056) / feeling of writing "in an unfamiliar way" - the design of the environment (ID0050) Flow - attitude towards use, easy of use (ID0065) Satisfaction - easiness of use (ID0057) / environment (ID0052) (gender, ID004,0034) (job status, ID004) / technology (ID002, 0054) (gender, ID0030) / Self-regulation - design (ID006)	<p>Engagement - attitude dimensions (ID0011)</p> <ul style="list-style-type: none"> appropriateness of the virtual environment (0.62) realism of the virtual environment (0.55) attitude to the environment (0.24) 	<p>Attitude (towards use) - intention ($\beta = 0.87$) (ID0065) Utility - attitude ($\beta = 0.66$) (ID0065)</p> <p><i>Predictors:</i> Utility (easy of use, usefulness) Interface Friendliness / Content Richness / Perceived Flexibility) -> satisfaction (γ -values: 0.35/0.37/0.27) (ID004)</p>
Focus 4: Emotion recognition		
Emotion - PA (pulse average) (ID0066)	N/A	N/A

ID = The ID number of the article in this review (see Appendix 1)

* PDRQ (Perceived Didactic Resources Quality)

The relationships between the emotion-related concepts are presented in Table 2.

Figure 3. The key emotional relationships between variables reported in the reviewed articles (For details, see Appendix 1)

Taking together the different relationships and associations, we identified the following conclusions that the results of the reviewed studies appear to support. Several studies reported a relation between emotions and learning outcomes (e.g. Ardura & Artola, 2016; Baturay, 2011; Chaparro- Peláez et al., 2013; Huang, Hwang, & Chen, 2016; Konradt et al., 2003; Lin et al., 2015) and found a strong relation between perceived satisfaction and perceived learning and its outcomes. More specifically, Kim et al. (2014) reported a strong correlation between anger and learning outcomes and moderate correlations between achievement and boredom and enjoyment.

There were also some studies reporting the effects of the student predispositions to their use of the available technologies. For example, Rodríguez-Ardura and Meseguer-Artola (2016) found that student attitude towards virtual learning (or “e-learning” as the authors called it) had a positive and significant impact on students’ intentions to continue using it. Students with a positive attitude towards e-collaboration have also been found to be more ready to work with their group mates on group assignments (Cheng, Chu, & Ma, 2016).

Several studies reported the effects of the successful use of technology on students’ emotional experiences. The quality of the learning environment seems to be one key factor for student satisfaction (Ardura & Artola, 2016; Azran & Ravid, 2016; Charity & Robson, 2016; Cheng et al., 2016; Huang, 2017; Hung, 2017; Jou, Lin, & Wu, 2016; Maratou, Chatzidaki, & Xenos, 2016; Papachristos et al., 2014). For example, Lu and Chiou (2010) found that students’ satisfaction with e-learning systems could mostly be explained by the following four *predictors*: interface friendliness, perceived community, content richness and perceived flexibility.

Participation in social interactions seems especially important for student satisfaction in virtual learning (Baturay, 2011; Cheng & Chau, 2016; Edirisingha et al., 2009; Kim, 2011; Park, Cha, Lim, & Jung, 2014;). Social participation was not always successful, for example because of asynchronous communication (Edirisingha et al., 2009; Jung-Ivannikova, 2016). Social “lurkers” (i.e. students who follow the interactions without participating themselves) (Nummenmaa & Nummenmaa, 2008) and students with a lower response frequency in interactions (Cheng et al., 2014) had more negative emotions than other students. Human tutors (Edirisingha et al., 2009; Jou et al., 2016), fostering trust (Liu et al., 2008; Makos, Lee, & Zingaro, 2015), collaborative tagging (Halimi et al., 2014), live webcasts (Hew, 2016), and use of nicknames (Hung, 2017) were reported as successful methods in fostering social participation.

To structure these findings, we applied the meta-theory for the affective domain (Hannula, 2012). In the main results (Figure 3, Table 5), satisfaction, emotion, enjoyment, affect and feeling can be categorized as emotional states, while attitude belongs to the category of traits. Moreover, we found other constructs, namely self-regulation, flow and engagement, which we have defined as process-type emotion-related concepts. These concepts embody emotions that are situational in nature and closely intertwined with an activity. On the other hand, even these concepts were typically operationalized using survey instruments, i.e. as trait-type constructs.

Discussion

There is substantial educational research on emotions and virtual learning, but these areas have tended to develop along separate lines. Few studies have focused on understanding emotions in a virtual learning or have studied emotions from the point of view of “affect”. The present review explored whether a synthesis can be made based on studies that have addressed students’ emotions and virtual learning simultaneously. Our review identified conceptual tools, contexts (how the virtual learning has been used or organized), research designs, methods and the results from a selection of empirical studies on university students’ emotions in virtual learning.

The review showed that the most common emotion-related concepts through which emotions were viewed were *engagement*, *enjoyment / joy*, and *satisfaction* (Appendix 1). Over half (57%) of the articles examined here applied quantitative methods, and most used an explanatory design, possibly combined with another research design. Mixed approaches were used in 30 of the articles, with only nine articles using qualitative methods alone (Table 3). Moreover, more than half of the studies (57%) conducted in a completely non-physical learning environment included some type of virtual interaction (Appendix 1). The results may seem unexpected, as the combination of emotion and virtual learning is as yet little researched. One might expect more small-scale, explorative qualitative studies to map out the variety of experiences, approaches and so on. Explorative studies might be followed up by instrument development and quantitative approaches to establish the frequency or spread of a phenomenon.

We analysed the different theoretical frameworks used in our 91 selected articles and found that most of them drew on theories of virtual learning (Table 4). We identified nine frequently cited learning theorists related to virtual learning (Arbaugh, Barab, Garrison, Gunawardena, Kim, Kreijns, Rovai, Rourke, and Salmon), in the affective domain theorists (Ajzen, Bandura, Csikszentmihaly, Deci / Ryan, Frijda, Pekrun, Pintrich, Schunk, and Zimmerman), and learning theorists (Biggs, Chickering, Fredricks, Johnson, Lave, Laurillard, Ramsden, Topping, and Vygotski). According to our selection, the most used theoretical frameworks related to virtual learning were Garrisons' studies of blended and online learning (community), distance education (computer conferencing, critical thinking, presence) and e-learning. The small number of affect and learning theorists may be explained, at least in part, by the fact that only 28 of the 91 articles had emotion as their main focus. Even though today the field of web-based learning emphasizes its benefits for social learning, the articles seemed to focus only on individual-centric theories. We found only eight articles that referred to (Bandura) to social theories on affect or learning. Furthermore, the articles focused mainly on the learning environment, learning strategies, flow, anxiety and experience from the perspective of the individual student. The social learning theories such as those on collaborative knowledge construction played a minor role.

The results of the articles reviewed here were also analysed based on how compelling their evidence was. In general, several weak or isolated relations were found and only a few strong relations. Our review identified strong relationships amongst the emotion concepts identified (attitude, engagement, flow, satisfaction, and self-regulation) (Figure 2). One of these, namely satisfaction, was the most often used concept in the articles. The concepts of attitude, engagement, flow and self-regulation were found to be the key variables, as the first tree concepts were related to more than two emotion concepts and self-regulation had two strong relationships, suggesting that these are important variables to take into account in future studies. Moreover, in the same way as in the physical learning environment, we need to pay attention to students' general satisfaction in a non-physical learning environment, as this is considered to be a notable factor in learning and study results. However, students' satisfaction can be a misleading indicator of learning, which often requires stepping outside one's comfort zone, thereby creating emotions (such as discomfort) rarely associated with satisfaction.

The majority of the emotion-related concepts identified in our review were emotional state-type concepts and related to the learning environment (technology, usability or content) or to interaction (with a teacher, a tutor, or a team) or to students' motivation or study outcomes. Only a few trait- or process-type concepts were found. Furthermore, the special virtual learning concepts, namely "social presence" and "socialization", were connected to two state (enjoyment/joy, satisfaction) and one process type of emotion (engagement). Two emotional state-type concepts (enjoyment/joy and satisfaction), one process-type concept (engagement) and one trait-type concept (attitude) appeared to be the most important key concepts for understanding students' social actions in a virtual learning environment (Table 2 (frequencies), Table 5 (relations)). On the basis of the above, we can conclude

that in the articles reviewed here, students' emotions have been mainly studied through concepts that describe less stable aspects.

