European Journal of Psychology of Education
2004, Vol. XIX, nº 4, 423-436

Experienced emotions, emotion regulation and student activity in a web-based learning environment

Minna Vuorela
Lauri Nummenmaa
University of Turku, Finland

We examined what events cause emotional reactions when students use a web-based learning environment (WBLE) in their studies, and how the emotions experienced while using the WBLE, emotion regulation strategies and computer self-efficacy are related to collaborative activities in the environment. