TURUN YLIOPISTON JULKAISUJA
ANNALES UNIVERSITATIS TURKUENSIS

SARJA – SER. B OSA – TOM. 304

HUMANIORA

EMOTIONS IN A WEB-BASED LEARNING ENVIRONMENT

by

Minna Nummenmaa

TURUN YLIOPISTO
Turku 2007

From the Department of Teacher Education
University of Turku, Finland

Supervised by

Professor Erno Lehtinen
Department of Teacher Education
University of Turku
Finland

Professor Marja Vauras
Department of Teacher Education
University of Turku
Finland

Reviewed by

Professor Jari-Erik Nurmi
Department of Psychology
University of Jyväskylä
Finland

Professor Simone Volet
School of Education
Murdoch University
Western Australia

Opponent

Professor Jari-Erik Nurmi
Department of Psychology
University of Jyväskylä
Finland

ISBN 978-951-29-3400-3
ISSN 0082-6987

EMOTIONS IN A WEB-BASED LEARNING ENVIRONMENT

Minna Nummenmaa
Educational Technology Unit
University of Turku
Finland

ABSTRACT

The aim of this thesis was to examine emotions in a web-based learning environment (WBLE). Theoretically, the thesis was grounded on the dimensional model of emotions. Four empirical studies were conducted. Study I focused on students' anxiety and their self-efficacy in computer-using situations. Studies II and III examined the influence of experienced emotions on students' collaborative visible and non-collaborative invisible activities and lurking in a WBLE. Study II also focused on the antecedents of the emotions students experience in a web-based learning environment. Study IV concentrated on clarifying the differences between emotions experienced in face-to-face and web-based collaborative learning. The results of these studies are reported in four original research articles published in scientific journals.

The present studies demonstrate that emotions are important determinants of student behaviour in a web-based learning, and justify the conclusion that interactions on the web can and do have an emotional content. Based on the results of these empirical studies, it can be concluded that the emotions students experience during the web-based learning result mostly from the social interactions rather than from the technological context. The studies indicate that the technology itself is not the only antecedent of students' emotional reactions in the collaborative web-based learning situations. However, the technology itself also exerted an influence on students' behaviour. It was found that students' computer anxiety was associated with their negative expectations of the consequences of using technology-based learning environments in their studies.

Moreover, the results also indicated that student behaviours in a WBLE can be divided into three partially overlapping classes: i) collaborative visible ii) non-collaborative invisible activities, and iii) lurking. What is more, students' emotions experienced during the web-based learning affected how actively they participated in such activities in the environment. Especially lurkers, i.e. students who seldom participated in discussions but frequently visited the online environment, experienced more negatively valenced emotions during the courses than did the other students. This result indicates that such negatively toned emotional experiences can make the lurking individuals less eager to participate in other WBLE courses in the future. Therefore, future research should also focus more precisely on the reasons that cause individuals to lurk in online learning groups, and the development of learning tasks that do not encourage or permit lurking or inactivity.

Abstract

Finally, the results from the study comparing emotional reactions in web-based and face-to-face collaborative learning indicated that the learning by means of web-based communication resulted in more affective reactivity when compared to learning in a face-to-face situation. The results imply that the students in the web-based learning group experienced more intense emotions than the students in the face-to-face learning group. The interpretations of this result are that the lack of means for expressing emotional reactions and perceiving others' emotions increased the affectivity in the web-based learning groups. Such increased affective reactivity could, for example, debilitate individual's learning performance, especially in complex learning tasks. Therefore, it is recommended that in the future more studies should be focused on the possibilities to express emotions in a text-based web environment to ensure better means for communicating emotions, and subsequently, possibly decrease the high level of affectivity. However, we do not yet know whether the use of means for communicating emotional expressions via the web (for example, "smileys" or "emoticons") would be beneficial or disadvantageous in formal learning situations. Therefore, future studies should also focus on assessing how the use of such symbols as a means for expressing emotions in a text-based web environment would affect students' and teachers' behaviour and emotional state in web-based learning environments.

CONTENTS

ACKNOWLEDGEMENT

Conducting research is usually a joint effort, not an individual activity. Although the topic of this thesis was – at least in the beginning of the research – very novel, I have been lucky to have the opportunity to collaborate with other people while doing my thesis.

First of all, I would like to thank Professor Erno Lehtinen, who has been my supervisor during these years. Although he has been very busy with his administrative work recent years, he has always had time for me when I have asked for it. Even though we did not have so many appointments relating to my research, all these appointments have been remarkably important to me. Erno has always been positive about my research ideas and offered valuable guidance for my research.

I wish to thank also my other supervisor, Professor Marja Vauras, and the reviewers of my thesis, Professor Jari-Erik Nurmi and Professor Simone Volet, for their valuable comments, which will also be useful for my future research.

I would also like to thank Doctor Markku Niemivirta for his guidance in the construction of interest scale for these studies.

An essential part of this thesis consisted of the measures conducted in real university courses. I wish to express my gratitude to all the teachers who offered their courses for the purpose of these studies. And most of all I am grateful to the 266 students, who have patiently answered all the measures and questionnaires during their courses.

The thesis was financially supported by the Finnish Academy during the years 2002-2005. I am grateful for this opportunity to conduct research full-time as a doctoral student. I would also like to thank the people in the Educational Technology Unit, who allowed me to finish my thesis during spring 2006 without any other work duties.

I would also like to thank my family, my mother and father, and my friends for being there for me during these years. Especially I would like to thank my friend and colleague Anna Kouvo with whom I have had many refreshing lunch break discussions during the working days. These breaks have been important breathing breaks for me to get work issues out of my mind for a while.

This thesis would never have been possible without the extremely important assistance from and cooperation with my loving husband Lauri Nummenmaa. Lauri has been an extremely important personal supporter and encourager for me. Without Lauri I would never have reached this stage in my academic career. There are no words to express my gratitude to you, Lauri.

Finally, we have also been very lucky to have a lovely daughter, Kerttu with whom I have had a great opportunity to stay at home first in Turku and then for one year in

Cambridge since she was born. Although I was away for a while from academic work and my dissertation was delayed, there is nothing to compare with the great opportunity to be at home with you, Kerttu, and to see you growing up every day. You have reminded me and your daddy what the really important things in life are.

Cambridge, October 2007

Minna Nummenmaa

LIST OF ORIGINAL PUBLICATIONS

The dissertation is based on four original articles. The articles are referred to in the text by their Roman numerals.

I Vuorela[1], M. & Nummenmaa, L. (2004). How undergraduate students meet a new learning environment? Computers in Human Behavior, 20, 763-777.

II Vuorela[1], M. & Nummenmaa, L. (2004). Experienced Emotions, Emotion Regulation and Student Activity in a Web-Based Learning Environment. European Journal of Psychology of Education, 19(4), 423-436

III Nummenmaa, M., & Nummenmaa, L. (2007). University Students' Emotions, Interest and Activity in a Web-Based Learning Environment. In press, British Journal of Educational Psychology

IV Nummenmaa, M. & Nummenmaa, L. (2007). Emotional reactions in web-based versus face-to-face small-group learning situations. Submitted for publication.

[1] Formerly Vuorela, currently Nummenmaa

1 INTRODUCTION

Nowadays, learning situations are becoming increasingly complex, and students have to take more responsibility for their own learning. Especially technology-based learning environments increase the openness, choices and student control of the learning process, while trying to achieve more adaptive, collaborative and situational learning (Järvenoja & Järvelä, 2005). Despite the potential enhancements that results from the use of technology, the transition into a technology-based learning environment might also be challenging. Students and teachers feel more comfortable with traditional educational methods, and are often resistant to change. The change process is influenced not only by what the teachers do, but also by how the students perceive and interpret what is done (Hall & Hord, 2001). These varied interpretations can contribute to unintended effects, and affect the change process in a significant way (Hall & Hord, 2001). Each individual develops his or her own interpretations based on his or her past experiences. Thus, students' appropriate use of the technology may be limited due to their negative attitudes toward the instruction that is not consistent with their past experience (Shaw & Marlow, 1999; Åkerlind & Trevitt, 1999). Studies (e.g. Dewhurst, Macleod, & Norris, 2000; Monteith & Smith, 2001) have shown that although students' opinions on technology are generally positive, there is still overwhelming preference for face-to-face contact in lectures.

The learning environment also creates a context for a variety of emotional experiences that can potentially influence learning processes. Research on emotions in education has shown that students experience a rich variety of emotions in academic settings (Pekrun, Goetz, Titz, & Perry, 2002; Schutz & DeCuir, 2002). The experienced emotions do exert an influence on learning and achievement, and the effects are mediated by attention, self-regulation and motivation (Pekrun et al., 2002). Thus, emotions are an integral part of the learning process, as are cognition and motivation.

The importance of emotions in traditional face-to-face learning situations is widely accepted, but the impact of emotions on learning process in different computer-supported virtual learning environments has received less attention. With the exception of computer anxiety (e.g. Brosnan, 1998a, 1998b; Chua, Chen, & Wong, 1999), it seems that emotions experienced in technology-based environment have not yet been adequately analyzed. Learning situations in technology-based environments provide diverse causes of emotions, but the technology is not the only antecedent of experienced emotions. According to previous studies (e.g. Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005), emotions in computer-supported learning can also result from self, context, task or technology, and other people.

Most of the research on affective reactions in technology-based learning involves measuring learners' affective state by means of, for example, interviews or retrospective self-report questionnaires. In such measures, researchers often ask learners about their responses and feelings that have resulted from using such technologies for learning. However, emotional reactions are embedded in time. Thus, the validity of such

retrospective questionnaires can be questioned. To understand the role of the affective in learning in technology-based environments, we need more specific means to measure students' affective states during the learning process. Specifically, to examine emotions occurring during the online learning process we need online measures of the emotional reactions.

The aim of this thesis was to examine how the emotions that emerge during learning in a web-based learning environment (WBLE) affect different behaviour in such an environment. This aim can be further broken down into four subgoals. First, how computer self-efficacy and interests influence students' activities in a web-based learning environment? Second, how emotions experienced while using a WBLE and regulation of emotional reactions influence students' different activities in the WBLE? Third, what events cause emotional reactions when students use a WBLE? And fourth, are there differences in experienced emotions between face-to-face and web-based collaborative tasks? To answer these questions, we conducted a series of four independent studies in which we recorded and analyzed students' actions and emotional reactions while using a WBLE.

2 CONCEPTUAL FRAMEWORK OF THE STUDIES

2.1 Web-based learning environments

Currently, nearly all web-based learning environments provide facilities for open computer-mediated communication (CMC) that allows interaction with other students. CMC is widely used in web-based learning. Computer-mediated communication has diverse applications, ranging from text-based, audio-based or video-based communication, synchronous and asynchronous, to one-to-one, one-to-many and many-to-many communications. Of these applications, the enduring documentation of the learning activities is most prominent in the text-based communication.

CMC has also enabled an increasing use of collaborative learning through technology. The use of networks as a means for collaboration as a part of a learning process is continuously increasing, and students have to get accustomed to participating in collaborative activities in web-based learning environments (WBLE). The previous studies on the use of information and communication technology in education have more or less explicitly considered the possibilities to facilitate social interaction and collaboration among students via technology. The difficulties associated with defining collaborative learning are discussed in detail by Dillenbourg (1999). According to Dillenbourg (1999) numerous interpretations have been made of the broad definition of collaborative learning as "a situation in which two or more people learn or attempt to learn something together." First, 'two or more people' may be interpreted as a pair, a small group, a class or a larger community. Second, 'to learn something' may be interpreted as following a course, studying course material, performing learning activities and so on. Finally, the term 'together' may be interpreted as different forms of interaction such as face-to-face or computer-mediated, synchronous or asynchronous etc. (Dillenbourg, 1999). In this thesis collaborative learning is defined as an activities where a small group of students participate in joint learning activity, that is, perform together some learning task in computer-mediated asynchronous (studies I-III) or synchronous (Study IV) interaction.

Collaborative web-based learning environments can be studied as social environments (Kirschner, Strijbos, Kreijns, & Beers, 2004; Lehtinen, 2003) where students participate in a collective learning project and knowledge construction. Considering collaborative learning in a web-based learning environment, it can therefore be assumed that learning is associated with social activity, i.e. students' participation in group discussion activities in the environment, though this view does not imply that students do not also learn on their own while using the WBLE. The collaborative learning activities in a WBLE consist of, for example, writing and sharing texts and commenting on them. The results of such activities (i.e. the texts and comments published in the WBLE) are visible for all the students involved in the learning process. For example, when one student publishes his / her essay on the WBLE, other students can read the essay and subsequently post comments on it. Consequently, the author of the essay can read and evaluate the comments and make corrections to his / her work. As such actions leave visible marks on the WBLE, such a process gives the students an opportunity to appraise and assess the

behaviour of other students in the WBLE, and to use the WBLE as a means of collaboration.

Not all the students' learning-related activities in a WBLE are visible to the other members of the learning group, and these activities are typically not related to the collaborative learning. For example, when a student reads some other student's essay in the WBLE but does not publish a comment on it, the action can not exactly be considered as a collaborative activity, because it is invisible to the other students and does not result in learning-related social behaviour in the environment. Accordingly, a student can read and follow the discussions in the online learning groups very actively, but still prefer to stay in the background without participating in the discourse. Therefore other students may not consider such invisible behaviour in a WBLE as a collaborative activity.

As discussed above, it is important to distinguish between collaborative visible and non-collaborative invisible activities in the WBLE. However, it is worth noting that the non-collaborative invisible activities do not always mean total inactivity. These non-participating students do not constitute a homogenous group, and there are various definitions for what constitutes non-participation and invisibility in a WBLE. At least two subsets of non-participating students can be defined. Firstly there exists a group of students who neither participate in nor follow the discussions. Such students are usually defined as inactive students. Secondly, there are students who do not actively participate in the joint learning effort but visit the online environment frequently and spend a considerable time using the environment and following the discussions. Such students are usually called lurkers (Preece, Nonnecke, & Andrews, 2004).

Lurking in online learning groups is defined as a specific pattern of participation that utilizes the fact that students cannot see one another. The lurkers only take advantage of teacher's and other students' contributions, but do not themselves contribute to the learning of the group. Therefore, lurkers can sometimes be considered as free riders. The free rider effect develops when one or more group members expend a decreasing amount of effort on the group tasks, assuming that the job will be done mainly by the others (Salomon & Globerson, 1989), and the free riders often debilitate the group work (Salomon & Globerson, 1989). However, it is important to note that most of the lurkers are not free riders (Preece et al., 2004). There are many reasons why individuals might choose to lurk instead of participating actively in the web-based learning (Preece et al., 2004). These are, for example, a certain level of discomfort, unsatisfactory group dynamics, the need to get acquainted with the group, shyness, the will to remain anonymous, and a feeling that participation is not necessary (e.g. Beaudoin, 2002; Preece et al., 2004). Lurking can be seen as a negative behaviour that can debilitate communities' existence, but on the contrary, lurking can also be considered as a way of getting to know the group and the learning community and becoming an integral part of it.

Lurking may or may not be a problem in online learning communities depending on the perspective from which this behaviour is judged by other students. If a considerable number of students participate in the online learning actively, then having some lurkers

may not deteriorate the collaboration. But if the online discussion is not active - especially in the beginning of the course - lurking can debilitate the development of an effective online learning community, as nobody wants to be a part of an inactive group. However, there is also evidence that lurkers seem to be more similar to active participants than to inactive ones concerning participation in e-learning (Eunok, 2003).

Although it is not known whether or not the lurkers are engaged in the learning process and actually learning while not actively involved in the discourse in a WBLE, there is evidence that these non-participating students actually spend time on other, non-collaborative learning-related tasks, and feel that they are learning and benefiting from their non-visible participation similarly as are the participating students (Beaudoin, 2002). However, recent evidence suggests that a high level of visible collaborative activities in a WBLE is positively associated with the course grade (Beaudoin, 2002) implying that the inactive students might not actually be learning as effectively as the active ones.

Two conclusions can therefore be drawn from the studies reviewed above. First, visible and invisible behaviour in the WBLE have different causes and consequences for students' learning. Thus, when studying the student behaviour in a WBLE, a distinction must be made between the collaborative visible and the non-collaborative invisible behaviours. Second, the reasons for lurking and non-participation presented above can be divided into two broad but distinct categories: i) affective reactions resulting from the web-based activities and ii) participants' will and interest to use the online groups as tools for knowledge construction. Hence, when studying students' activities in a WBLE one must try to assess simultaneously how these different factors exert influence on the visible and invisible behaviours in the web-based learning environment to be able to predict why some students participate or do not participate in the joint learning effort.

2.2 Emotions and their regulation

Emotions are fundamental to human behaviour and interaction as they motivate activity (Izard & Ackerman, 2000). In their daily interactions with others, most people interpret and anticipate each other's emotions and emotional responses, and seek to modify them. Emotions occur when individuals encounter situations that have affective properties (Lang, Bradley, & Cuthbert, 1998). The perception and appraisal of the affective properties lead to changes in individuals' action tendencies, i.e. the probabilities of taking different actions in the environment (Frijda, 1986; Lazarus, 1991; Scherer, 1999). Emotion is a multidimensional change in individuals' cognitive, social and physiological activity (Cacioppo & Gardner, 1999; Levenson, 1999) that guides their actions in the environment. The emotions people experience or expect to experience in certain situations also affect their motivation (Atkinson, 1957) and perceived capabilities to perform various tasks (Bandura, 1997).

There are numerous schemes for classifying emotional responses into discrete categories, ranging from definitions based solely on behaviour to diverse social emotions (see

Adolphs, 2002 for discussion). The emotions can also be described as regions in a two-dimensional space defined by valence and arousal dimensions (Lang, 1995; Russell, 1980). This view was employed in the current study, as it describes emotions in terms of specific motivational systems (Lang, 1995) which are relevant to the aims of the study. The valence of an event or stimulus depicts the perceived pleasantness or unpleasantness of the event. Arousal, sometimes called also activity or activation (Russell & Carroll, 1999) reflects the intensity of such an emotional reaction, ranging from calm to excited. The so-called basic emotions, happiness, surprise, fear, anger, disgust and sadness (e.g. Ekman, Friesen, O'Sullivan, & Chan, 1987; Yamada, 1993), and many other commonly named emotions can be positioned along the valence-arousal dimensions (Russell & Carroll, 1999; Russell, 1980). Both pleasant (positive) and unpleasant (negative) emotions vary in their level of arousal (Russell & Carroll, 1999). For example, the negative emotion, sadness has a low arousal level, whereas the positive emotion, happiness has a high arousal level (see Figure 1). Thus, any of the emotion words can be defined as some combination of the valence and arousal components.

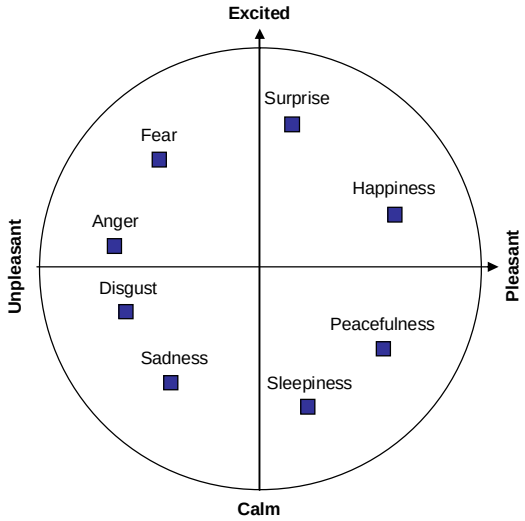

Figure 1. A two-dimensional bipolar model of affect (adapted from Russell, 1980).

However, not all emotions facilitate effective functioning. As emotions occur due to the properties of the physical and social setting, individuals' affective reactions can sometimes conflict with their goals and well-being. For example, long-lasting negative emotions are hazardous to health (Suinn, 2001), interpersonal relations, and learning and work performance (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001; Gallo & Matthews, 2003; Kiecolt-Glaser & Newton, 2001). Individuals, however, have an ability to manage their own emotionality, and such regulatory processes can dampen the effects of emotions that do not facilitate achieving their current goals. Emotion regulation refers to the actions with which individuals can affect what emotions they experience, how and when they experience them, and how they express them to others (Gross, 1998b). Emotion regulation is an everyday process and it is important for effective functioning (Gross & John, 2003; Morris & Reilly, 1987), and recent studies have provided evidence that effective emotional regulation is an important mediator of

academic success (Grazianoa, Reaves, Keane & Calkins, 2006). Recently, many studies have focused on the consequences of two emotion regulation strategies: cognitive reappraisal and expressive suppression (Gross & Levenson, 1993; Gross, 1998a; Gross, 2002; Gross & John, 2003). Cognitive reappraisal is an antecedent-focused strategy, which is used before an emotion is elicited. It refers to active cognitive reinterpretation of the situation that can potentially elicit emotions. By contrast, expressive suppression is a response-focused strategy, which is used to modulate emotions that have already been elicited. Thus, suppression refers to the actions people take to mask their emotional expressions.

The strategies an individual uses for emotion regulation have different consequences on physiological, experiential, and behavioural components of emotion. In a series of laboratory experiments, it has been demonstrated that using both reappraisal and suppression decrease behavioural expression of emotions, but using only reappraisal decreases the intensity of the experienced emotions (Gross & Levenson, 1993; Gross, 1998a). Moreover, using suppression leads to increases in cardiovascular activity whereas reappraisal does not (Gross, 1998a). Furthermore, while reappraisal has no impact on long-term memory, suppression impairs it (Richards & Gross, 2000). It has also been shown that individuals differ in their use of these two emotion regulation strategies, and that using suppression as the dominant strategy has a negative impact on interpersonal functioning and well-being (Gross & John, 2003). Therefore, it can be argued that emotion regulation skills and strategies are important factors of effective functioning, because negative emotions are disadvantageous, for example, in many achievement situations as they can increase avoidance behaviour.

2.3 Emotions in the learning process

The learning situation creates a context for a variety of emotional experiences that have the potential to influence learning processes. Though the psychological literature regarding, for example, the six basic emotions is extensive (see Ekman, 1999), one tends to get the impression that anxiety is the only emotion that can occur in learning situations (Pekrun et al., 2002, Pekrun, 2005). For example, previous studies on students' emotional reactions in academic settings have mostly focused on test anxiety (Pekrun et al., 2002). The term, test anxiety, refers to the set of physiological and behavioural responses that include concern about the possible negative consequences of or poor performance on an exam or other evaluative situation (Zeidner, 1998). Many studies have investigated the relationship between test anxiety and different kinds of performance, and it has been found that test anxiety impairs cognitive performance (see Zeidner, 1998 for a review).

Most theories on anxiety have drawn a distinction between trait and state anxiety (Eysenck, 1992). Trait anxiety is a relatively stable personality dimension, whereas state anxiety, e.g. the above-mentioned test anxiety, is a situational, subjective emotional state (Eysenck, 1992; Spielberger, Gorsuch, & Lushene, 1970). Very high levels of state anxiety can cause impairment in virtually all aspects of performance (Eysenck, 1992; Eysenck & Calvo, 1992). State anxiety often occurs in response to environmental stimuli

or situations (Eysenck, 1992). Therefore, the effects of state anxiety on learning have been extensively studied. In addition of test anxiety, other forms of state anxiety, e.g. mathematics anxiety (e.g. Townsend, Moore, Tuck, & Wilton, 1998) and statistics anxiety (e.g. Birenbaum & Eylath, 1994) have also been studied in specific learning situations.

Although anxiety impairs cognitive performance (Eysenck, 1992), the effects are not necessarily direct (Bandura, 1997). A number of recent studies have demonstrated that both the anxiety experienced in a learning situation and the individual's perceived capabilities to perform the learning task affect learning, but that the effects of anxiety are mediated by the perceived capabilities (Chen, Gully, Whiteman, & Kilcullen, 2000; Compeau, Higgins, & Huff, 1999; Pajares, 1996). For example, anxiety has the most extensive influence on learning when an individual is uncertain of his/her own capabilities (Pajares, 1996). Therefore, the effects of anxiety or other negative emotions on learning are not deterministic: a number of other factors also influence how these emotions affect the learning process.

In addition to anxiety, students experience a wide range of other emotions in academic settings (Pekrun et al., 2002; Pekrun, 2005; Schutz & DeCuir, 2002). Emotions exert an influence on, for example, attention, memory and decision making (Cacioppo & Gardner, 1999), all of which are important in the learning process. Accordingly, it is not surprising that the emotions experienced while studying are related to students' learning and achievement (Pekrun et al., 2002). The effects of emotions on learning are mediated by self-regulation and motivation (Pekrun et al., 2002), and both positive and negative emotions influence learning. Anxiety usually impairs cognitive performance (Zeidner, 1998) but also other negative emotions (e.g. boredom, hopelessness) correlate negatively with interest and effort, whereas positive emotions (e.g. enjoyment, hope) correlate positively with these motivational variables (Pekrun et al., 2002). Moreover, positive emotions promote exploration and enjoyment of new ideas and new ways of looking other things, and facilitate creative problem solving (Isen, 2004), which could be hypothesized to promote an efficient learning process. Therefore, well designed learning environments should also promote experience of positive emotions, and attenuate the experience of task-irrelevant negative emotions resulting from learning.

Emotions also influence communication in collaborative learning settings. They facilitate coordination of social interaction through their informative functions, and the possibility of expressing emotions is an important element in interaction and communication between individuals (Keltner & Kring, 1998). As Bandura (1986) has pointed out, the ability to read the signs of emotions in social interaction has an important adaptive value in guiding one's actions toward others. Because learning often occurs in social situations and through interaction between the learners, it can therefore be hypothesized that emotional expression also enhances interaction and group performance in social learning situations. The significance of emotional communication in groups is further highlighted by studies showing that emotions are contagious, i.e. the sender's affective state is often likely to cause a similar emotional response in the perceiver (Hatfield, Cacioppo, & Rapson, 1994; Hess & Blairy, 2001; Wild, Erb, Eyb, Bartels, & Grodd, 2003), and even

very subtle facial expressions can exert an influence on the perceiver's affective state (Surakka & Hietanen, 1998).

2.3.1 Measuring emotions occurring during the learning process

A number of instruments have been devised to measure emotions related to learning. These methods can be divided into two categories (Wosnitza & Volet, 2005): i) measurements immediately before and / or after the learning process, and ii) measurements during the learning process. The Academic Emotions Questionnaire (AEQ) (Pekrun et al., 2002), the Computer Anxiety and Learning Measure (CALM) (McInerney, Marsh, & McInerney, 1999) and the test anxiety scale in the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, D. A. F., Garcia, & Mckeachie, 1993) are designed to measure emotions before and/or after the learning process. Stimulated recall measurements are also used to study students' emotions after the learning process (Wosnitza & Volet, 2005). These types of measurement focus on studying the individual differences in retrospectively self-reported emotions. In Study I, we also applied such a method by measuring students' computer anxiety before and after the learning process (see Section 3.2) with a scale specifically developed for this purpose

However, memory-based reports of emotions must be distinguished from on-line reports. People often report different emotions when they are experiencing them than when they are recalling or predicting experiencing them. This discrepancy occurs because the responder may, for example, be unable to retrieve the resulted or predict the resulting affective reaction (Robinson & Clore, 2002). Any delay between an experienced emotion and its report can lead to less accurate information. This is why these types of measurements providing information only on students' anticipated or reflected emotions at the end of the learning process cannot yield a reliable index of emotions as they occur during the learning.

One method for accessing emotions during the learning process is the observation of facial expressions of emotions. The use of facial expression for measuring people's emotions has dominated psychology since the late 1960s, based on the theory of a tight linkage between emotional reactions and their prototypical facial expressions (see, e.g. Ekman, 1999) Ekman and Friesen (1978) developed the Facial Action Coding System (FACS), which was the first, and still mostly used, comprehensive technique for scoring observable facial movements. This method is available for researchers, for example, through a video recording during the learning process, thus giving on-line access to the emotions occurring during learning. In similar vein, it is also possible to use facial electromyography (EMG) to measure the electrical activity of the facial muscles prototypically linked to specific emotional states (e.g Dimberg, 1990). Albeit popular in experimental psychology, neither of these methods is commonly used in the field of education for measuring emotions during the learning process.

The availability of students' text-based verbal interactions in online learning environments has provided new opportunities for research on emotions during the

learning process. Therefore, content analysis (see, e.g. Chi, 1997) has become a widely used approach for accessing emotions, especially in online learning environments (Wosnitza & Volet, 2005). Also the use of emoticons ('smileys' like J) has been studied in online environments (e.g. Derks, Bos, & Grumbkow, in press). The limitation of these approaches is that researcher could only observe the emotions that participants were willing to make public to the other students using the environment, thus social desirability effects in emotion expression may confound the results. However, a major benefit of the content analysis is that it can be performed after the learning situation has occurred, and therefore does not interfere with the learning process.

Another possible method to access emotions during the learning process is the experience-sampling/time-sampling method (Wosnitza & Volet, 2005), which was also implemented in our studies. Such a method typically includes very short questionnaires which are presented to students on several occasions during the learning process. Examples of such short questionnaires are the Self-Assessment Manikin (SAM) (Bradley & Lang, 1994), which was used in our studies (see Section 3.2) and the Positive and Negative Affect Schedule (PANAS) (Watson & Clark, 1988). A major benefit of these methods is that they provide access to the range of emotions during the learning compared with methods measuring emotions only beginning and/or after the learning process. Additionally, being self-reports, they are very convenient to gather from large student samples. However, compared to measurements before/after the learning process, the major limitation of time-sampling methods is that they might interrupt the learning process. Because the main interest in our studies was on examining emotions experienced especially during the learning process in a WBLE, we decided to implement this kind of method in studies II-IV (see Section 3.2).

2.4 Emotions and technology

Although emotions are important determinants of individuals' actions, little attention has been paid to the affective causes and consequences of the users' behaviour in computer-based environments. Most of the previous studies on affective processes and computer-related performance have focused on computer anxiety (e.g. Beckers & Schmidt, 2003; Brosnan, 1998a, 1998b; Chua et al., 1999; Wilfong, in press). Although emotions and computers have been widely studied in the field of human-computer interaction, these studies have mainly focused on the relationship between the users and the computers. Recent studies have, for example, examined how computers can be programmed to recognize and respond to users' emotions (Picard, 2000). However, many web-based learning environments are also used to mediate the interaction between users, and emotions can arise also from other sources than technology.

2.4.1 Anxiety in computer-using situation

Most theories on anxiety have drawn a distinction between trait and state anxiety (Eysenck, 1992). Computer anxiety can be considered to be a specific example of state

anxiety (Eysenck, 1992; Spielberger et al., 1970), which occurs at the time of computer use or at the time of imagined future computer use, and not inherently a personality trait (Chua et al., 1999). In this study, anxiety in a computer-using situation is defined as a subjective emotional state with perceived feelings of tension and apprehension (Spielberger et al., 1970) resulting from working with computers.

Anxiety should be distinguished from negative attitudes towards computers. Computer attitudes consist of people's feelings about the impact of computers on their daily life and their understanding of computers, whereas anxiety involves more affective response, such as worries, apprehensions and tensions (Spielberger et al., 1970). Sometimes anxieties in a computer-using situation and techno- or computerphobia are used as synonyms, or the factors of computer anxiety and computer attitude are combined to indicate computerphobia (Brosnan, 1998a). However, because the term phobia usually refers to a clinically diagnosed mental disorder (ICD-10, 1992), it is not reasonable to use such a term when describing relatively weak affective reactions resulting from using a computer.

In the 1990s, it was estimated that one-third of individuals among different populations of the industrial world experienced some level of computer anxiety, varying from avoiding computers at all costs to minor stress (Brosnan, 1998a). Even though nowadays technology is everywhere and these figures may not be so dramatic, the computers still very often seem to be perceived as threatening and to produce anxiety at least to some extent. Although most undergraduate students have some experience with computers, not all students feel comfortable with using computers for studying. It has been found that gaining more computer experience lowers the level of computer anxiety (e.g. Beckers & Schmidt, 2003; Chua et al., 1999; Wilfong, in press). However, it is still not clear whether the experiences with computers have only positive consequences and result in a lower level of anxiety (Brosnan, 1998a). Furthermore, anxiety often occurs in situations where one is learning something new, which causes resistance to change, and also has negative effects on cognitive performance (Eysenck, 1992; Häkkinen, 1995). Because learning situations involving computers - especially the web-based learning environments - could still be novel to some students', it can be hypothesized that such novelty can create anxiety for at least some students. Further, a high level of computer anxiety is negatively associated with an individual's performance outcome (Brosnan, 1998b). Previous studies also suggest that anxiety in computer-using situations can also hinder users' performance because they evaluate their own computer skills to be insufficient (Beckers, Rikers, & Schmidt, 2006; Rozell & Gardner, 2000; Smith & Caputi, 2001). Therefore, although not be many people may experience high levels of computer anxiety, the impact of anxiety on individuals' behaviour cannot be totally ignored.

2.4.2 Emotions in web-based learning environments

Computers are, however, also used to mediate interactions between people. This is especially evident when using web-based learning environments for collaborative purposes. Therefore, individual differences in students' affective reactivity toward computers or the web might not be a sufficient predictor of their actions in such

environments. Other antecedents of students' emotions such as interactions between them should also be considered in research.

Making learning tasks more collaborative and increasing the use of web-based learning environments increase the complexity of learning situations. For a learner, a learning situation is not merely a mental performance, but also an emotional coping situation. According to previous studies (e.g. Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005), emotions in computer-supported learning could be derived from self, context, task or technology and other people. Hence, the computer anxiety discussed above is not a sufficient factor when studying students' emotions in web-based learning environments. Further, in a web-based learning context, the dynamics of emotional state are less visible than in traditional face-to-face learning, but can nevertheless influence students' learning.

It is evident that all the affective reactions occurring while using a WBLE are not conducive to successful performance. Although emotions are usually adaptive reactions, they can also hinder performance. Negative emotions such as anxiety, frustration, or anger, have disadvantageous consequences for an individual's adaptation and well being in many situations (Suinn, 2001). Negative emotions often occur in situations where one is learning something new (Eysenck, 1992). Although the use of technology in education has increased remarkably in recent years, in most cases in which a WBLE is implemented, the learning situation still presents the students with new elements. It is obvious that one should consider the effects of negative emotions experienced while using a WBLE. Further, negative emotions often occur in situations in which people experience events that conflict with their goals and needs (see, e.g. Nummenmaa & Niemi, 2004), and it is known that the learning situation in a WBLE creates many potential conflicts with students' learning goals and needs.

Wosnitza and Volet (2005) distinguish between solo and social situations in online learning. According to them, the emotions elicited in the context of working alone with computer-based learning software are typically directed at the self, the task or the technology or the learning environment. Equally, the emotions elicited in social online learning situations tend to be self, task and technology-directed, while the social situation can also elicit emotions that are directed at other students (Wosnitza & Volet, 2005). Web-based learning environments can therefore be studied as a technical environment, because using them involves an interaction process between an individual and technology. The degree to which a WBLE as a technical environment answers students' needs and expectations has an influence on their emotional state (Brave & Nass, 2002). How students feel about the environment and technology can be hypothesized to determine the amount of attention they allocate to their learning activities. For example, an impractical environment or unstable technology could distract attention, cause frustration, and disturb the users (Brave & Nass, 2002; Picard, 2000). Previous research (Wosnitza & Volet, 2005) has shown that students' self-reported emotions directed at the technology are usually negative during the process of learning, and they experienced relief that the technology had not created problems after the learning, rather than positive emotions toward the technology.

Using a web-based learning environment is in many cases an interaction process between the students working in the environment, and it can also be studied as a social environment or a learner community (Henri & Pudelko, 2003), where students participate in a collective learning project and knowledge construction. Because different social situations are likely to elicit emotions (Frijda, 1986), it can be presumed that the affective reactions occurring while using the environment for collaborative purposes may not result only from the computer using, but also from the interactions between the individuals in the environment. These other-directed emotions can be generated by one student and directed at another student in the group to which the student belongs, or at another group (Wosnitza & Volet, 2005). However, in a WBLE, the presence of other students is not always as perceivable as it is in a face-to-face communication. Although there is evidence that social presence influences students' interactions also in on-line learning environments (Tu & McIsaac, 2002) and elicits emotions (Wosnitza & Volet, 2005), it is not known whether the interactions in computer-mediated communications result in affective reactions similarly as in traditional face-to-face interactions. Therefore one of the aims of this thesis was to assess the similarities and differences in students' affective reactions in face-to-face and web-based group work.

It can also be hypothesized that emotion regulation is important for effective functioning in web-based learning environments. For example, users can direct their attention away from a negative emotion-eliciting stimulus such as unstable technology, and actively try to ignore the cause of the frustration, while instead trying to focus more intensively on the relevant aspects of the learning activity. Positive emotions may also sometimes require regulation. For example, the charm of novelty could cause positive emotions in web-based learning environments, but lead to inappropriate learning activity if users direct their attention only to the interesting aspects of the novel technical environment. Further, effective emotion regulation can enhance social interactions (Gross & John, 2003). As the social presence is a vital element influencing students' interaction in a virtual environment (Tu & McIsaac, 2002), skilful emotion regulation can be hypothesized to be beneficial for the interactions of the individuals while collaborating in a WBLE.

2.4.3 Expression of emotions through technology

People express their emotional states via numerous channels. These consist of, among others, interpersonal distance, body movements, facial movements (i.e. facial expressions), intonation, and prosody. The role of emotional expression was already emphasized by Darwin (1872), who postulated that expressions of emotions evolved to facilitate interaction among members of the same species. Expressions of emotions can be considered as aspects of emotional response and social communication (Darwin, 1872; Fridlund, 1994; Russell, Bachorowski, & Fernández-Dols, 2003), though it has also been argued that emotion displays are inherently informative about how a situation is perceived by the sender (Hess & Kirouac, 2004). At all education levels, learning often occurs in social interaction between students. Nowadays this interaction occurs not only in face-to-face group meetings and in lectures, but also via different communication

media, e.g. videoconferencing and web discussion groups. Interaction between individuals in these communication media differs in terms of the richness of emotional information that can be transmitted.

Fischer (in press) suggests that expressing emotions in text-based computer-mediated communication is different from face-to-face communication for two reasons. Firstly, because all information exchange must be typed, computer-mediated communication is slower and less spontaneous than face-to-face communication. Secondly, emotions cannot be expressed by nonverbal means. Face-to-face communication is the richest form of social interaction because it provides opportunities for displaying both verbal and nonverbal expressions of emotions such as facial, postural, and gestural cues, as well as tone of voice. When compared to face-to-face interaction, communication by telephone is less rich in terms of emotional expressivity, because it does not allow individuals to express emotions with nonverbal signals. This lack of means for emotional expression has been shown to exert an influence on communication between individuals. Drolet and Morris (2000) found that participants who communicated in face-to-face conversation expressed a higher degree of rapport and more positive affect than those who communicated by telephone. On the contrary, video-mediated communication provides much more versatile possibilities for expressing emotions, which makes communication via such media more comparable to face-to-face discussion. Accordingly, a recent study by Van der Kleij, Paashuis and Schraagen (2005), found no differences in the satisfaction between participants performing a complex object-centric team task (folding Japanese origami figures) in a face-to-face or a video-mediated communication situation.

In spite of the advantages of video-mediated communication, the use of videoconferencing as a means of small-group communication in education is rare. Most courses organized via e-learning tools use asynchronous or synchronous text-based tools through various web-based learning environments for mediating communication among the members of a learning group. As the use of such environments as tools for learning is constantly increasing, it is therefore crucial to assess whether students find these environments as satisfactory means for learning and communicating. A recent meta-analysis comparing the student satisfaction between different learning environments demonstrated that learners participating in courses employing text-based computer-mediated learning are in general less satisfied than those in face-to-face groups (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). Though the dissatisfaction might be due to, for example, dissatisfaction with the technology itself, the role of emotions in human communication provides an alternative explanation for the dissatisfaction in computer-mediated learning. Namely, the text-based learning environments allow individuals to express their own emotions and perceive the senders' emotional state only by means of semantics of the text. What is more, when communicating in a WBLE, the participant’s emotional state is revealed to the other learners only when he / she is prepared to disclose it. This suggests that learning via web-based communication could be considered as a less emotional learning environment than a face-to-face learning group, and further, that the lack of emotionality in computer-mediated interaction could be hypothesized to be an antecedent of dissatisfaction towards the web-based learning.

2.5 The role of interest in web-based learning

Certain emotional behaviours appear to emerge spontaneously, not elicited by changes in the environment but rather emerging from the previously existing readiness or motives of the individual (Frijda, 1986, 42). Whereas emotions mainly modulate courses of action that have already started (Frijda, 1986, p460), interest in a specific action can readily exist before the action is taken. Interest is a relatively transient psychological state including focused attention, increased cognitive functioning, persistence, and affective involvement (e.g. Krapp, Hidi, & Renninger, 1992). In contrast to many other motivational concepts, interest is characterized by its content or subject specificity. Interest determines how individuals attend, select, and persist in processing certain types of information in preference to others (Hidi, 1990).