However, on a more critical note, we observed that only a few of the studies actually pay attention to the fluctuation of emotions in the context and in the flow of events (e.g. Chen & Lee, 2011; Hung & Young, 2017; Nummenmaa & Nummenmaa, 2008). Most studies rely on post-hoc data and operationalize emotions as traits rather than states (e.g. Azran & Ravid, 2016; Salmon, Pechenkina, Chase, & Ross, 2017; Teo, 2016). The methods were often not able to capture the dynamic nature of state type emotions, and might in fact have rather measured emotional traits than states. As the state type concepts flow and satisfaction were identified to be among the key variables, future research in this area could benefit from measures that better address the dynamic nature of emotional states, such as experience sampling method.

With regards to the social aspect of learning, the learning theories and emotion theories appear to address it with different emphases. The most cited learning theorists and virtual learning theorists include several researchers who address social aspects of learning explicitly. However, among the most cited emotion theorists the main focus is on the individual, and few address the group level processes explicitly.

The study is limited to a relatively narrow selection of journals, and it is possible that another selection might have produced different outcomes. However, several rounds of reading were done in order to ensure the thorough and consistent treatment of all data. The scope of journals could be expanded in future reviews.

With respect to emotion terminology, our selection criteria were inclusive resulting in analysing several studies only marginally discussing emotions. We are confident that our criteria have captured all those articles which give emotions a central role. However, it is possible that some articles marginally dealing with emotions might have evaded our criteria.

We have used the terminology introduced by the authors of the articles themselves. It should be noted that these authors use causal language to describe their research findings. This, however, may not always imply causal effects (or associations, as we have described previously) in a statistical sense, but rather the situation highlights possible relations between different aspects of student learning.

Virtual learning is developing rapidly. The earlier studies in our review have been conducted in learning environments that may have had significantly different tools for facilitating interaction than modern virtual learning environments. In addition, both students and teachers may have been less experienced with virtual technologies than average students today. Thus, the results may not apply to the very latest virtual learning environments.

Statements on open data, ethics and conflict of interest

The data of the review consists of articles published in journals. Many of these are not freely available online, but can be accessed for a fee or through subscription. An overview of the data (Appendix 1) can be accessed through BJET online option. The authors declare no conflicts of interest. No ethics review was required to undertake this review. The study did not involve human research participants.

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Appendix 1: Descriptions of the 91 reviewed articles.

Year	Reference (Article's technical ID number in this review)	Article	Journal	Sample size	Design	Data source	Research design	Research focus **	Nature of interaction	Patterns in interaction	Formal emotion concepts	Hypotheses related to students' emotions (H)	Research questions related to students' emotions (Q)	Main results related to students' emotions	Additional findings and data excerpts
										Student to					
2002	Sunderlin, 2002 (ID 003)	New Communication Practices, Identity and the Psychological Gap: The affective function of e-mail in a distance doctoral program	RJET	12	1	E-mail messages	Case study	F3	Partly virtual	teacher/tutor, technology/ content	Affect Feeling	N/A	N/A	N/A	E-mail made student feel like a member of a community.
2003	Konrad, Filip & Hoffmann, 2003 (ID 0026)	Flow experience and positive affect during hypertext learning	RJET	32, 34	1,2	Knowledge Card tests	Mixed method / model	4	Virtual	technology/ content	Affect Flow Mood	H: "Subjects are in a positive MOOD following their work with the training program" (p.313-314). H: Supported.	N/A	NOTE: Concept of "Affect" only appears in the title of the article. Positive AFFECT and MOODS were correlated with training success.	Those who used the training programme were far into a positive MOOD and about a quarter of the users experienced FLOW . An association between FLOW and training success was not observed.
2006	Richardson, 2006 (ID 0023)	Investigating the relationship between variations in students' perceptions of their academic environment and variations in study behavior in distance education	RJET	1123, 2049	2	Survey	Predictive	F1	Virtual	N/A	Satisfaction	N/A	N/A	N/A	Students' age, gender or prior qualification was not significantly related to the students' general SATISFACTION . Higher scores on Assessment, Workload, Clear Goals and Standards, Generic Skills and Good Materials led to produce higher ratings of general SATISFACTION .

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															Students who produced higher scores on Issue-related Ideas and Inprovidence ended to produce higher ratings of general SATISFACTION . Students who produced higher scores on Surface Approach and Fear of Failure ended to produce lower ratings of general SATISFACTION . ANXIETY affected students' fear of failure. With a low level of interaction, students tended to produce higher ratings of general SATISFACTION and vice versa.
2008	Gedrit, Thorpe, & Richardson, 2008 (ID 0020)	The impact of computer-mediated interaction on distance learning	RJET	4500	2	Institutional records Survey	True Experimental	F2	Partly virtual	student, teacher/tutor	Anxiety Satisfaction	N/A	N/A	N/A	
	Lia, Majidka, & Lee, 2008 (ID 0017)	The effects of cognitive thinking styles, time, conflict management on online students' learning and virtual team performance	RJET	208	2	Logs Peer evaluation Surveys	Predictive Longitudinal	F2	Virtual	student	Satisfaction	H: "Students with external styles will be more SATISFIED with the teamwork process than those with internal or flexible styles in terms of overall SATISFACTION , perceived learning, rating teamwork process and perceived quality of decision making" (p.333).	N/A	Students with external cognitive styles were SATISFIED with the teamwork process. The students with a higher level of trust had a heightened level of trust SATISFACTION .	
	Nuorteva & Nuorteva, 2008 (ID 0018)	University students' emotions, interest and activities in a web-based learning environment	RJET	99	2	Survey	Predictive Longitudinal	F1, F2	Virtual	student, teacher/tutor	Affect Emotion	H1: "The fluctuation of EMOTIONAL reactions would not influence the in stable, non-collaborative activities in the WRL ."	N/A	The fluctuation of EMOTIONAL reactions was positively associated with both visible collaborative and	

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													<p>H2: "Students' interest in the course topic and in the web-based learning would be associated with positive AFFECTIVE reactions resulting from studying in a WRL." (p.167-168).</p> <p>H1: Not supported H2: Supported</p>	<p>Intuitive non-collaborative activities.</p> <p>Positive EMOTIONS were associated with students' level of interest.</p> <p>"Learners" had more negative valence towards low-social EMOTIONS / engagement AFFECTIVE reactions than other students.</p> <p>The interest was associated with the experience of pleasant EMOTIONS.</p>
2009	Dennis, 2009 (ID 0025)	E-Assessment and the student learning experience: A survey of student perceptions of e-assessment	RJET	130	1,2	Survey	Mixed method / model	F1	Partly virtual	teacher/tutor, technology/ content	Attitude Feeling	N/A	<p>Q1: "Do students FEEL comfortable doing assessments on computers?" Q2: "Do male students have different ATTITUDES from female students?" (p.204).</p>	<p>Positive FEELINGS were slightly stronger than negative FEELINGS about e-components, especially with stress and expectations.</p> <p>Age and gender did not significantly affect students' ATTITUDES towards e-component.</p>
	Edirisingha, Ne, & Phumkha, 2009 (ID 0012)	Socialization for learning at a distance is a 3-D multi-user virtual environment	RJET	6	1	Interview Logs Observation	Phenomenology	F2, F3	Virtual	student, teacher/tutor, technology/ content	Engagement Feeling Frustration	N/A	N/A	<p>The experience of socialization included positive FEELINGS about the nature of the environment.</p> <p>ENGAGEMENT is associated with how social presence is manifested and socialization occurs.</p> <p>Positive FEELINGS were associated with users, group belonging.</p>