There are two types of interest: individual and situational. Individual interest is a relatively stable motivational orientation or personal disposition to attend to certain objects and events, engage in certain activities, and experience positive affects during the engagement (e.g. Ainley et al., 2002; Krapp et al., 1992; Krapp, 1999). The state of interest can also result from a specific stimulus in the environment. This is referred to as situational interest (e.g. Ainley et al., 2002; Krapp et al., 1992; Krapp, 1999). Situational interest can be elicited not only by specific stimulus characteristics, but by a very specific content, which implies that it may last longer than simple arousal and may develop into a relatively enduring individual interest (Hidi, 1990; Hidi & Anderson, 1992; Krapp et al., 1992).

Interest is conceptualized as a specific kind of "person-object relationship". Under certain conditions, an individual can develop a close relationship toward a certain object of his/her environment (Krapp et al., 1992; Krapp, 1999) which will increase the likelihood that he / she will experience interest in the object. This tendency to experience interest in a certain activity or topic has a strong influence on cognitive and affective functioning, persistence, and effort (Ainley, Hidi, & Berndorff, 2002; Schiefele et al., 1992). Such an object of interest in a WBLE could be, for example, the course topic or the concept of studying in an online learning environment. As interest is an important determinant of academic motivation and learning (Schiefele et al., 1992) and it is associated with experience of positive affects (e.g. Ainley et al., 2002; Krapp et al., 1992), students' interest in the course topic and the web-based learning can be hypothesized to have an effect on their activities and emotional state in a WBLE.

Researchers are not unanimous about whether interest should be regarded as an emotion, or as being comprised of component structures, including both an emotional and a non-emotional component. While most emotion theorists do not consider interest either as a basic emotion or as a more complex social emotion (e.g. Adolphs, 2002), some researchers (see Fredrickson, 1998; Izard & Ackerman, 2000; Silvia, 2001) conceive of interest as an emotion associated with curiosity, exploration and information-seeking. It has been suggested that if strong negative emotions are not experienced, individuals experience at least some degree of interest (Silvia, 2001). Hence, some researchers classify interest as a positive emotion (e.g. Fredrickson, 1998). Although the affective

reactions associated with interest tend to be positive, interest should be distinguished from positive affects such as happiness or enjoyment (Reeve, 1989; Silvia, 2001), as feelings of enjoyment and interest have different antecedents (Reeve, 1989). For example, a feeling of interest while performing some task usually results from a feature of a task stimulus, e.g. novelty or complexity, whereas enjoyment results from good performance of the task (Reeve, 1989). Therefore, students can be interested in participating in a collaborative learning discussion in a WBLE, while at the same time, they may or may not feel enjoyment in the successful discussion.

Whether interest is perceived as an emotion or not, it is accepted that interest has both motivational and goal-related components, particularly for learning, exploration, and information-seeking (e.g. Fredrickson, 1998; Izard & Ackerman, 2000; Krapp, 1999; Schiefele, Krapp, & Winteler, 1992; Silvia, 2001). Curiosity about the new possibilities broadens individuals' experiences, and subsequently, supports the possibility to promote the continuous development of knowledge and skills (Fredrickson, 1998; Silvia, 2001).

Individuals are often more interested in things that they already know about. Therefore, students who have previous experience of learning in a WBLE or the course topic might be more interested in them before the course than students who lack such experience. However, direct experience with a previously unfamiliar topic, content or situation can also result in development of interest in that topic (Hidi, 1990; Hidi & Anderson, 1992). Although direct experience with the situation is not necessary for the development of interest, awareness of or exposure to the situation is necessary (Bergin, 1999). Such situational interest also directs learning (Hidi, 1990; Hidi & Anderson, 1992), and is therefore important in courses organized through a WBLE when students have previous experience neither about the course topic nor the web-based learning. In other words, the course organized in a WBLE must be designed in such a way that it will result in increased interest in the web-based learning.

2.6 Efficacy beliefs and web-based learning

Interest, however, is not the only factor that affects peoples' tendencies to take different courses of action. The individual's perceived capabilities of performing different tasks have emerged as effective predictors of people's motivation and performance. Bandura (1982, 1997) defines self-efficacy as personal judgments of one's capabilities to organize and execute certain courses of action. Self-efficacy beliefs influence motivational and self-regulatory processes in several ways. They influence the choices people make and the effort they expend on an activity. Efficacy beliefs also influence how long people persist in the face of failure or other obstacles. Thus, the higher are the beliefs of personal competence, the greater the effort and persistence. Self-efficacy beliefs also influence the nature and intensity of emotional experiences (Bandura, 1997). Anxiety, for example, has the most extensive influence on learning when the individual is uncertain of his own capabilities (Pajares, 1996). Generally individuals' high self-efficacy about their ability to manage certain tasks decreases stress and anxiety (Bandura, 1997). Therefore, efficacy

beliefs can also be regarded as modulators of emotional experiences caused by managing different tasks.

Efficacy beliefs are context-, task- and domain-specific assessments of personal competence (Bandura, 2001), and there is no such thing as “general” self-efficacy. In this study, we measured students’ efficacy in computer-using situations. Computer self-efficacy refers to a person’s judgment of his or her capability to use a computer in prospective situations (Compeau & Higgins, 1995). Therefore, high computer self-efficacy can increase the likelihood that individuals will use computers, and successful interaction with the computer can have a positive influence on their self-efficacy. Typically, individuals tend to prefer activities for which they have capabilities (Bandura, 1982, 1997). Agarwal, Sambamurthy and Stair (2000) demonstrated that many factors such as previous experience with computers and support influence the development of computer self-efficacy. Further, the computer self-efficacy affects how willing people are to use previously unfamiliar technologies, as well as their attitudes towards technology. Accordingly, it could be hypothesized that students’ high computer self-efficacy would have a positive influence on their motivation to use a web-based learning environment and to participate to computer-mediated communication.

3 METHODS USED IN THE STUDIES

3.1 The learning environment

All the courses in Studies I-III and the web-based discussion in Study IV were organized through a web-based learning environment called WorkMates. WorkMates is a web-based collaborative learning environment developed in the Educational Technology Unit in the University of Turku in Finland. WorkMates provides a technical structure and environment for learning, and can be adapted to a wide variety of courses and contents. Access to a course work area is restricted to the teacher and the students enrolled in the course. WorkMates supports collaborative group work through the web by means of asynchronous text-based commentary and discussions. It enables students to share, view, and modify files, communicate, and comment on each other's work electronically. The user interface of the WorkMates environment is very simple and using it does not need any special computer-using skills. Using WorkMates is easy even for students with only basic computer-using skills.

3.2 Participants and measures in the studies

Altogether 266 students volunteered to participate in the four independent studies. The participants were Finnish undergraduate students from different university courses organized through the WorkMates web-based learning environment. Participants majored in different university subjects. Table 1 summarizes the measures employed in studies I-IV. Depending on the study, the participants completed various questionnaire measures before, during and after the courses, and on-line measures during the courses. Participants' behaviour in the WBLE was also analyzed.

Table 1. Measures employed in Studies I-IV

	Number of participants	*Questionnaire measures*	*On-line measures*	*WBLE behaviour analysis*
Study I	42	Computer anxiety Computer self-efficacy		Visible activity
Study II	104	Emotion regulation Computer self-efficacy	SAM (valence and arousal)	Visible activity
Study III	99	Web interest Course interest	SAM (valence and arousal)	Visible activity Invisible activity Lurking
Study IV	21	Web interest Group interest	SAM (valence and arousal)	Achievement

Study I

Anxiety in computer-using situations is usually measured through self-assessments with Likert-type scales. These scales typically contain positive and negative statements (e.g. "computers make me nervous" or "computers are fascinating") where respondents endorse a response from strongly agree to strongly disagree. However, such scales cannot be considered very valid instruments for assessing state anxiety, if the content of the items covers concepts that are unrelated to anxiety-related feelings and physiological states. Instead of using these existing scales, a new scale for measuring computer-related state anxiety was constructed for the purpose of Study I. In the scale participants were asked to rate how much they would experience anxiety-related feelings and sensations (such as nervousness and uneasiness; see Eysenck & Calvo, 1992) in different kinds of computer-related situations (e.g. "I am writing an e-mail", "I am alone in a computer lab, and the computer crashes out", "I am searching information from the www")

Computer self-efficacy was measured with the Finnish version of the Computer Self-Efficacy Scale (Compeau & Higgins, 1995). The scale consisted of ten items that measured level, strength and generality (Bandura, 1997; Compeau & Higgins, 1995) of computer self-efficacy. Participants were asked to evaluate on a scale ranging from not at all confident (0) to totally confident (10) how confident they felt about performing the behaviours described in the questionnaire. Questionnaire items were task-specific, varied in difficulty and captured varying degrees of confidence (e.g. "I can cope with a given assignment even if I have not used the program before" or "if I can get help when needed").

Analysis of the *visible activities* in WorkMates was based on the archived comments in the students' discussions and was done off-line after the courses. Because our main interest was to analyze and model students' learning-related activities in the WBLE, we did not use, for example, a text-based content analysis method for data analysis. However, we did not want to ignore the content of the students' discussions. The total number of students' comments in a WBLE can be regarded as an insufficient indicator of learning activities, because it lacks information about the *type* of the activities. For example, one student could write 20 comments including just a couple of words such as "I Agree", "That sounds good" etc. On the other hand, another student could write much fewer comments, but with more profound ideas. Hence, if we would have used only the number of students' comments in analyzing their learning activities, we could have ended up with a misrepresentation of their learning activities. As there was no pre-existing appropriate scheme for encoding student's comments, we developed a novel method (Vuorela & Nummenmaa, 2004) for classifying students' activities in discussions, which also takes into account the versatility of the comments.

Two researchers classified the participants' comments into six types according to their content: (1) proposing or suggesting, (2) supporting or agreeing, (3) opposing or disagreeing, (4) information giving, (5) inquiring, and (6) answering or specifying. Content classes used in the classification were developed for the purpose of this study on

the basis of contents of the discussions. As the number of content classes in a comment can be assumed to index how elaborate the comment is, we computed how many content classes each note included. Subsequently, we constructed the total visible activities score by weighting the number of the notes with the number of contents in the notes. This measure reflects both the activity in writing the notes and the versatility of the contents in the notes. However, it should be noted that the visible activities merely index how often and how much the students participate in the collaborative learning process; it does not measure how great an impact a single student has on the learning task.

Study II

Previous studies (including Study I of this thesis) have mainly focused on studying the effects of self-reported individual differences in affective reactivity, mainly computer anxiety (see e.g. Gaudron & Vignoli, 2002) instead of differences in actual affective reactions occurring while using a WBLE. However, memory-based reports of affective reactions are bound to be less reliable than on-line reports (see Section 2.3.1). Moreover, web-based learning environments are often used to mediate interactions between people. This is especially evident when using online environments for collaborative purposes. Therefore, individual differences in users' affective reactivity toward computers (such as computer anxiety) might not sufficiently predict their activities in such learning environments. Other antecedents of users' emotions should also be considered in research. Therefore, for Study II, we implemented an experience-sampling/time-sampling method for repeatedly measuring other emotions than computer anxiety during the use of a WBLE.

Emotional reactions were measured with valence (i.e. pleasantness / unpleasantness) and arousal (i.e. activation / deactivation) dimensions of the Self-Assessment Manikin (SAM, see Bradley & Lang, 1994). In this instrument, a graphic human figure depicting the values of the measured dimension on a continuously varying scale is used to indicate emotional reactions (Figure 2). The human figure ranges from a smiling happy figure to a frowning unhappy figure when depicting the valence dimension, and from an excited, wide-eyed figure to a relaxed, sleepy figure when depicting the arousal dimension (Bradley & Lang, 1994).

In Study II, the html-formatted on-line SAM questionnaire was presented automatically to participants each time they logged out from WorkMates. Participants were instructed to complete the questionnaire each time they encountered it. In Study II, we also assessed what events caused emotional reactions while studying in the Work Mates environment. This was accomplished by asking the participants to report the antecedents of their affective state in free form each time they filled the on-line SAM questionnaire.

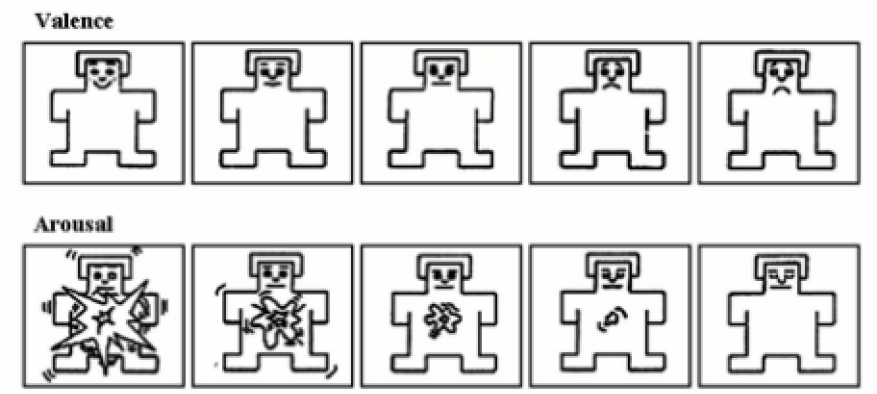

Figure 2. The Self-Assessment Manikin (SAM; Bradley & Lang, 1994)

Participants' use of *emotion regulation* strategies was measured in Study II with a Finnish translation of the Emotion Regulation Questionnaire (ERQ, Gross & John, 2003). The ERQ is a brief self-report instrument consisting of ten items that measures the use of reappraisal and suppression as emotion regulation strategies. In ERQ, participants were asked to rate on a scale ranging from strongly disagree (1) to strongly agree (7) how they regulate their emotions. (e.g. "When I want to feel less negative emotion, I change the way I'm thinking about the situation." and "I keep my emotions to myself.").

Computer self-efficacy was measured with the Computer Self-Efficacy Scale (Compeau & Higgins, 1995) (see Study I). Students' *visible activities* in the WBLE were analyzed similarly as in Study I. Due to the more diverse nature of the discussions in Study II, the content classes were complemented with three other content types: (1) sharing own experience, (2) summarizing and (3) organizing the exercise.

Study III

Participants' *emotions* were measured with the Self-Assessment Manikin (SAM, see Bradley & Lang, 1994) (see Study II). Participant's *interest* in the course topic (course interest) and in the web-based learning (web interest) was measured with a scale constructed for the purposes of this study. In the Course Interest Scale, the participants were asked to evaluate items concerning the course topic (e.g. "This course seems interesting" and "It would be nice if the course were more extensive") on a scale ranging from Not at all true (1) to Completely true (7). Similarly, on the Web Interest scale, participants were asked to evaluate items concerning web-based learning (e.g. "Studying in the web seems interesting" or "It would be nice if there were more web-based learning in the course"), on a scale ranging from Not at all true (1) to Completely true (7).

Visible activities in the study were measured similarly as in Studies I and II. The activities in a WBLE can also consist of *invisible activities,* e.g. some students can follow the discussions very actively, but still prefer to stay in the background without participating in the discussions in the environment. As discussed above (see Section 2.1),

visible and invisible activities can have different causes and consequences. Therefore, participants' *invisible activities* in WorkMates were analyzed in Study III. The analysis was based on the log data (i.e. records of when participants logged on to the systems and participated in the discussions) of the environment. The invisible activities' score for each participant was computed as the number of occasions a participant had accessed the course discussion forums without contributing to the discussions, that is, the total number of a participant's written notes in the WBLE's discussion forum (see visible activities above) was subtracted from the total number of occasions the participant had accessed the discussion forum.

The standardized invisible and visible activities variables were dichotomized with a mean split in order to classify participants into lurkers and non-lurkers. In this study, the *lurkers* were defined as individuals who frequently visited the online environment but seldom participated in the discussions. Accordingly, a participant was classified as a lurker if his or her dichotomized invisible activities score was in the upper category (frequently visits the environment) and the dichotomized visible activities in the lower category (seldom participates in discussions). All the remaining participants were classified as non-lurkers. Only participants from whom both invisible and visible activities data were available were included in this classification.

Study IV

In Study IV, participants' *emotional state* was measured with the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). Study IV involved an experimental learning task performed in the laboratory, either in small face-to-face groups or in a WBLE. Thus, participants completed the SAM once at the beginning of the learning task, repeatedly during the experiment, and once after completion of the task. During the experiment, the participants were also asked to complete the SAM questionnaire repeatedly at equally spaced intervals (7 minutes).

The participant's *interests* in the small-group learning (group interest) and web interest were measured using a scale similar to the course and web interest scales in Study III. Both scales consisted of similarly formatted items but with different content (e.g. "Studying in the web seems interesting" / "Working in a small group seems interesting" or "It would be nice if there were more web-based learning at the university" / "It would be nice if there were more small-group learning at the university"). Additionally, participants' achievement in the experimental learning task was evaluated by a teacher naïve to the purpose of the study.

4 AN OVERVIEW OF THE EMPIRICAL STUDIES

This thesis consists of four separate studies, of which three have been published and one have been submitted for publication. In total, 266 Finnish undergraduate students participated in these studies during the years 2002-2005. In Study I (Vuorela & Nummenmaa, 2004), we assessed how the theory of planned behaviour, efficacy beliefs and computer anxiety influence students' behaviour in a WBLE. In Study II (Vuorela & Nummenmaa, 2004), we tested whether emotional reactions and their regulation would predict students' visible activities and achievement in the WBLE. In Study III (Nummenmaa & Nummenmaa, in press) we compared whether emotions experienced while learning in the WBLE would influence visible and invisible activities in a WBLE differently. Study IV (Nummenmaa & Nummenmaa, submitted for publication) employed an experimental design to test whether web-based and face-to-face collaborative learning settings would result in comparable levels of affective reactivity.

Study I
Vuorela, M. & Nummenmaa, L. (2004). How undergraduate students meet a new learning environment? Computers in Human Behavior, 20, 763-777.

The purpose of Study I was to analyze how students with different behavioural and efficacy beliefs, learning approaches and levels of anxiety in computer-using situations meet a new web-based learning environment, and consequently interpret the learning situation. We evaluated whether the theory of planned behaviour (Ajzen, 2002) would explain students' activities in a web-based learning environment. Specifically, we tested how attitude toward the behaviour (behavioural beliefs and outcome evaluations) and perceived behavioural control (computer self-efficacy) influence students' behaviour in a WBLE. The scope was also widened to include students' approaches (deep / surface) to learning and anxiety in computer-using situations, as well as their interpretations of the environment and the learning situation. Data (N=42) for this study were collected in autumn 2002 from undergraduate medical and sociology students who participated in two different courses (Children's nutrition and Research planning) organized through the WorkMates learning environment. The participants answered pre- and post-test questionnaires (e.g. computer anxiety and computer self-efficacy) in face-to-face meetings both at the beginning and end of the courses. Participants' visible activities in the WorkMates environment were analyzed after the courses.

The data did not support the hypothesis that the theory of planned behaviour could be used to explain students' activities in the WBLE. Additionally, neither deep approaches to learning nor anxiety predicted the activities. The result suggests that students can take advantage of a WBLE regardless of their experiences with computers and the environment or learning approaches. Although the participants had quite positive expectations about using WBLE in the course, the course or the environment did not correspond to their expectations. Participants interpreted the learning environment more negatively after the course, which may have made them less eager to participate in similar courses in the future.

All the participants had fairly high levels of computer self-efficacy, while the average level of computer anxiety among them was quite low. Neither the participant's level of computer anxiety or efficacy beliefs were related to their previous experience with computers. However, participants' anxiety in the computer-using situation was associated with negative expectations of the consequences of using WBLE in their studies. Thus, it is possible that computer-anxious students are less eager to participate, for example, in voluntary courses that are organized through technology.

Study II
Vuorela, M. & Nummenmaa, L. (2004). Experienced Emotions, Emotion Regulation and Student Activity in a Web-Based Learning Environment. European Journal of Psychology of Education, 19(4), 423-436

In Study II, we examined what events cause emotional reactions when students use a WBLE in their studies, and how the emotions experienced while using the WBLE, emotion regulation strategies and computer self-efficacy are related to collaborative visible activities in the environment. Data (N=104) for this study were collected in autumn 2003 from undergraduate students who participated in a five-week national web-course of the programme in educational use of information and communication technologies. The course was organized through the WorkMates environment. Participants were students from seven Finnish universities majoring in various subjects. All the students enrolled on the course were contacted by a pre-test questionnaire measuring emotion regulation strategies and computer self-efficacy before the course. The SAM was presented automatically to participants each time they logged off from the environment, and they were instructed to complete it each time they encountered it. Participants' visible activities in the WorkMates environment were analyzed after the courses.

Students experienced a wide range of emotions while using the WBLE and especially the nature of interaction during the activities was an important antecedent of the affective reactions. This result underlines that although the presence of technology is very obvious in web-based learning environments, it is not, however, the prevailing antecedent of the affective reactions experienced while using such learning environments. Additionally, we found that fluctuation of valence and use of reappraisal as an emotion regulation strategy directed and maintained effective collaborative visible activities in the web-based learning environment. Contrary to our predictions, the data did not support the hypothesis that high computer self-efficacy would increase students' motivation to participate in computer-mediated communication. However, the data demonstrated a moderately strong association between students' computer self-efficacy and mean arousal. Students with high computer self-efficacy were less aroused during the course than students with low efficacy.

Study III
Nummenmaa, M., & Nummenmaa, L. (2007). University Students' Emotions, Interest and Activity in a Web-Based Learning Environment. In press, British Journal of Educational Psychology

In Study III, we examined how emotions experienced while using a web-based learning environment and students' interest in the course topic and web-based learning exerted an influence on their collaborative visible and non-collaborative invisible activities and lurking in a WBLE. Data for this study were collected in 2004. Participants (N=99) were Finnish undergraduate students from five different courses organized in the University of Turku through the WorkMates environment. All the students enrolled in the courses filled in pre- and post-test questionnaires of interest, and repeatedly completed an on-line questionnaire on emotions experienced while using the WBLE during the courses. In the middle of the courses, the participants were instructed to complete html-formatted on-line web and course interest questionnaires in WorkMates. Right after the courses, participants' web and course interest was measured once again with the questionnaires. Participants' visible and invisible activities and lurking in the WorkMates environment were analyzed after the courses.

We found that the fluctuation of emotional reactions was positively associated with both visible collaborative and invisible non-collaborative activities in the WBLE. Further, the results implied that a high level of interest in the web-based learning during the courses was positively correlated with students' invisible activities. Therefore, interest in the web-based learning increased students' interest in the WBLE (i.e. invisible activities), but not with the participation in collaborative activities. Although neither interest in the web-based learning nor the course topic enhanced students' contribution to collaborative learning activities in a WBLE, it was demonstrated that the interest in the web-based learning modulated students' affective reactions as it was associated with their positive emotions. The results also demonstrated that students not actively participating in the collaborative activities (i.e. lurkers) had more negative emotional experiences during the courses than other students. These somewhat negative experiences may make the lurking individuals less eager to participate in other WBLE courses. All in all, the results underline that emotions and interest have distinct effects on different web-based learning activities, and that they should be considered when designing web-based courses.

Study IV
Nummenmaa, M. & Nummenmaa, L. (2007). Emotional reactions in web-based versus face-to-face small-group learning situations. Submitted for publication

The purpose of Study IV was to assess whether the web-based learning situation causes different emotional reactions from the face-to-face learning situation by measuring the two primary dimensions of emotions - valence and arousal (SAM, Self Assessment Manikin) - during the learning process. Data for the study were collected in 2005. Participants (N=21) were Finnish undergraduate students from a university course entitled Educational applications of information and communication technology.

Participants were majoring in different university subjects, and had voluntarily chosen to participate in the course. In Study IV participants were tested in groups of three. They were randomly assigned to the face-to-face (9 participants, 3 groups) and web-based conditions (12 participants, 4 groups) before the experiment. Upon arriving at the laboratory (one experimental group at a time), participants' interest in web-based learning and small-group learning was measured. Next, participants were informed that they were going to complete a small-group learning task in a face-to-face condition or through a text-based web-discussion forum, depending on the experimental group they had been assigned to. Participants in each face-to-face group were set to work together around one table with a computer. Each participant in the web-based groups was set to work in a separate cubicle with a computer. While performing the learning assignment, participants were asked to fill in the SAM questionnaire every time they heard an auditory signal during the experiment. The auditory signal was presented to participants at equally spaced intervals (7 minutes).

We found that learning by means of web-based communication resulted in more intense emotional reactivity when compared to learning in a face-to-face situation, i.e. students experienced more arousal and fluctuation of valence and arousal than students in the face-to-face learning situation. Contrary to previous studies, satisfaction (i.e. mean valence) in the web-based communication groups, however, did not differ from that in the face-to-face groups. Importantly, no differences between groups were found in the learning process, i.e. the time spend on the task and its achievement. This suggests that, despite the different communication media and different affective reactions experienced by the students in the two groups, the two learning situations were comparable in terms of learning and satisfaction.

5 GENERAL DISCUSSION

In a series of four studies we assessed how emotional reactions and their regulation, as well as interest influence students' visible and invisible behaviour in a WBLE. We confirmed that students experience a wide range of emotions while using the WBLE for collaborative purposes (Study II), and that fluctuation of valence (i.e. experienced pleasantness - unpleasantness) influenced both visible (Studies II and III) and invisible (Study III) activity in the environment. Further, we demonstrated that web-based learning might result in increased levels of affective reactivity, when compared to collaborative face-to-face learning (Study IV). However, individual differences in affective reactivity as measured by computer anxiety (Study I) did not influence students' behaviour in the environment. Nevertheless, interest in web-based learning increased participation in web-based learning (Study III). The implications of these findings are discussed in detail in the following sections.

5.1 Emotions influence students' activities in a WBLE

The emotions experienced while studying in a WBLE, the regulation of emotional reactions and interest had distinct effects on the different activities in a WBLE. The results of the empirical studies II and III indicated that students' experienced emotions while using the WBLE affected how actively they participated in the different activities in the environment. Our first hypothesis in Study II regarding the experience of emotions was that positive affectivity would result in more extensive activities in the environment, but the hypothesis was not supported as such. Instead, the results demonstrated that the fluctuation of valence rather than the average level of valence itself predicted both visible collaborative and invisible activities in the web-based learning environment. The mean valence for all the students was approximately 3, which is very close to the midpoint of the scale that refers to a neutral affective state. Therefore, it is not surprising that the fluctuation of valence rather than the valence itself explained their activities. If a student's mean valence is relatively neutral and his / her affective fluctuation is low, this implies that the individual has been in a neutral affective state for most of the time. Large fluctuation, on the contrary, indicates that the individual's affective state has deviated from the neutral valence in both positive and negative directions. Both positively and negatively valenced affective states are likely to result in changes in action tendencies (e.g. Bradley, 2000) when compared to a neutrally valenced affective state. Therefore, it is understandable that the fluctuation of emotional reactions predicted the activities in the environment.