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2010	Lu & Chou, 2010 (ID 004)	The impact of individual differences on e-learning system satisfaction: A contingency approach	RJET	522	2	Survey	Predictive Cross-sectional	F3	Virtual	student, technology/ content	Satisfaction	H1: "E-Learners' perception of quality (Interface Friendliness, Perceived Community, Content Richness and Perceived Flexibility) are positively related to the SAT [satisfaction]" (p.312). H2: "E-Learners' SAT is correlated with three contingent variables (gender, job title and industry)" (p.312). H3: "These three contingent variables have moderating effects on the relationship between various perception of quality and SAT " (p.312). H1-EE: partially supported (See main results)	N/A	Singles' SATISFACTION positively links with the e-learning system. Four predictors (Interface Friendliness, Perceived Community, Content Richness and Perceived Flexibility) can explain the 75% of variance in SATISFACTION . Gender and job status influenced students' SATISFACTION with the e-learning system.
2011	Batany, 2011 (ID 0021)	Relationship among sense of classroom community, perceived cognitive learning and satisfaction of students at an e-learning course	IJE	88	1,2	Exam Survey	Mixed method / model	F1, F2	Virtual	student, teacher/tutor	Satisfaction	N/A	Q1: "Are there any differences between students' sense of classroom community, perceived cognitive learning, the degree self-efficacy and final exam scores by students?" Q2: "Is there a relationship between students' sense of classroom community, SATISFACTION	The sense of community and cognitive learning were related to course SATISFACTION . SATISFACTION was positively associated with the other participants' (p.770). "I was influenced by the other participants' MOODS " and "I ENJOYED learning personal stories with the other participants" (p.770). "I ENJOYED engaging in exchange e-mails with the other participants" (p.770).

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															<p>perceived cognitive learning, the Internet self-efficacy and final exam scores")</p> <p>Q1: "Can classroom community and course SATISFACTION predict perceived cognitive learning?" (p.566).</p> <p>N/A</p>
Chen & Lee, 2011 (ID 0031)	Emotion recognition and communication for reducing second language speaking anxiety in a web-based one-to-one synchronous learning environment	RJET	10 (construction) 4 (test)	2	Physiological data Pulse signals Survey	Predictive Descriptive	F4	Virtual	student, teacher/tutor	Anxiety Emotion Joy	N/A	N/A	N/A	<p>The human EMOTION recognition system is helpful in reducing language-based ANXIETY.</p> <p>Extracting the EMOTIONAL features for AV was the most difficult of the three human EMOTIONS.</p> <p>The lowest correlation found between participants' degree to which they participated in a sense of community.</p>	
Kim, 2011 (ID 0016)	Developing an instrument to measure social presence in distance higher education	RJET	401, 49, 221, 63 (pilot test)	2	Survey	True Experimental	F1, F2	Virtual	student	Affect Emotion Enjoyment Mood Satisfaction	N/A	N/A	N/A	<p>Social presence correlates with learning SATISFACTION.</p> <p>Approximately 36% of variance of students' SATISFACTION was accounted for by their perception of social presence.</p> <p>The measurement of social presence confirmed four factor constructs: mutual attention and support, AFFECTIVE connectedness, the degree to which participants feel connected EMOTIONALLY and socially with others), a sense of community and open communication.</p>	

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																Students who reported high levels of social presence tended to be highly SATISFIED with their learning. "I was influenced by the other participants' MOODS " and "I ENJOYED sharing personal stories with the other participants" (p.770). "I ENJOYED engaging in exchange e-mails with the other participants" (p.770).
	Xie & Ke, 2011 (ID 0022)	The role of students' motivation in peer-mediated asynchronous online discussions	<i>RJET</i>	23	1,2	Metadisc Online Discussion Survey	Mixed method / model	F2	Partly virtual	student, teacher/tutor	Emotion Engagement	NA	N/A	N/A	The highly motivated students demonstrated high cognitive ENGAGEMENT . Students performed quite a few online interactions for social purposes in which they expressed their personal EMOTIONS .	
2012	Sun & Raada, 2012 (ID 0027)	Situational interest, computer self-efficacy and self-regulation: Their impact on student engagement in distance education	<i>RJET</i>	203	2	Survey	Explanatory	F1	Virtual	student, technology/ content	Engagement Self-regulation	NA	Q1: "How do interest, self-efficacy and SELF-REGULATION influence ENGAGEMENT of distance education learners?" (p.192).	N/A	Situational interest and SELF-REGULATION are correlated with all types of ENGAGEMENT .	
2013	Chapman-Peterson, Iyengar-Padua, Pascual-Miguel, & Hernandez-Garcia, 2013 (ID 0024)	Factors affecting perceived learning of engineering students in problem-based learning supported by business simulation	<i>IJE</i>	30	2	Survey	Predictive	F1	Partly virtual	student, teacher/tutor, technology/ content	Attitude Engagement Satisfaction	H: "Due to the gaming nature of simulation-based PBL , a first perception of SATISFACTION - or DISSATISFACTION - may arise in early stages of the course in the form of confirmation or exceeding course expectations and the set of achievement goals and thus	N/A	There is a strong relation between perceived SATISFACTION and the ATTITUDE towards teamwork. Collaborative learning was partly related to the ATTITUDE towards teamwork. ENJOYMENT acted as a predictor of SATISFACTION .		

[illegible]

	Yungis, Ajim, & Hwang, 2013 (ID 002)	Using social media in teaching for educational outcomes in college teaching: A structural equation analysis	<i>RHT</i>	12, 249	1	Interview Survey	Mixed method / model	F3	Partly virtual	student, teacher/late, technology content	<i>Satisfaction</i>	H1: "The use of social media in teaching has a positive effect on student SATISFACTION " H2: "Student SATISFACTION has a positive effect on student learning outcomes" (p. 585). H3: Not supported H2: Supported	Students' SATISFACTION , using social media application, has a positive effect on outcomes	differences in group identity during collaborative activities (between test groups)
	Yokselciok & Top, 2013 (ID 003b)	Exploring the link among any characteristics, participation behavior and course outcomes of online learners: An examination of learner profile using cluster analysis	<i>RHT</i>	179	2	Survey	Explanatory	F1	Virtual	student	<i>Satisfaction</i> <i>Self-regulation</i>	N/A	N/A	Gender influenced students' SELF-REGULATION and SATISFACTION
2014	Bresnahan, So-Baden, Connell, & Puchon, 2014 (ID 005)	Evaluating a Second Life Platform Based Learning (PBL) demonstration project: what can we learn?	<i>ILE</i>	10, 12	1, 2	Internal and external project documentation (interviews etc.) Evaluation activities	Mixed method / model	F3	Virtual	student, teacher/late, technology content	<i>Engagement</i> <i>Employment</i> <i>Feeling</i>	N/A	N/A	Second Life provided an ENGAGING environment Several students said they FEELT lost, confused and helpless at the start. Students reported ENJOYING the experience and considered that usability issues were not serious. If a student agrees to a position statement, it is likely that she/he uses a positive AFFECTION .
	Cheng & Chou, 2014 (ID 009)	Assessing peer support and usability of blogging in hybrid learning environments	<i>ILE</i>	240 comment, 285 responses	1, 2	Blog Communication Feedback Survey	Mixed method / model	F1, F2	Partly virtual	student, teacher/late	<i>Affect</i>	N/A	N/A	N/A

[illegible][illegible]