It is also important to note that the fluctuation of emotional reactions while using the WBLE exerted a positive influence on all the students' activities in the environment, not just the visible ones. As emotions typically result from, and are experienced in, social interactions, the initial hypothesis in Study III was that the fluctuation of emotional reactions would not influence the invisible activities in a WBLE. However, it is possible that students might have perceived the presence of other students in the WBLE even when they were not actually participating in collaborative activities. Consequently, they

could have considered both their visible collaborative and invisible non-collaborative activities comparable in terms of the presence of others in the environment. As Study II demonstrated that interaction in the WBLE was a significant cause of emotions in the WBLE, this could also explain why the fluctuation of valence predicted both visible and invisible activities.

However, no evidence was found that arousal would have had an effect on the students' activities. Arousal is usually thought to be associated with valence so the valenced events can differ in their level of arousal (Bradley, 2000; Russell & Carroll, 1999). However, valence and arousal are not linearly associated with each other: instead, the relationship is curvilinear. Arousal reflects the intensity of the emotional reaction (Russell & Carroll, 1999) and the psychological and physiological state including changes in cortical, sympathetic and somatic nervous systems (Bradley, 2000). Therefore, the assumption is that these short-term psychological and physiological changes may not alone explain individuals' constant participation in the learning process in a WBLE. Instead, the participation or non-participation occurs because of the changes in the experienced pleasantness or unpleasantness of the situations, as was shown in these studies.

It should be noted that the valence and arousal scores were averaged for each participant. Thus, in these studies, it was not possible to assess the different valence/arousal combinations occurring at each time point. Thus, from a methodological point of view, the best way to analyze the data would have been the use of autoregressive factor models. In that case it would have been possible to examine the combined effects of both valence and arousal simultaneously in each time point. However, the study designs did not allow for this kind of analysis as there were unequal numbers of answers to the SAM questionnaire from each participant.

Although emotions usually occur automatically due to changes in the environment, individuals also have the ability to control their own emotionality. It can be argued that emotion regulation skills and strategies are important factors of effective functioning. The results of Study II also confirmed that using reappraisal as an emotion regulation strategy led to increased collaborative activities in the environment. In a general sense, this supports the hypothesis (see Gross, 1998a; Gross & John, 2003) that the ability to anticipate and manipulate one's own emotional reactions in advance is advantageous for effective functioning. The suppressive emotion regulation was not, however, negatively associated with the collaborative activities. This might be due to the fact that, in a WBLE, expressive suppression is not used as much as in face-to-face situations, because expressions of emotions can only be mediated via text-based commenting in the environment. Hence, expressive suppression might not be necessary in such an environment. On the grounds of results of Study II, we can not, however, say what kind of regulation strategies were used, and how students actually used them during their activities in a WBLE. It is known that suppression debilitates encoding of material into long-term memory (Richards & Gross, 2000). However, the data demonstrated that, in general, participants used reappraisal as an emotion regulation strategy more often than suppression. Thus, it is likely that inappropriate use of emotion regulation strategies would not hinder students' learning performance in a web-based learning.

Emotions and their regulation were not, however, the only factors that affected students' behaviour in a web-based learning environment. The hypothesis in Study III was that interest in the web-based learning and in the course topic would increase both students' visible collaborative and invisible non-collaborative activities. When considering the invisible non-collaborative activities, the results showed that students' interest in the web-based learning was a reliable predictor of such activities. This suggests that the students follow the events in a WBLE actively because they are interested in, and curious about, the web-based learning itself and the events in the environment, rather than in participating in the collaborative discussions. Many researchers (e.g. Fredrickson, 1998; Izard & Ackerman, 2000; Silvia, 2001) have conceived of interest as an emotion associated with curiosity, exploration and information seeking, and it is known that curiosity about the new possibilities broadens individuals' experiences, and supports their development of knowledge and skills (Fredrickson, 1998; Silvia, 2001). Thus, students' curiosity about web-based learning might support their knowledge and skills even if they do not participate in collaborative activities in a WBLE. However, the results of Study III did not support the hypothesis that interest in the web-based learning would increase the visible collaborative activities. Interest in the web-based learning neither enhanced nor deteriorated students' contribution to collaborative learning processes in a WBLE. This implies that students can take advantage of the collaborative online discussions regardless of their interest in the web-based learning itself. Therefore, students with various experiences and opinions regarding web-based learning and studying can adapt to such environments and use them efficiently. This suggests that such learning environments can be applied with various student populations, without the risk of debilitating learning performance due to students' lack of interest in the web-based learning.

The results of Study III also indicated that the interest in the course topic predicted neither visible collaborative nor invisible non-collaborative activities in a WBLE. What is more, the course and web interests were not associated with achievement. This may have been due to the fact that in Finnish universities students usually have high extrinsic motivation for completing courses to get their degree. Extrinsic motivation refers to performing an activity for its instrumental value, rather than for the enjoyment or interest in the activity itself (Ryan & Deci, 2000). Thus, such motivation could make students eager to participate in the learning in the courses regardless of their interest in the course topic.

5.2 Lurkers experience negative emotions and learn ineffectively while studying in a WBLE

Students manifest different behaviours in a web-based learning environment – collaborative visible and non-collaborative invisible activities – and the emotional reactions occurring during learning and interest towards the subject matter and web learning have distinct effects on such activities. In a more detailed analysis, we assessed, in Study III the influences of emotions and interest on a specific pattern of non-collaborative invisible activities called lurking. Some authors (Preece et al., 2004)

identify lurkers as individuals who never contribute to the discussions. In our study, we defined lurkers as students who visited the environment frequently but seldom contributed to the discussions. Thus, all the students classified as lurkers had contributed to the discussions at least once. The results demonstrated that the lurkers experienced more negatively valenced emotions during the courses than did other students, but the mean arousal (i.e. intensity) of the emotional reactions was similar in lurkers and non-lurkers. There are at least two possible explanations for this: experience of negatively valenced emotions may lead to lurking behaviour, or lurking itself could cause negative emotions. There is evidence (e.g. Beaudoin, 2002; Preece et al., 2004) that individuals lurk in online groups for affective reasons such as discomfort or unsatisfactory group dynamics. This would support the former explanation. However, as Study III employed a correlative design we can not draw strong conclusions about whether the experience of negative emotions was a cause or consequence of lurking. However, this finding implies that these negative experiences may make the lurking individuals less eager to participate in other WBLE courses in the future.

From the perspective of the learning community the lurkers can be seen as wasted resources who are not participating in the collaborative learning process. In fact, recent evidence suggests that the students who do not participate in the web discussions actually spend time in learning-related activities (i.e. invisible activities in the environment) and feel they are learning and benefiting from their non-visible participation (Beaudoin, 2002). This does not, however, imply that the invisible non-collaborative activities are actually related to learning. Thus, it is possible that the lurkers are learning but not contributing to the joint learning effort. However, the results of Study III are in line with those reported by Beaudoin (2002), suggesting that students who were not actively involved in the discourse in a WBLE got poorer grades than the participating students. This implies that these non-participating students might not actually learn as effectively as the participating ones. This notion also converges with the socio-cultural view in which learning is considered as participation in a social process of knowledge construction rather than an individual endeavour (Vygotski, 1978). However, we can not conclude that invisible activities are not related to learning at all. Instead, this result implies that participation in the collaborative discussions may be one essential part of the effective learning, and further efforts should be made to devise learning environments and tasks in which lurking would be either not very tempting or even impossible. This would ensure that all the participants are both contributing to each other's learning, and also learning by themselves.

5.3 Social interaction is a major antecedent for emotions while studying in a WBLE

According to previous studies (e.g. Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005), emotions in computer-supported learning could be derived from self, context, task or technology, and other people. Study II confirmed that a wide range of anteceding events - such as social interaction and functionality of technology - result in emotions while using a WBLE. It is important to note that although the presence of technology is evident in the

web-based learning environments and that this may make some individuals anxious (c.f. Study I), the technology was not the prevailing antecedent of the emotions experienced while using the WBLE. The results of Study II underlined the importance of considering the social aspects of the learning situation when planning the use of a WBLE in instruction. This notion is supported by the finding that student interaction in the learning environment was mentioned as a cause of emotions more often than the technical environment itself. This supports the hypothesis that when a WBLE is used for collaborative purposes, the affective reactions occurring during the learning do not result only from using a computer and the environment, but also from the interactions among the students in it.

As emotions are usually elicited in different social interactions (Frijda, 1986) and it is known that the social situation in a WBLE generate emotions directed at other students (Wosnitza & Volet, 2005), it is understandable why especially the interaction between students was mentioned so often as a cause of emotions. Another possible explanation of this result might be the revealing openness of a typical web-based discussion. In web-communication it is common that all the notes and comments remain visible for other students in the environment. Such openness could make some students think very carefully what they want to write in shared web-discussions, or on the other hand, to react very emotionally to all the comments made on their own texts. Such reticence may hinder students' participation in a web-discussion and create more negative affective reactions. On the other hand, some students might like such openness and it could make them behave very spontaneously and cause more positive emotions. Thus, the social situation in a WBLE could be very emotional, but due to numerous different reasons. Taken together, this suggests that while the presence of others influences students' interaction in a virtual environment (Tu & McIsaac, 2002), it is also as important an antecedent of students' affective reactions in a WBLE as it is in face-to-face learning situations.

However, not only the environment and student interaction elicit emotions in students using a WBLE. The number of reported causes of emotions relating to the external factors was also remarkably higher in Study II than the number of causes relating to technical or any other aspects. Therefore, even if the environment and used technology are functional, the course is well designed and the interaction within the student group is effective, it is almost impossible to control all the events that influence the emotions students experience during the activities in a WBLE. Teachers and tutors should be aware of this when they are evaluating the success of their courses: they can not control everything. In other words, negative emotions experienced during the course are not necessarily due to the course or the technological environment.

5.4 Expression of emotions is restricted in a WBLE

The lack of means for expressing emotions in text-based web-learning environments differentiates such learning environments from face-to-face and other technology-based (e.g. video conferences) environments. Text-based learning environments allow individuals to express their own emotions and perceive the senders' emotional state

mainly only by means of the semantics of the text. As a consequence of this, we hypothesized in Study IV that learning via web-based communication would provide a less emotional environment than a face-to-face learning situation. However, the results of the study do not support the hypothesis. Instead, learning by means of a web-based communication resulted in more affective reactivity when compared to learning in a face-to-face situation.

A possible explanation for this result might be, contrary to what we expected, that the lack of means for expressing emotional reactions actually increased the affectivity in the web-discussion groups. This hypothesis is supported by the results of Butler et al. (2003). In the study, the participants discussed an upsetting topic in dyads. The data showed that when one communication partner was instructed to suppress his / her emotional expressions, the other subject's cardiovascular activity (as measured by blood pressure) increased, they experienced less rapport, and rated their communication partner as less likable. According to Butler et al. (2003), the results implied that the lack of emotional expressivity in the communication partner might be considered as a stressor, and can itself lead to increased affective reactivity. Similarly, the participants in the web-based groups of the current study might have experienced increased stress due to the artificial restrictions on expressing and perceiving emotions.

Importantly, no differences between groups were found in the learning process, i.e. the time spent on task and achievement. This suggests that, despite the different communication media and different affective reactions experienced by the students in the two groups, the two learning situations were comparable in terms of learning. Further, contrary to previous studies (see Baltes et al., 2002 for review), satisfaction in the web-based and face-to-face learning groups was similar. But why then did the groups differ in the emotional reactivity but not in achievement or satisfaction? Although expression of emotions is a crucial element of face-to-face communication between individuals (Keltner & Kring, 1998) and lack of emotional expression in communication situation could be a stressor (Butler et al., 2003), one can still question whether there are any consequences of restricted means for emotion expression in the web-based learning situations if this does not exert any influence on the achievement or students' satisfaction.

Previous studies (see Baltes et al., 2002) have demonstrated that, in general, people are less satisfied in a computer-based discussion when compared to face-to-face communication, but it has also been shown that a videoconferencing discussion (van der Kleij et al., 2005) is as satisfying as face-to-face communication. One possible explanation for the results could have been the differences in means for emotional expression in the computer-based discussion and the videoconferencing. However, our results in Study IV, demonstrating that learners in web-based communication groups were equally satisfied and succeeded as well as than those in face-to-face groups do not fit this view. Therefore the lack of means for expressing emotional reactions might not hinder students' satisfaction in a WBLE, but merely lead to increased affective reactivity.

However, the increased affective reactivity did not exert any influence on the learning process. Some caution should be warranted with interpretation of these results, as we

measured only two components of the learning process, namely, achievement and time taken to complete the relatively short and simple assignment. It is possible that on a longer time scale, the higher fluctuation of emotional reactions occurring in the web-based learning environment could influence the achievement and time spent on learning, but also other components of the learning process or motivational variables, e.g. interest and effort, as Pekrun (2002) has suggested. The increased affective reactivity could, for example, debilitate individual's learning performance especially in complex learning tasks. According to the Yerkes-Dodson law (Yerkes & Dodson, 1908), tasks requiring high-level cognitive functioning benefit from lower affective reactivity whereas tasks requiring endurance and persistence benefit from slightly higher affective reactivity. Thus, in a simple learning task, such as the one used in this study, increased affective reactivity probably does not hinder performance very much. Although in this study the restricted means for emotional expression in a WBLE did not have substantial consequences on learning, more research is needed in this area to assess the longer time influences of the increased affective reactivity in a web-based learning, and especially in complex learning tasks.