Kim, Park, & Court, 2014 (ID 0028)	Affective and motivational factors of learning in online mathematics courses	RRET 72	L.2 Survey	Mixed method / model	FI	Virtual	N/A	Anxiety Emotion Engagement Self-regulation	N/A	Q1: "How do motivational variables (i.e. self-efficacy and internal value) predict student achievement (EMOTIONS) in online mathematics courses?" Q2: "How do AFFECTIVE factors (i.e. mathematics achievement, EMOTIONS: boredom, ANXIETY, APOLOPMENT, anger, shame, and hopelessness) predict student achievement in online mathematics courses?" Q3: "How do cognitive power factors (i.e. cognitive strategy use and SELF-REGULATION) predict student achievement in online mathematics courses?" Q4: "How are student motivation, mathematics achievement, EMOTIONS and cognitive processes related to each other in online	The correlations between the motivational variables (i.e. self-efficacy and internal value) and the achievement EMOTIONS (i.e. boredom, ANXIETY, APOLOMENT, anger, shame, pride and hopelessness) were significant. Among the achievement EMOTION variables, boredom, ENJOYMENT and anger were the significant individual predictors of the final score. EMOTIONS accounted for 37% of the variance in student achievement. The EMOTION of anger was the strongest individual predictor of student achievement. SELF-REGULATION did not explain any additional variance in student achievement.	Students' lower levels of boredom, anger, shame and hopelessness but with the higher levels of ENJOYMENT and pride tended to report a higher level of SELF-REGULATION. Students with the lower levels of boredom but with higher levels of ENJOYMENT and pride tended to report a higher level of cognitive strategy use. The findings illustrates the interdependency of EMOTIONS, motivation and learning.
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La & Churchill, 2014 (ID 0010)	The effect of social interaction on learning engagement in a social networking environment	HE	13	1,2	Blog Bookmarks Comments Data files Interviews Data Wiki	Mixed method / model	P2, P9	Virtual	student, teacher/tutor	Affect <i>Excitation Engagement Feeling</i>	N/A	authenticity of courses?" (p.175) Q1: What was the effect of social interaction on learning ENGAGEMENT in the SNE? (p.402)	N/A	The 12.5% of comments in the SNE (Facebook Environment) were AFFECTIVE , containing expressions of EMOTION . Social patterns in the SNE intended to enhance social ENGAGEMENT . " FEEL a stronger sense of class community in this course" (p. 409)
Park, Cha, Lim, & Jung, 2014 (ID 014)	The relationship between activity-based learning outcomes and participants in social network services, social acceptance and attitude towards school life	BNET	730	2	Survey	Predictive	P2	Partly virtual	student, teacher/tutor	Affect <i>Attitude Engagement Satisfaction</i>	HE "University Attitude student CP Cognitive outcomes are related to social network acceptance." AT "attitude towards university HE" and SP "social networking service participants" J2: "University student: AP Affective domain: learning outcomes are related to SA, AT and SP" "University student: SD learning outcomes are related to SA, AT and SP" "University student: AT are related to SP" (p.101).	N/A	Participation directly affects ATTITUDES towards university life. Social networking (SNS) participation indirectly affects the AFFECTIVE domain (AD) ENVIRONMENT of learning, sharing and willingness to participate in leisure activities (Subsides).	Participation indirectly affects ATTITUDES towards university life / culture. SATISFACTION in social networking indirectly affects the AFFECTIVE domain (AD) ENVIRONMENT of learning, sharing and willingness to participate in leisure activities (Subsides).

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Papachristou, Vasilis, Natsis, & Mikropoulos, 2014 (ID 0011)	The role of environment design in an educational Multi-User Virtual Environment	RIET	51	2	Survey	True Experimental	F2, F3	Partly virtual	student, teacher/late, technology/ content	Attitude Engagement Satisfaction	NA	NA	The presence dimension ENGAGEMENT correlated with all positive experiences. The ENGAGEMENT correlated positively with ATTITUDE.	Most of the students expressed SATISFACTION with the experience and reported the similarity of this experience to those in real-world university courses.	
Stepanyan, Richard, & Reizer, 2014 (ID 007)	Culture, role and group work. A social network analysis perspective on an online collaborative course	RIET		2	Time-stamped postings	Explanatory (Probabilistic SNA)	F3	Virtual	student, teacher/late	Attachment	H: "There is no tendency towards preferring ATTACHMENT within the simulated network" (p.083). H: Not supported.	NA	NA	There is a tendency towards preferring ATTACHMENT within a multicultural online collaborative learning environment.	The mean value for presence, ENGAGEMENT, was high.
Zhao, Sullivan, & McElissos, 2014 (ID 0015)	Participation, interaction and social presence: An exploratory study of collaboration in online peer review groups	RIET	18	1,2	Messages Survey	Mixed method/ model	F2	Virtual	student	Affect Emotion Feeling Mood	NA	NA	NA	An analytical framework for the assessment of social presence has an AFFECTIVE category (the expression of EMOTIONS, FEELINGS and MOOD).	
2015 Al-Zahrani, 2015 (ID 0042)	From passive to active: The impact of the flipped classroom through social learning platforms on higher education students' creative thinking	RIET	27	1,2	Bloggs	Mixed method/ model	F2	Partly virtual	student, teacher/late, technology/ content	Enjoyment Satisfaction	NA	NA	NA	The total SATISFACTION score from moderate to high. The flipped classroom found to be ENJOYABLE approach.	
Brth, Jordan, Schaffert, Rock, & Kim, 2015 (ID 0048)	Responsibility and generativity in online learning communities	ILE	24	1,2	Comments Discussion transcripts	Mixed method/ model	F2	Partly virtual	student, teacher/late	Anxiety Emotion Engagement Flow Engagement	NA	NA	NA	Participants in all groups across all discussions appeared interculturally ENGAGED. One student: "I've ENJOYED reading everyone's comments".	

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Chuang, Jon, Lin, & Li, 2015 (ID 0033)	Development of a virtual structure analysis learning platform for enhancing student technical skills.	<i>ILE</i>	31	2	Survey	Pre-Experimental	F3	Virtual	technology/ content	<i>Satisfaction</i>	NA	NA	NA	NA	(p.479). The often revealed EMOTIONAL reaction to the material through personal examples. Her response to the thread on FLOW and intrinsic motivation illustrates her warm, expressive style. When I think about the times, I have been in FLOW there is usually an element of ANXIETY and/or being with a fine balance between the two. Students were, on average, SATISFIED with the learning process.
Garido-Blago & Rodriguez-Moran, 2015 (ID 0067)	The reality of virtual worlds: pros and cons of their application to foreign language teaching.	<i>ILE</i>	108	2	Recording activities Several answers (to evaluate the attempt at which the student has chosen the correct answer).	True Experimental	F4	Virtual	student, teacher/late, technology/ content	<i>Enjoyment Feeling</i>	NA	NA	NA	Students FEEL themselves to be members of different groups but part of a single community that shares one common goal.	The experience using the environment was ENJOYABLE . All the students confirm that the teacher needs to be present, not only in the form of an avatar, as they could ignore this figure by means of private messages, but also by mixing with them in the classrooms so that they sense his or her presence, because this makes them FEEL that they are actually learning. The teacher should be SATISFIED with the virtual communications related to activities (chat and forums) and the professors.
Gutierrez-Santana & Galdago-Aranda, 2015 (ID 0044)	Internal structure of virtual communications in communities of inquiry in higher education. Phases, evolution	<i>RIET</i>	27	1,2	Bloggs Survey	Mixed method / model	F2	Virtual	student, teacher/late	<i>Affect Satisfaction</i>	Q: "Are students SATISFIED with the communication structure in the environments	Students are SATISFIED with the virtual communications related to activities (chat and forums) and the professors.	Q: "Are students SATISFIED with the communication structure in the environments	Students are SATISFIED with the virtual communications related to activities (chat and forums) and the professors.	Q: "Are students SATISFIED with the communication structure in the environments

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Horvat, Davora, Krizanovic, & Celisov, 2015 (ID 0034)	Student perception of Moodle learning management system: a satisfaction and significance analysis	<i>ILE</i>	395	2	Survey	Predictive Cross-sectional	F3	Partly virtual	technology/ content	<i>Satisfaction</i>	H1: "There is no difference between males and females in their SATISFACTION with the Moodle LMS." (p. 517) H2: "The difference in student SATISFACTION with the Moodle LMS is statistically significant among different age groups." (p. 517) H3: "The difference in student SATISFACTION with the Moodle LMS is statistically significant among students' different years of study." (p. 517) H4: "According to the time spent using the Moodle application, the difference in student SATISFACTION with the Moodle LMS is statistically significant." (p. 518) Results: H1: Not supported. H2: Supported. H3: Supported. H4: Supported.	NA	Male / female students are equally SATISFIED with Moodle. The students that use a Moodle only before an exam have a significantly lower SATISFACTION . The actual attendance in the same programme does not cause different levels of SATISFACTION to female students than is otherwise caused in male students.	NA
Jung & Suzuki, 2015 (ID 0040)	Scaffolding strategies for wiki-based collaboration: Action research in a multicultural Japanese language program	<i>RIET</i>	27, 17, 13	2	Grades Interviews Logs Observation Survey	Action research	F2	Partly virtual	student, teacher/late	<i>Enjoyment Frustration Satisfaction</i>	NA	NA	NA	The overall SATISFACTION score was high. Several students expressed FRUSTRATION when some group members valued

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Lee & Lee, 2015 (ID 0032)	The use of virtual reality for creating unusual environmental stimulation to motivate students to explore creative ideas	<i>ILE</i>	NA	2	Observing	Explanatory	F3	Partly virtual	student, technology/ content	<i>Emotion Engagement Feeling</i>	NA	NA	NA	Student agreed that the platform helped them to relax and to FEEL free to suggest, explore and evaluate ideas.	Student used EMOTIONAL displays more in the later stage of the research, because they were more familiar with the ways of expressing their FEELINGS and comments by using the avatar's gestures.
Liu, Huang, & Chang, 2015 (ID 0039)	The impacts of network centrality and self-regulation in an e-learning environment with the support of social network analytics	<i>RIET</i>	62	2	Survey	Pre-Experimental	F2	Virtual	student	<i>Self-regulation</i>	Q1: "How do network centrality (social network position) and SELF-REGULATION influence students' learning in an SNS learning environment?" (p.26) Q2: "Whether these two variables have a significantly higher number of asking for help than those with high SELF-REGULATION affect student learning in an SNS learning environment?" (p.34) NA	The high-level SELF-REGULATION students significantly outperform low-level SELF-REGULATION students in terms of learning achievement / self-regulation. The students with low-level SELF-REGULATION have a significantly higher number of asking for help than those with high SELF-REGULATION .	Q1: "How do network centrality (social network position) and SELF-REGULATION influence students' learning in an SNS learning environment?" (p.26) Q2: "Whether these two variables have a significantly higher number of asking for help than those with high SELF-REGULATION affect student learning in an SNS learning environment?" (p.34) NA	Student had a positive ATTITUDE towards the use of Facebook in	Learning process over learning product. Students ENJOYED collaborating in collecting and interpreting the data. During the lesson in the simulated virtual reality, the students ENJOYED their learning experiences. Student used EMOTIONAL displays more in the later stage of the research, because they were more familiar with the ways of expressing their FEELINGS and comments by using the avatar's gestures. NA
Magwene, Ntshole, & Phele, 2015	Facebook and classroom group work: A trial	<i>RIET</i>	49	1,2	Interview Postings Survey	Mixed method / model	F2	Partly virtual	student, teacher/late, technology/ content	<i>Attitude Emotion Feeling</i>	NA	NA	NA	There were also some exciting findings of not the use of Facebook in	There were also some exciting findings of not the use of Facebook in

Appendices to be added as additional online material

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(ID 0045)	study involving University of Birmingham Advanced Oral Presentation students								content				education. Students ENJOY using Facebook.	comfortable using Facebook because of privacy and security concerns. Our student ENJOY working with my team members and sharing experiences with them
Makos, Lee, & Zeng, 2015 (ID 0043)	Examining the characteristics of student postings that are liked and linked in a CSCL environment	<i>RIET</i>	27	1,2	Logs Notes	Mixed method / model	F2	Virtual	student, teacher/late	<i>Affect Engagement</i>	H: "NOTES that review their analysis are linked to other NOTES are of higher cognitive complexity than those that do not because students are more willing to ENGAGE in discourse when a sense of AFFIRMATION and trust is cultivated in the learning community." Results: Supported.	NA	Students are more willing to ENGAGE in discourse when a sense of AFFIRMATION and trust is cultivated in the learning community.	NA
Papp & Reipold, 2015 (ID 0049)	Learning from a wiki way of learning	<i>SBE</i>	58	1,2	Self-reports Wiki data	Mixed method / model	F2	Virtual	student	<i>Enjoyment Satisfaction</i>	NA	NA	Specific feedback on the wiki technology students as ENJOYABLE , innovative, practical project highly linked to the module content. On completing the class created an average SATISFACTION score of 4.6 out of 5 (5 = very satisfied)	
Salmon, Gregory, Dean, & Ren, 2015 (ID 0059)	Experiential online development for education: The example of the Cape Diem MOOC	<i>RIET</i>	155, 29	2	Survey	Quasi-Experimental	F1	Virtual	student, technology/ content	<i>Enjoyment Feeling</i>	NA	NA	Student ENJOYED (1) using discussion boards, wikis and digital badges (2) collaborating / sharing with peers and / participating online with like-minded people	One respondent FEELT ENJOYED to be the most useful aspect of the CD MOOC. One respondent ENJOYED both experiencing and learning about and

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Trindade, Hernandez, & Aguiar, 2015 (ID 0047)	The effect of centralization and cohesion on the social construction of knowledge in electronic exchanges in synchronous and asynchronous computer-mediated communication: the effect of culture as a mediating variable	<i>ILE</i>	73	1,2	Messages	Mixed method / model	F2	Virtual	student, teacher/late	<i>Affect Emotion</i>	NA	NA	NA	NA	using new online learning design tools. One respondent stated that he/she ENJOYED using "the forum" allowing social media content as resources. Our ENJOYED the structured building of a MOOC: the emphasis on student centered learning and the multi-checker feedback to culminate into a workable plan." The rate of EMOTIONAL participation is low. In social presence, AFFECTIVE participation in this category is rare. Dyslike learners in synchronous CMC exchanged significantly more features of EMOTIONS . The tendency among dyslike learners to include EMOTIONAL features in their dialogues was mediated by their cultural background. The American learners made evaluations that were significantly more EMOTIONALLY charged and based on their own country of
2016 Angeli & Schwartz, 2016 (ID 0053)		<i>ILE</i>	850	2	Logs	Pre-Experimental	F2	Partly virtual	student	<i>Emotion</i>	NA	NA	NA	NA	One respondent stated that he/she ENJOYED using "the forum" allowing social media content as resources. Our ENJOYED the structured building of a MOOC: the emphasis on student centered learning and the multi-checker feedback to culminate into a workable plan." The rate of EMOTIONAL participation is low. In social presence, AFFECTIVE participation in this category is rare. Dyslike learners in synchronous CMC exchanged significantly more features of EMOTIONS . The tendency among dyslike learners to include EMOTIONAL features in their dialogues was mediated by their cultural background. The American learners made evaluations that were significantly more EMOTIONALLY charged and based on their own country of

Amun & Rensil, 2016 (ID 0052)	Can blogging increase students' satisfaction in the classroom? Lessons from multiple case studies	ILE	180	L2	Survey	Mixed method/ model	F2	Partly virtual	student, technology/ content?	Engagement Flow Satisfaction	H1 "Students' SATISFACTION at the end of the course will be higher than in-classroom satisfaction" (p.110). Results: Not supported.	N/A	Either the task or the platform caused DISSATISFACTION among the participants. SATISFACTION with the blogging assignment	origin that Southern European learners. Several bloggers were successful in attracting students and posting in their blog, and they expressed SATISFACTION with the blogging assignment
Cheng & Chan, 2016 (ID 0055)	Exploring the relationships between learning styles, online participation, learning achievement and course satisfaction: An empirical study of a blended learning course	BLET	78	L2	Feedback Survey	Mixed method/ model	FL/F2	Partly virtual	student, teacher/instructor, technology/ content	Attitude Engagement Satisfaction	H1: "Participation in information access is significantly related to course SATISFACTION ." (p-262) H2: "Participation in interactive learning is significantly related to course SATISFACTION ." (p-262) H3: "Participation in networked learning is significantly related to course SATISFACTION ." (p-262) H4: "Participation in materials development is significantly related to course SATISFACTION ." (p-262) Results: H1: Not supported	N/A	Learners had a high level of ENGAGEMENT with online quizzes, simulation and participation in simulations and estimators (i.e. who like to use tools to simulate diverse items with an integrated whole) were more likely to show positive ATTITUDES towards online participation than other types of learners. SATISFACTION	One blogger stated that she thoroughly ENJOYED the course and the opportunity to share her thoughts with the world. Accompanied (i.e. those who learn best through concrete experimentation like participating in simulations) and estimators (i.e. who like to use tools to simulate diverse items with an integrated whole) were more likely to show positive ATTITUDES towards online participation than other types of learners.