5.5 Why anxiety and computer self-efficacy do not influence students' behaviour in a WBLE?

It has been shown that a high level of computer anxiety is negatively associated with an individual's performance outcome (Brosnan, 1998b). However, the results of Study I contradicted this notion by demonstrating that students' computer anxiety was not related to their learning activities in a web-based learning environment. Instead students' computer anxiety was associated with their negative expectations of the consequences of using a WBLE in their studies. This may make anxious students less eager to participate especially in voluntary courses that are organized through technology. Moreover, anxiety was not associated with students' experiences of the learning situation in a WBLE after the courses, indicating that anxious students did not experience learning in a WBLE as unpleasant. These results are promising, as they suggest that students can take advantage of such environments regardless of their level of anxiety in computer-using situations.

Previous studies have suggested that anxiety in computer-using situations hinders users' performance because users with a high level of anxiety evaluate their own computer skills as insufficient (Beckers et al., 2006; Rozell & Gardner, 2000; Smith & Caputi, 2001). This was not supported by the results of Study I, which instead showed that computer anxiety did not influence students' activities in the WBLE. This might be due to the fact that most of the students participating in our study had fairly low levels of computer anxiety and high levels of computer efficacy. Although Study I was based on a fairly restricted sample, it could be hypothesized that anxiety in computer-using situations is a vanishing phenomenon, especially in universities. This argument is based on the finding that the use of computers is continuously increasing, and nowadays almost everybody has some experience with computers. Thus, the average computer-using skills are nowadays higher than they were, for example, ten years ago, so computers are probably becoming increasingly familiar and less prone to evoke anxious responses.

Experience with computers does not, however, always have only positive consequences and result in lower levels of anxiety. As Brosnan (1998a) points out, the fact that some studies have identified a relationship with greater prior experience and lower anxiety cannot be taken to imply that greater experience results in a reduced level of anxiety. Our findings support this conclusion, as computer anxiety level was not related to participants' previous experience with computers.

Further, the results of the empirical Studies I and II did not support the hypothesis that high computer self-efficacy would increase students' motivation to use a WBLE and participate in a computer-mediated communication. The results indicate that in a general sense, university students have very high efficacy beliefs in their own capabilities to use computers. Therefore, the scores of the efficacy scale may not be discriminative enough due to a ceiling effect. This would seem to imply that although individuals usually tend to prefer activities for which they have capabilities (Bandura, 1982, 1997), university students' computer self-efficacy may not be a good predictor of their motivation to use computers or to participate in web-based learning activities simply because most students are reasonably skilled with computers. However, the data of Study II demonstrated a moderately strong association between students' computer self-efficacy and average level of arousal. Students with high computer self-efficacy were less aroused during the course than students with low efficacy. The result may indicate that high efficacy beliefs function as a calming feature when working in a WBLE, suggesting that efficacy beliefs are also related to the self-regulation of affective states as Bandura (1982, 1997) has suggested.

As a consequence of these results of Studies I and II, it may be relevant to ask whether the concepts of computer anxiety and computer self-efficacy are relevant factors for explaining university students' learning-related behaviour in a WBLE. Both these factors are related to technology, and attitudes towards and skills with technology might not appear to hinder the studies of most students at university level. Technology is, however, also used to mediate interactions between people. This is especially evident when using web-based learning environments for collaborative purposes. Therefore, individual differences in students' affective reactivity toward computers and computer-efficacy beliefs might not be a sufficient predictor of their activities in such environments as there are other antecedents that could cause emotions. However, although closely related to technology, these factors do indeed influence students' learning behaviour. As stated above, the results of these empirical studies suggest that although anxiety and computer self-efficacy were not directly associated with students' activities in the web-based learning environment, they do, however, have other influences on students' behaviour. For example, although computer self-efficacy did not directly correlate with students' motivation to use a WBLE for learning, high efficacy beliefs in one's own computer-using skills might be important for learning. For example, a student with a high level of computer self-efficacy does not have to concentrate on coping with the technology used for mediating the learning, and instead can concentrate on learning and studying.

Anxiety usually occurs in situations where one is learning something new (Eysenck, 1992; Häkkinen, 1995). As technology is continuously developing, using web-based

learning environments could still be a novel experience for some students. It is highly likely that there will always be some new innovations, new trends and new methods for using technology in education. Thus, if students have to learn something new every once in a while it could be hypothesized that such novelty could induce a certain amount of anxiety in at least some students. Moreover, students' belief in their own capabilities with computers might provide a better predictor of behaviour in such novel technology-based situations where new skills might be needed. Importantly, this also implies that the scales used to measure technology-related anxiety and computer efficacy should be continuously revised to correspond with new situations and requirements.

5.6 Critical remarks

There are some limitations to the present studies and their methodology that should be taken into account in the future. Firstly, a significant challenge in studying emotion in web-based learning environments is that emotions are not as easily available for public examination as in face-to-face environments, unless the individual is prepared to disclose them. Therefore, the one limitation of the method used, and of most of the available methods for assessing emotional states, is their dependence on the willingness of the participant to reveal his / her emotions. However, if we want to measure emotions in authentic web-based learning situation where participants are situated in different places and of different times, the use of methods other than self-reports is difficult.

Another methodological possibility is to create web-based learning situations in laboratory settings. This would enable us to measure emotion-related psychophysiological changes unobtrusively by means of facial electromyography or electrocardiogram. These situations can, however, only be synchronous learning situation, not asynchronous, which are more common in a web-based learning. As relatively artificial learning situations such setups cannot be considered as ecologically very valid, but they could nevertheless increase the experimental control over the measurement of the emotional reactions occurring while learning with computers. However, currently the use of repeatedly acquired self-reports of emotions occurring while learning may be the optimal way to access the affective reactions elicited in web-based learning environments.

The methodological improvement over previous studies on emotions and learning was the acquisition of on-line measures of emotions that occur during the learning process. However, in the strictest sense, this could only be accomplished in Study IV, where students' learning process was synchronous and measurement of emotions took place in laboratory settings. Thus, we were able to control for the timing of the emotion measures. In Studies II and III, the learning process was asynchronous and occurred in different places and within different time frame, and it was therefore impossible to measure students' emotions precisely during the time they were actually doing something in the WBLE. It is known that any delay between an experienced emotion and its report can lead to less accurate information (Robinson & Clore, 2002). However, the delay between the actual behaviour and the measurement of emotions in Studies II and III was very

short, and participants knew that their emotions would be measured whenever they logged out from the environment, thus potentially enhancing the memory of the emotional states experienced while using the WBLE. Therefore, the delay between emotional experience and its' measurement probably does not present a serious problem in Studies II and III.

Finally, the number of answers to SAM ranged from 1 to 40 in Study II and 1 to 41 in Study III. Therefore, there were participants whose valence and arousal scores consisted only of one response, and the variance of valence for these participants was zero. As within-subject standard deviation of valence and arousal was used to assess the fluctuation of the respective dimensions, we had to exclude from the sample participants with less than three answers to the SAM questionnaire during the course to avoid artificially low fluctuation scores resulting from only one or two answers from a participant. However, this was done only in Study III. Although the number of such participants was relatively small in Study II (n=10), the variance of valence may not be a totally robust estimate of actual variation in affective valence in Study II. Because the results of Study III replicate the results of the Study II, this may not decrease the validity of the results. Further, as the sample size was rather modest in Study IV, the observed results should be interpreted with caution, and preferably the study should be replicated with a larger sample.

5.7 Directions for future research

These studies raise some important issues that future studies should consist. Firstly, on the basis of these and other studies (e.g. Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005), it seems clear that students' emotion during the web-based learning derives mostly from the social interaction rather than the technology context and further, that the technology is not the only antecedent of students' emotional reactions in collaborative web-based learning environments. Despite the fact that studying in a web-based environment relies in many respects on different technological aspects, the presence of other individuals in such an environment has a remarkable effect on what courses of action people take in these environments. Teachers and tutors should especially be aware of this when they are planning and organizing highly intensive collaboration periods for online courses. However, we do not yet know how the development of web-culture promoting experience of emotions that facilitate working in a collaborative learning situation could be encouraged so that enjoyment of learning is enhanced, and negative emotions hindering learning would be avoided. Therefore, more studies on the time course of students' experience of emotions during computer-supported collaborative learning are needed.

Further, the problem of accessing emotional experiences during the learning process in web-based environments is not only a problem for researchers. Teachers and tutors of online courses also share this problem. For them having access to their students' emotions, especially negative ones, is critical in order to provide appropriate and timely assistance to students for the intervention to be effective. This is a significant problem in

web-based learning environments, because the use of technology inevitably creates delays in providing support to students. Moreover, the restricted means of expression of emotions may debilitate the individual's learning performance, especially in complex learning tasks, if such restrictions lead to increased affectivity, as was shown in our study. Therefore, more detailed studies on the role of emotional expression in computer-mediated text-based learning with direct experimental manipulations on emotion expression are required to assess the facilitative or hindering effects of emotion expression in computer-based learning environments.

People can reliably categorize even very simple schematic line drawings of emotional expressions (Yamada, 1993). Thus, a relatively straightforward possibility for enhancing the means for expressing emotions in a text-based WBLE would be to add the option of using emoticons (emotion icons, "smileys") that depict various emotional states in communication Students could then add the emoticons into their text discourse to illustrate either their emotional state or the emotional tone of their message. It could be assumed that emoticons could, at least partially, serve the same functions as mediators of an individual's emotions in web-based as in face-to-face interactions. Although emoticons are commonly used in many informal web-discussion forums, their use for communicating emotions via the web has not been widely studied.

Derks et al. (in press) have demonstrated that when responding to short internet chats, people used emoticons according to the emotional context of their communication, but were also more likely to use them in socio-emotional than in task-oriented contexts. As learning situations in web-based environments could be defined as more task-oriented than socio-emotional contexts, it could be hypothesized that students might not use emoticons in a learning context as much as in informal web-discussion forums. However, the fact that emoticons are generally being developed and used implies that individuals at least feel the need to express some of their emotions with emoticons rather than text (Fischer, in press). We do not yet, however, know whether the use of emoticons would be beneficial or harmful in formal learning situations. Therefore, future studies should focus on assessing how the use of emoticons or other means for expressing emotions in a text-based web-environment affect both students' learning process and the assistance provided by teachers and tutors. It is also important to study how the possibility to express one's own emotions and to perceive others' emotions influence an individual's experienced affectivity in web-based learning environments.

REFERENCES

Adolphs, R. (2002). Recognizing emotion from facial expressions: Psychological and neurological mechanisms. Behavioral & Cognitive Neuroscience Reviews, 1(1), 21-62.

Agarwal, R., Sambamurthy, V., & Stair, R.M. (2000). Research report: the evolving relationship between general and specific computer self-efficacy – an empirical assessment. *Information System Research, 11*, 418-430.

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning, and the psychological processes that mediate their relationship. Journal of Educational Psychology, 94(3), 545-561.

Ajzen, I. (2002). Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. Journal of Applied Social Psychology, 32, 1–20.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. Psychological Review, 64, 359-372.

Baltes, B. B., Dickson, M. W., Sherman, M. P., Bauer, C. C., & LaGanke, J. S. (2002). Computer-mediated communication and group decision making: A meta-analysis. Organizational Behavior and Human Decision Processes, 87(1), 156-179.

Bandura, A. (2001). Constructing self-efficacy scales., 2001 from http://www.emory.edu/EDUCATION/mfp/banduraguide.html

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. New Jersey: Prentice- Hall.

Bandura, A. (1982). Self-efficacy mechanism in human agency. American Psychologist, 37, 122-147.

Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W. H. Freeman/Times Books/ Henry Holt & Co.

Beaudoin, M. F. (2002). Learning or lurking?: Tracking the "invisible" online student. The Internet and Higher Education, 5(2), 147-155.

Beckers, J. J., & Schmidt, H. G. (2003). Computer experience and computer anxiety. Computers in Human Behavior, 19(6), 785-797.

Beckers, J. J., Rikers, R. M. J. P., & Schmidt, H. G. (2006). The influence of computer anxiety on experienced computer users while performing complex computer tasks. Computers in Human Behavior, 22(3), 456-466.

Bergin, D. A. (1999). Influences on classroom interest. Educational Psychologist, 34, 87-98.

Birenbaum, M., & Eylath, S. (1994). Who is afraid of statistics? Correlates of statistics anxiety among students of educational.. Educational Research, 36(1), 93.

Bradley, M. M. (2000). Emotion and motivation. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.), Handbook of psychophysiology (pp. 602-642). New York: Cambridge University press.

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. Journal of Behavior Therapy & Experimental Psychiatry, 25(1), 49-59.

Brave, S., & Nass, C. (2002). Emotion in human-computer interaction. In J. Jacko, & A. Sears (Eds.), Handbook of human-computer interaction (pp. 251-271). New York: Lawrence Erlbaum Associates.

Brosnan, M. (1998a). Technophobia. The psychological impact of information technology. London: Routledge.

Brosnan, M. (1998b). The impact of computer anxiety and self-efficacy upon performance. Journal of Computer Assisted Learning, 14(3), 223-234.

Butler, E. A., Egloff, B., Wlhelm, F. H., Smith, N. C., Erickson, E. A., & Gross, J. J. (2003). The social consequences of expressive suppression. Emotion, 3(1), 48-67.

Cacioppo, J. T., & Gardner, W. L. (1999). Emotions. Annual Review of Psychology, 50, 191-214.

Chen, G., Gully, S. M., Whiteman, J., & Kilcullen, R. N. (2000). Examination of relationships among trait-like individual differences, state-like individual differences, and learning performance. Journal of Applied Psychology, 85(6), 835-847.

Chi, M. T. H. (1997). Quantifying Qualitative Analyses of Verbal Data: A Practical Guide. Journal of the Learning Sciences, 6(3), 271-315.

Chua, S. L., Chen, D., & Wong, A. F. L. (1999). Computer anxiety and its correlates: A meta-analysis. Computers in Human Behavior, 15(5), 609-623.

Compas, B. E., Connor-Smith, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. E. (2001). Coping with stress during childhood and adolescence: Problems, progress, and potential in theory and research. Psychological Bulletin, 127(1), 87-127.