Cheng, Chu, & Ma, 2016 (ID005)	Tertiary students' intention to co-collaborate for group projects: Exploring the missing link from an extended theory of planned behavior model	BNET	1120	2	Survey	Explanatory Cms. structural	F2	Virtual	student, teacher/trainee	Attitude	H2: Not supported. H3: Supported. H4: Supported.	N/A	Students with a positive ATTITUDE towards co-collaboration were more ready to work with their group mates on group assignments.	Specifically, students from pre-entrance-funded institutions had larger mean values of their ATTITUDE than students from private institutions.
Cheng, Yuanxun, Sun, & Huang, 2016 (ID007)	Application of a novel collaboration engineering method by learning design: A case study	BNET	40, 31	2	Chart test Created ideas Meeting schedule Voting scores	True Experimental	F1, F2	Partly virtual	student, teacher/trainee	Satisfaction	H2: Not supported. H3: Supported. H4: Supported.	Q: "Can CE [Collaboration Engineering] <i>method</i> improve efficiency and SATISFACTION of the case studies?" (p. 107)	With the support of Discussion Platform, students demonstrated high SATISFACTION with collaborative learning.	The <i>mean</i> at case people are with the <i>mean</i> they they were to feel SATISFIED with the outcome.
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Cheng, Chu, & Ma, 2016 (ID005)	Tertiary students' intention to co-collaborate for group projects: Exploring the missing link from an extended theory of planned behavior model	BNET	1120	2	Survey	Explanatory Cms. structural	F2	Virtual	student, teacher/trainee	Attitude	H2: Not supported. H3: Supported. H4: Supported.	N/A	Students with a positive ATTITUDE towards co-collaboration were more ready to work with their group mates on group assignments.	Specifically, students from pre-entrance-funded institutions had larger mean values of their ATTITUDE than students from private institutions.
Cheng, Yuanxun, Sun, & Huang, 2016 (ID007)	Application of a novel collaboration engineering method by learning design: A case study	BNET	40, 31	2	Chart test Created ideas Meeting schedule Voting scores	True Experimental	F1, F2	Partly virtual	student, teacher/trainee	Satisfaction	H2: Not supported. H3: Supported. H4: Supported.	Q: "Can CE [Collaboration Engineering] <i>method</i> improve efficiency and SATISFACTION of the case studies?" (p. 107)	With the support of Discussion Platform, students demonstrated high SATISFACTION with collaborative learning.	The <i>mean</i> at case people are with the <i>mean</i> they they were to feel SATISFIED with the outcome.
Cheng, Chu, & Ma, 2016 (ID005)	Tertiary students' intention to co-collaborate for group projects: Exploring the missing link from an extended theory of planned behavior model	BNET	1120	2	Survey	Explanatory Cms. structural	F2	Virtual	student, teacher/trainee	Attitude	H2: Not supported. H3: Supported. H4: Supported.	N/A	Students with a positive ATTITUDE towards co-collaboration were more ready to work with their group mates on group assignments.	Specifically, students from pre-entrance-funded institutions had larger mean values of their ATTITUDE than students from private institutions.
Cheng, Yuanxun, Sun, & Huang, 2016 (ID007)	Application of a novel collaboration engineering method by learning design: A case study	BNET	40, 31	2	Chart test Created ideas Meeting schedule Voting scores	True Experimental	F1, F2	Partly virtual	student, teacher/trainee	Satisfaction	H2: Not supported. H3: Supported. H4: Supported.	Q: "Can CE [Collaboration Engineering] <i>method</i> improve efficiency and SATISFACTION of the case studies?" (p. 107)	With the support of Discussion Platform, students demonstrated high SATISFACTION with collaborative learning.	The <i>mean</i> at case people are with the <i>mean</i> they they were to feel SATISFIED with the outcome.
Cheng, Chu, & Ma, 2016 (ID005)	Tertiary students' intention to co-collaborate for group projects: Exploring the missing link from an extended theory of planned behavior model	BNET	1120	2	Survey	Explanatory Cms. structural	F2	Virtual	student, teacher/trainee	Attitude	H2: Not supported. H3: Supported. H4: Supported.	N/A	Students with a positive ATTITUDE towards co-collaboration were more ready to work with their group mates on group assignments.	Specifically, students from pre-entrance-funded institutions had larger mean values of their ATTITUDE than students from private institutions.
Cheng, Yuanxun, Sun, & Huang, 2016 (ID007)	Application of a novel collaboration engineering method by learning design: A case study	BNET	40, 31	2	Chart test Created ideas Meeting schedule Voting scores	True Experimental	F1, F2	Partly virtual	student, teacher/trainee	Satisfaction	H2: Not supported. H3: Supported. H4: Supported.	Q: "Can CE [Collaboration Engineering] <i>method</i> improve efficiency and SATISFACTION of the case studies?" (p. 107)	With the support of Discussion Platform, students demonstrated high SATISFACTION with collaborative learning.	The <i>mean</i> at case people are with the <i>mean</i> they they were to feel SATISFIED with the outcome.
Cheng, Chu, & Ma, 2016 (ID005)	Tertiary students' intention													

Hew, 2004 (ID 0056)	Promoting engagement in online courses: What strategies can we learn from three highly rated MOOCs?	<i>RIET</i>	965	1,2	Comments Observation Reflection	Mixed method/ model	FI, F2	Virtual	student, teacher, tutor	<i>Affect Engagement Feeling</i>	NA	Q1: "Five the factors that could influence student ENGAGEMENT in traditional online courses that apply to online courses that are massive and open?" p. 526 Q2: "What factors do students consider important in terms of their perceived ability to promote a knowledge or ENGAGEMENT online learning experience?" (p. 520)	The sense of relationships affects students' AFFECTIVE ENGAGEMENT . The text indicates extra FEELINGS of connectedness and commitment.	expressed that the process was easier, humorous and peers interactions could increase students' positive FEELINGS through a community help them stay ENGAGED .
Huang, Blomig, & Chen, 2016 (ID 0066)	Matching learning style to web-based learning: a perspective based on cognitive styles and physiological factors	<i>ILE</i>	96	1,2	Emotional Feedback Pattern Pre- and post-tests Pulse rate Survey	Explanatory	F1	Virtual	NA	<i>Emotion</i>	NA	Q: "Whether the relationship with cognitive styles in WBL is linked to learners' EMOTIONS , as reflected by changes in pulse rate?" (p. 1261)	The matching condition enabled learners to feel more positive EMOTIONS when linked to better results in learning performance.	Despite the large class size, the personal aspect is the student FEELING that the video was being directed directly at them as obtained when the instructor appeared to be only addressing me."
													Learners in the matching condition had relatively stable EMOTIONS compared with those in the mismatching condition. Learners in the mismatching condition demonstrated more negative EMOTIONS .	

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											<ul style="list-style-type: none"> - Students in leading the learning activities (79%) - Made participants feel welcome in discussion (87%) - Encouraged participants to express ideas (86%) - Stimulated cooperation between participants (85%) - Standard formation of the online community (85%) - Gave feedback during activities (73%) - Gave appropriate suggestions (73%) <p>Hoped in solving problems (65%)</p>		
Jung-Bunsummers, 2016 (ID 008)	Communication challenges learners face online: Why addressing CMC and language proficiency will "value our learners' profiles"	RJET 17	1	Interviews Focus discusses	Phenomenon exp.	F2	Virtual	student, teacher, technology/ context	Attitude Engagement Feeling Frustration Satisfaction	N/A	Q: "How does the students' experience of online communication compare to their overall ENGAGEMENT and participation?" (p.342)	<p>Students felt the obstacle to write in as well as unfamiliar because of the asynchronous mode of presence of the tutor and the design of the VLE.</p> <p>All students pointed out that expressing their thoughts clearly when writing asynchronously was often</p> <p>UNSATISFACTORY RESULTS. The results showed that there is a negative relationship between students' academic performance and their attitudes.</p>	"I FELT FRUSTRATED on a lot of modules where peer discussions just did not happen because of that diversity in background and educational backgrounds." (p. 248)
Liu, 2006 (ID 006)	Using educational games and simulation software in a computer science course: learning achievement and student flow orientations	IJE 110	1.2	Interviews Surveys	Mixed method/ model	F1	Virtual	technology/ context	Anxiety Engagement Feeling Flow Satisfaction	H1: "Students who experience different interventions show no significant difference in their mathematics FLOW" (p.712) H2: "There is a significant correlation between students' satisfaction toward learning and their performance."	Q2:"What is the difference between the mathematics FLOW and the game-oriented learning and what of situation..."	<p>Some students in the experimental group commented that this type of gaming world design is life-like, making the SATISFACTION gained from beating the avatar.</p>	

Mariano, Charizaldi, & Xenos, 2016 (ID 0036)	Enhance learning on software project management through a role-play game in a virtual world	JLE	34	1	Interview Laysurvey	Case study	F2, F3	Virtual	student, technology/ content	Anxiety Engagement	N/A	N/A	N/A	Students felt ANXIETY within short time limits.	
McCarthy, 2016 (ID 0037)	Enhanced learning partnerships in the Gulf: peer feedback as a formative assessment tool for animation students	JLE	71	1,2	Survey	Mixed method/ model	F2, F3	Virtual	student, technology/ content	Enjoyment	N/A	N/A	N/A	88% of respondents indicated that they ENJOYED using student work from another country. 88% of participants indicated the Gulf provide an ENJOYABLE learning environment. "I really ENJOYED seeing work from the Iraqi program students. It was beneficial to see what other students do." (p. 1186)	

												'Truly ENJOYED being able to watch everyone's progress and abilities develop over the time of the course' (<i>p. 1196</i>) N/A
Nygren, Clarke & Robson, 2016 (ID 008)	Students' perceptions of campus-based learning environments; their attitude towards business statistics; and their academic achievement implications from a UK university	SME	453	2	Survey	Explanatory Longitudinal	F1	Partly virtual	N/A	Anxiety Attitude	N/A	The results found A relationship between students' perceptions of collaborative, task orientation, and ANXIETY. The ATTITUDE towards statistics is significantly related to Achievement, explaining almost 40% of variation.
Noval, Johnson, Torresblum, & Shaw, 2016 (ID 082)	Effects of an instructional gaming characteristic on learning efficiency, effectiveness, engagement; using a timeline for teaching basic scientific skills	I/E	64	2	Pre-test Post- test Survey	Pre- Experimental	F1	Virtual	technology/ content	Engagement Satisfaction	H " Adding a storyline to a simulation will improve students' perceived effortiveness, efficiency, and ENGAGEMENT." (q.525) H: Not supported.	N/A The results indicated that adding a storyline to a simulation affected students' SATISFACTION.
Rodriguez-Aranda & Meseguer-Aranda (ID 085)	What kinds people is long on e-learning? An empirical analysis of user experiences and their effects on continuance intentions	I/E	2530	2	Survey	Predictive Descriptive	F1	Virtual	teacher/tutor, technology/ content	Attitude Flow	H1: "ATTITUDE towards using the e-learning environment has a positive effect on e-learning continuance intention". (p.183) H2: "Perceived ease of use has a positive effect on ATTITUDE towards using the e-learning environment". (p.185) H3: "Perceived usefulness has a positive effect on ATTITUDE towards using the e-learning environment". (p.185)	N/A ATTITUDE towards use has a positive and significant impact on continuance intention. Perceived usefulness has a direct effect on ATTITUDE towards use. ATTITUDE towards use has a positive and significant impact on continuance intention. Perceived didactic resources quality has a positive,

Shin, An, & Kim, 2003 (ID 0058)	How the second screen changes the way people interact and learn the effects of second screen use on information processing	ILE	09	2	Survey (pre-questionnaire recognition memory questionnaire learning effect questionnaire)	Pre-Experimental	FI, F2	Virtual	technology/ context	Intercity Location Engagement	<p><i>H1: "Perceived didactic resources quality has a positive effect on FLOW in the e-learning environment."</i> (p. 1036)</p> <p><i>H5: "FLOW in the e-learning environment has a positive effect on academic performance."</i> (p. 1036)</p> <p><i>H6: "FLOW in the e-learning environment has a positive effect on attitude towards using the e-learning environment."</i> (p. 1036)</p> <p><i>H7: "Presence has a positive effect on FLOW in the e-learning environment."</i> (p. 1036)</p> <p>Results: All supported</p> <p><i>H1: "Users in media multitasking use a technology more benefit from higher EMOTIONAL ANXIETY learning effect than those who do not simultaneously use a second screen, specifically in terms of ANXIETY, which is expected to be lower when computer's load is higher" (p. 206)</i></p> <p><i>H2: "An interaction occurs between the attentional skill and secondary tasks in the EMOTIONAL."</i></p>	<p>and direct impact on FLOW.</p> <p>There is an indirect effect of perceived didactic resources quality on FLOW.</p> <p>FLOW is influenced by perceived ease of use and presence.</p> <p>FLOW has a positive effect on academic performance and on ATTITUDE towards use.</p>	Media multitasking: there was a positive difference in EMOTIONAL ANXIETY levels during learning compared to participants who were in simultaneous use.
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												people who were in the same room as the teacher). N/A	
Chang, 2017 (ID071)	Analysis of learning behavior in a flipped programming classroom adopting problem-solving strategies	I/E	44	2	Comments Observation	Pw Experimental	F1	Partly virtual	student, teacher/tute	Enjoyment	N/A	N/A	When a respondent responds to the other respondent's answer, then the next respondent will respond to the previous respondent's answer with doubts and so offer his/her own thoughts. This could mean that every-one ENJOYS a heated debate, but they do not reach a definitive conclusion.
Chen, Xu, Tang & Chen, 2017 (ID072)	Webinars-classroom: an interaction-aware virtual learning environment for engineering learning interactions	I/E	464	2	Interview (30-40) Survey (30-40)	Qual Experimental	F2, F3	Virtual (the target group)	student, teacher/tutor	Satisfaction	N/A	N/A	The "Popularity Dashboard" gained 89.4%, the "Real-time Voice Chat" 79.8%, the "Post-and-Paper Incentive" 78.5%, the "Language Highlighter" 75%, and the "Online User List" 60.7% satisfaction.
Cho & Yoo, 2017 (ID073)	Exploiting online students' self-regulated learning with self-reported surveys and log files: a data mining approach	I/E	64	2	Log Files Survey	Explanatory	F1	Virtual	student, teacher/tute,	Self-regulation	N/A	N/A	N/A
Delaval, Michonov, Le Bobec & Le Moahec, 2017 (ID074)	How can students' academic performance in statistics be improved? Testing the	I/E	121	2	Scores Statistics Timesheets	Pw Experimental	F1	Virtual	technology/ course	Self-regulation	N/A	N/A	The benefits of social comparison feedback decrease as the SELF-REGULATION difference increases.

		social and temporal-self comparison feedback in a web-based training environment	ILE	98	1	Virtual session (chat, forum, and emails)	Descriptive	F2	Virtual	student teacher/teacher	Affect Emotion Satisfaction	N/A	N/A	The AFFECTIVE communication occur especially with gratitude and expression of SATISFACTION .	The social communication is with cohesion (with AFFECTIVE aspects, such as expression of EMOTIONS).
Gutierrez-Santesteban & Gallego-Arnau, 2017 (ID 0075)		Type and degree of co-occurrence of the educational communication in a community of inquiry	ILE	98	2	Virtual session (chat, forum, and emails)	Descriptive	F2	Virtual	student teacher/teacher	Affect Emotion Satisfaction	N/A	N/A	The AFFECTIVE communication occur especially with gratitude and expression of SATISFACTION .	The social communication is with cohesion (with AFFECTIVE aspects, such as expression of EMOTIONS).
Henderstein, Solvay, & Austin, 2017 (ID 0076)		What works and why? Student's perceptions of "useful" digital technology in university teaching and learning.	SHE	1658	1,2	Survey	Mixed method/ model	F3	Partly virtual	teacher/teacher, technology/ content	Engagement Feeling	N/A	N/A	One student's FEELING would be a <i>causal</i> forum where I can bounce ideas off friends, particularly those interested in similar areas as me, and I don't feel like I'm asking questions that are obvious or stupid like I do in Moodle". (p.1574)	One student's FEELING would be a <i>causal</i> forum where I can bounce ideas off friends, particularly those interested in similar areas as me, and I don't feel like I'm asking questions that are obvious or stupid like I do in Moodle". (p.1574)
Hung & Young, 2017 (ID 0077)		Applying multi-touch technology to facilitate the learning of art appreciation: from the view of motivation and innovation	ILE	118	1,2	Survey Grades	Mixed method/ model	F3	Partly virtual	teacher/teacher, technology/ content	Enjoyment Feeling Satisfaction	N/A	N/A	N/A	One of the cited reasons for digital technology was ability to ENGAGE "creatively" with academic work off-campus. The result of the two teaching scenarios (1) the experimental group using digital materials with multi-touch technology, and (2) the control group using both slides and printed materials.