Compeau, D., Higgins, C. A., & Huff, S. (1999). Social cognitive theory and individual reactions to computing technology: A longitudinal study. MIS Quarterly, 23, 145-158.

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. MIS Quarterly, 19, 189-211.

Darwin, C. (1872). The expression of emotions in man and animals. London: John Murray.

Derks, D., Bos, A. E. R., & Grumbkow, J. V. (in press) Emoticons and social interaction on the internet: The importance of social context. Computers in Human Behavior, In Press, Corrected Proof.

Dewhurst, D. G., Macleod, H. A., & Norris, T. A. M. (2000). Independent student learning aided by computers: An acceptable alternative to lectures? Computers & Education, 35, 223-241.

Dillenbourg, P. (1999). What do we mean by "collaborative learning"? In P. Dillenbourg (Ed.), Collaborative learning. Cognitive and computational approaches. (pp. 1-19). Amsterdam: Pergamon, Elsevier Science.

Dimberg, U. (1990). Facial electromyography and emotional reactions. Psychophysiology, 27(5), 481-494.

Drolet, A. L., & Morris, M. W. (2000). Rapport in conflict resolution: Accounting for how face-to-face contact fosters mutual cooperation in mixed-motive conflicts. Journal of Experimental Social Psychology, 36(1), 26-50.

Ekman, P. (1999) Basic emotions. In. T. Dalgleish, & M. Power (Eds.), Handbook of Cognition and Emotion (pp. 45-60). New York: John Wiley & Sons Ltd.

Ekman, P., & Friesen, W. V. (1978). Facial action coding system. Palo Alto: Consulting Psychologist Press.

Ekman, P., Friesen, W. V., O'Sullivan, M., & Chan, A. (1987). Universals and cultural differences in the judgments of facial expressions of emotion. Journal of Personality & Social Psychology, 53(4), 712-717.

Eunok, A. K. (2003). Understanding characteristics of lurkers in e-learning. Paper presented at The Annual Meeting of the Association for Educational Communications and Technology (AECT), Anaheim, CA., October, 2003.,

Eysenck, M. W. (1992). Anxiety: The cognitive perspective. Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Eysenck, M. W, and Calvo, M. G. (1992). Anxiety and performance: the processing efficiency theory. Cognition and Emotion, 6, 409-434.

Fischer, A. H. (in press). Gendered social interactions in face-to-face and computer-mediated communication. In A. Kappas (Ed.), Face-to-face communication over the internet: Issues, research, challenges. Cambridge, UK: Cambridge University.

Fredrickson, B. L. (1998). What good are positive emotions? Review of General Psychology, 2(3), 300-319.

Fridlund, A. J. (1994). Human facial expression: An evolutionary view. Academic Press, Inc.

Frijda, N. H. (1986). The emotions. New York: Cambridge University.

Gallo, L. C., & Matthews, K. A. (2003). Understanding the association between socioeconomic status and physical health: Do negative emotions play a role? Psychological Bulletin, 129(1), 10-51.

Gaudron, J., & Vignoli, E. (2002). Assessing computer anxiety with the interaction model of anxiety: Development and validation of the computer anxiety trait subscale. Computers in Human Behavior, 18(3), 315-326.

Grazianoa, P.A., Reavisa, R.D., Keane, S.P., & Calkins, S.D. (2006). The role of emotion regulation in children's early academic success. *Journal of School Psychology, 45*, 3-19.

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. Psychophysiology, 39(3), 281-291.

Gross, J. J. (1998a). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. Journal of Personality & Social Psychology, 74(1), 224-237.

Gross, J. J. (1998b). The emerging field of emotion regulation: An integrative review. Review of General Psychology. Special Issue: New Directions in Research on Emotion, 2(3), 271-299.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. Journal of Personality & Social Psychology, 85(2), 348-362.

Gross, J. J., & Levenson, R. W. (1993). Emotional suppression: Physiology, self-report, and expressive behavior. Journal of Personality & Social Psychology, 64(6), 970-986.

Hall, G. E., & Hord, S. M. (2001). Implementing change. Patterns, principles and potholes. USA: Allyn and Bacon.

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1994). Emotional contagion. Cambridge: Cambridge University Press.

Henri, F., & Pudelko, B. (2003). Understanding and analyzing activity and learning in virtual communities. Journal of Computer Assisted Learning, 19(4), 474-487.

Hess, U., & Kirouac, G. (2004). Emotion expression in groups. In M. Lewis, & J. M. Haviland-Jones (Eds.), Handbook of emotions (2nd ed.) (pp. 368-381). New York: Guilford Press.

Hess, U., & Blairy, S. (2001). Facial mimicry and emotional contagion to dynamic emotional facial expressions and their influence on decoding accuracy. International Journal of Psychophysiology, 40(2), 129-141.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. Review of Educational Research, 60(4), 549-571.

Hidi, S., & Anderson, V. (1992). Situational interest and its impact on reading and expository writing. In K. A. Renninger, & S. Hidi (Eds.), The role of interest in learning and development; the role of interest in learning and development. (pp. 215-238). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Häkkinen, P. (1995). Changes in computer anxiety in a required computer course. Journal of Research on Computing in Education, 27(2), 141-153.

ICD-10. (1992). The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines (1992). Geneva: World Health Organization.

Isen, A. M. (2004). Positive affect and decision making. In M. Lewis, & J.M. Haviland-Jones (Eds.), Handbook of emotions (2nd ed.) (pp. 417-435). New York: The Guilford Press.

Izard, C. E., & Ackerman, B. P. (2000). Motivational, organizational, and regulatory functions of discrete emotions. In M. Lewis, & J. M. Haviland-Jones (Eds.), Handbook of emotions (2nd ed.) (pp. 253-264). New York: The Guilford Press.

Järvenoja, H., & Järvelä , S. (2005). How students describe the sources of their emotional and motivational experiences during the learning process: A qualitative approach. Learning and Instruction, 15(5), 465-480.

Keltner, D., & Kring, A. M. (1998). Emotion, social function, and psychopathology. Review of General Psychology.Special Issue: New Directions in Research on Emotion, 2(3), 320-342.

Kiecolt-Glaser, J. K., & Newton, T. L. (2001). Marriage and health: His and hers. Psychological Bulletin, 127(4), 472-503.

Kirschner, P., Strijbos, J., Kreijns, K., & Beers, P. J. (2004). Designing electronic collaborative learning environments. Educational Technology Research & Development, 52(3), 47-66.

Krapp, A. (1999). Interest, motivation and learning: An educational-psychological perspective. European Journal of Psychology of Education, 14(1), 23-40.

Krapp, A., Hidi, S., & Renninger, K. A. (1992). Interest, learning, and development. In K. A. Renninger, & S. Hidi (Eds.), The role of interest in learning and development. (pp. 3-25). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion and motivation: Measuring affective perception. Journal of Clinical Neurophysiology, 15, 397-408.

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. American Psychologist, 50(5), 372-385.

Lazarus, R. S. (1991). Emotion and adaptation. London: Oxford University Press.

Lehtinen, E. (2003). Computer supported collaborative learning: An approach to powerful learning environments. In E. De Corte, L. Verschaffel, N. Entwistle & J. Van Merriënboer (Eds.), Powerful learning environments: Unraveling basic components and dimensions of powerful learning environments (pp. 35-53). Amsterdam: Elsevier.

Levenson, R. W. (1999). The intrapersonal functions of emotion. Cognition & Emotion. Special Issue: Functional Accounts of Emotion, 13(5), 481-504.

McInerney, V., Marsh, H. W., & McInerney, D. M. (1999). The designing of the computer anxiety and learning measure (CALM): Validation of scores on a multidimensional measure of anxiety and cognitions relating to adult learning of computing skills using structural equation modelling. Educational and Psychological Measurement, 59(3), 451-470.

Monteith, M., & Smith, J. (2001). Learning in a virtual campus: The pedagogical implications of students' experiences. Innovations in Education and Teaching International, 38, 119-127.

Morris, W. N., & Reilly, N. P. (1987). Toward the self-regulation of mood: Theory and research. Motivation & Emotion, 11(3), 215-249.

Nummenmaa, L., & Niemi, P. (2004). Inducing affective states with success–failure manipulations: a meta-analysis. Emotion, 4, 207-214.

Pajares, F. (1996). Self-efficacy beliefs and mathematical problem-solving of gifted students. Contemporary Educational Psychology, 21(4), 325-344.

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. Educational Psychologist, 37(2), 91-106.

Pekrun, R. (2005). Progress and open problems in educational emotion research. Learning and Instruction, 15(5), 497-506.

Picard, R. (2000). Toward computers that recognize and respond to user emotion. IBM Systems Journal, 3, 705-719.

Pintrich, P. R., Smith, D. A. F., Garcia, T., & Mckeachie, W. J. (1993). Reliability and predictive validity of the motivated strategies for learning questionnaire (mslq). Educational and Psychological Measurement, 53(3), 801-813.

Preece, J., Nonnecke, B., & Andrews, D. (2004). The top five reasons for lurking: Improving community experiences for everyone. Computers in Human Behavior, 20(2), 201-223.

Reeve, J. (1989). The interest-enjoyment distinction in intrinsic motivation. Motivation & Emotion, 13(2), 83-103.

Richards, J. M., & Gross, J. J. (2000). Emotion regulation and memory: The cognitive costs of keeping one's cool. Journal of Personality & Social Psychology, 79(3), 410-424.

Robinson, M. D., & Clore, G. L. (2002). Belief and feeling: Evidence for an accessibility model of emotional self-report. Psychological Bulletin, 128(6), 934-960.

Rozell, E. J., & Gardner III, W. L. (2000). Cognitive, motivation, and affective processes associated with computer-related performance: A path analysis. Computers in Human Behavior, 16(2), 199-222.

Russell, J. A. (1980). A circumplex model of affect. Journal of Personality and Social Psychology, 39(1), 1161-1178.

Russell, J. A., Bachorowski, J., & Fernández-Dols, J. (2003). Facial and vocal expressions of emotions. Annual Review of Psychology, 54, 359-349.

Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. Psychological Bulletin, 125(1), 3-30.

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. Contemporary Educational Psychology, 25(1), 54-67.

Salomon, G., & Globerson, T. (1989). When teams do not function the way they ought to. International Journal of Educational Research, 13(1), 89-99.

Scherer, K. R. (1999). Appraisal theory. In T. Dalgleish, & M. J. Power (Eds.), Handbook of cognition and emotion (pp. 637-663). New York: John Wiley & Sons Ltd.

Schiefele, U., Krapp, A., & Winteler, A. (1992). Interest as a predictor of academic achievement: A meta-analysis of research. In K. A. Renninger, & S. Hidi (Eds.), The role of interest in learning and development (pp. 183-212). Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Schutz, P. A., & DeCuir, J. T. (2002). Inquiry on emotions in education. Educational Psychologist, 37(2), 125-134.

Shaw, G., & Marlow, N. (1999). The role of student learning styles, gender, attitudes and perceptions on information and communication technology assisted learning. Computers & Education, 33, 223-234.

Silvia, P. J. (2001). Interest and interests: The psychology of constructive capriciousness. Review of General Psychology, 5(3), 270-290.

Smith, B., & Caputi, P. (2001). Cognitive interference in computer anxiety. Behaviour & Information Technology, 20(4), 265-273.

Spielberger, C. D., Gorsuch, R., & Lushene, R. (1970). The state-trait anxiety inventory (STAI) test manual. Palo Alto: Consulting Psychologist Press.

Suinn, R. M. (2001). The terrible twos - anger and anxiety: Hazardous to your health. American Psychologist, 56(1), 27-36.

Surakka, V., & Hietanen, J. K. (1998). Facial and emotional reactions to duchenne and non-duchenne smiles. International Journal of Psychophysiology, 29(1), 23-33.

Townsend, M. A. R., Moore, D. W., Tuck, B. F., & Wilton, K. M. (1998). Self-concept and anxiety in university students studying. Educational Psychology, 18(1), 41.

Tu, C., & McIsaac, M. (2002). The relationship of social presence and interaction in online classes. American Journal of Distance Education, 16(3), 131-150.

Van der Kleij, R., Paashuis, R., & Schraagen, J. M. (2005). On the passage of time: Temporal differences in video-mediated and face-to-face interaction. International Journal of Human-Computer Studies, 62(4), 521-542.

Vuorela, M. & Nummenmaa, L. (2004). How undergraduate students meet a new learning environment? Computers in Human Behavior, 20, 763-777.

Vygotski, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, Mass.: Harvard U.P.

Watson, D., & Clark, L. A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. Journal of Personality and Social Psychology, 54(6), 1063-1070.

Wild, B., Erb, M., Eyb, M., Bartels, M., & Grodd, W. (2003). Why are smiles contagious? An fMRI study of the interaction between perception of facial affect and facial movements. Psychiatry Research: Neuroimaging, 123(1), 17-36.

Wilfong, J. D. (in press). Computer anxiety and anger: The impact of computer use, computer experience, and self-efficacy beliefs. Computers in Human Behavior, In Press

Wosnitza, M., & Volet, S. (2005). Origin, direction and impact of emotions in social online learning. Learning and Instruction, 15(5), 449-464.

Yamada, H. (1993). Visual information for categorizing facial expression of emotions. Applied Cognitive Psychology, 7, 257-270.

Yerkes, R.M. & Dodson, J.D. (1908). The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology, 18, 459-482. <URL: http://psychclassics.yorku.ca/Yerkes/Law/> 13.3.2006

Zeidner, M. (1998). Test anxiety: The state of the art. New York: Plenum Press.

Åkerlind, G. S., & Trevitt, A. C. (1999). Enhancing self-directed learning through educational technology: When students resist the change. Innovations in Education and Training International, 36, 96-105.