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													H2: Supported H3: Rejected H4: Supported H5: Rejected			
Nel, 2017 (ID 008)	Students as collaborators in creating meaningful learning experiences in technology-enhanced classrooms: An engaged scholarship approach	BET	From year 2003 to 2015 average of 89 students	1	Discussion Messages Survey Teacher diary	The action inquiry model (plan, act, observe and reflect)	F1	Partly virtual	student, teacher/teach, technology/ context	Engagement	N/A	N/A	N/A	"How can my students be allowed to 'move active'?" ENGAGEMENT is class activities."The students were direct."	Students commented that it "seems to be class prepared," and "it seems to be allowed for 'more active'."	
Phelps, Scott, Chaffetz, Maniloff, Luster, & Le Jeunne, 2017 (ID 0084)	Mobile devices, training and clinical practice: Medical student use of smartphones in Parisian hospitals	BET	854	1,2	Survey	Mixed method/ model	F1,F3	Partly virtual	student, teacher/teach, technology/ context	Attitude	N/A	N/A	N/A	Students were far more likely to respond with "Strongly agree" or "Agree" than "Not 'strongly agree'" or "Disagree" or "Strongly Disagree" concerning ATTITUDE to statements about usage of mobile devices.		
Rajase & Crampton, 2017 (ID 0085)	Online learning: Cheap degrees or educational privatization?	BET	289	1	Survey	Mixed method/ model	F1	Virtual	-	Engagement Faculty Frustration	N/A	N/A	N/A	Student expectations and expectations about level of ENGAGEMENT with academics, peers, and administrators bifurcated between "nurt" and "lets."	"I don't have any expectations and FELL overboarded throughout" (p.1213)	

Rodriguez-Ardila & Mesinger-Ardila, 2017 (ID 086)	Flow in e-learning: What drives it and why it matters	BRET	29 723 (the survey response rate)	2	Survey Behavioral data	Descriptive	FI	Virtual	technology/ content	Affect Emotion Feeling Flow	<p>H1: "Challenge has a positive impact on FLOW" (p.902)</p> <p>H2: "Control has a positive impact on FLOW" (p.902)</p> <p>H4: "Focused attention has a positive impact on FLOW" (p.903)</p> <p>H7: "Presence has a positive impact on FLOW" (p.904)</p> <p>H8: "FLOW has a positive impact on positive AFFECT" (P.904)</p> <p>H9: "Positive AFFECT has a positive impact on</p>	NA	NA	<p>High expectations of DE (distance education) learning experiences coincided with greater FRUSTRATION.</p> <p>"I expected to actually be taught the subject, not just given information on it" (p.1213).</p> <p>FLOW states are elicited in the learners' sense of controlling the virtual education environment, their attention control on the learning activity, and their FEELINGS of physically being in virtual learning environment.</p> <p>Three benefits from FLOW states: (1) they facilitate e-learner's positive emotions, (2) they enhance e-learner's academic performance, and (3) they contribute to students' effective continuance in</p>
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Sun, Wu, & Lee, 2017 (ID 0096)	The effect of the flipped classroom approach to OpenCourseWare instruction on students' self-regulation	BIET	181	L2	Interviews Surveys	Quasi-experimental	F1	Partly virtual	student, technology/ content	Self-regulation	H1: "In the flipped classroom, the learning strategy of interaction with teachers and peers would <i>drive</i> the students to monitor and enhance their metacognition, thereby increasing their SELF-REGULATION " (p.715) Results: Partly supported. The study results indicate that among the six categories of self-regulation in hypotheses,	N/A	N/A	"Whether there is a significant difference in students' self-regulation between the flipped classroom model and distance learning" (OpenCourse Ware) integration the flipped classroom model and distance learning" (p.718)	The integration of GCW and a flipped classroom can more effectively enhance students' SELF-REGULATION of help-seeking than that of GCW and distance learning.	"I am" in his classmates. Rob shared, "I was enlightened more than I FELT heavy because I know that I wasn't alone in my head dealing with things." Rob added, "pivot finger gave me clarification that my group felt my emotions and the respect factor was evident for us all to see." Rob added, "pivot finger gave me clarification that my group FELT my emotions." The findings indicate there was no significant difference in terms of SELF-REGULATION concerning the flipped classroom model and distance learning.
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Tan, 2017 (ID 009)	Using online discussion forums to support learning of paraphrasing	BRET	43	1, 2	Discussion post	Cross sectional Explanatory	F2	Partly virtual	student, teacher	Feeling self-regulation	NA	NA	NA	only help-seeking showed a significant difference.	of the opportunities to interact with my peers and the TA (p.725) Students were found to do their assignment in a self-directed and SELF-REGULATED manner within cultural and institutional constraints in the online discussion forum (ODF). Messages with personal FEELINGS (P= 31.6%) and without personal FEELINGS (NP= 48.4%) were almost equal in proportion. Students interacted outside of the classroom; can be enhanced through the use of web-based conferencing tools to increase student ENGAGEMENT.
Vangham & Christie, 2017 (ID 002)	Evaluating a blended degree program through the use of the NSSSE framework	BRET	NA	2	Survey	Descriptive	F2	Partly virtual	student, teacher	Engagement, Fearment Feeding	NA	NA	NA		"ENGOTED the small class size" (p.1181) "I FELT like we were a community that focused on the relationship that we built" (p. 1183) The study revealed the activity patterns of students' FEELINGS.
Wang, Anderson, Chen, &	Interaction pattern analysis in cMOOCs based on the	BRET	2000 persons	1	Blog Twitter Facebook	Case study	F2	Virtual	student, teacher	Affect Attitude Emotion Engagement	NA	NA	The study revealed the activity patterns of students' FEELINGS.		Student typically share their own FEELINGS.

Barbers, 2017 (ID 008)	connective interaction and engagement framework									Feeling		interaction - wayfinding interaction - newsmaking interaction - interaction.	Findings demonstrate need for social and EMOTION presence to share AFFECTIVE states.
Watson, 2017 (ID 004)	The value of capture: Taking an alternative approach to using lecture capture technologies for increased impact on student learning and engagement	BET	650	1	Survey	Coc study	F3	Partly virtual	technology/ content	Engagement	N/A	N/A	Student replied to others' blog offers providing examples or arguments to explain and support their idea, clarifying their ATTITUDE , such as publicly agreeing or disagreeing. The pilot study provides an indication that more purposeful use of capture technologies to support and extend student learning leads to greater ENGAGEMENT with the types of captured content that are likely to have a positive impact on student attainment. N/A
Yilmaz, Gilmaz, Yilmaz, & Cakmak, 2017 (ID 005)	The impact of transactive memory system and interaction platforms in collaborative knowledge construction on social presence and self-regulation	ILE	97	1,2	Blog Facebook Pocket Wiki	Mixed method/ model	F2, F3	Partly virtual	student, teacher, technology/ content	Enjoyment Self-regulation	N/A	"Do interaction platform and TMS (Transactive Memory System) groups have a moderating impact on SELF-REGULATION skills of the students?" (p.94) Students SELF-REGULATION skills were found at 174.70 for blog, 201.30 for Facebook, 191.36 for podcast and 181.91 for wiki. Student stated that elements as videos and images added to the course made	

ENJOYABLE

Appendix 2: References of the 91 reviewed articles and their respective sources used in this review.

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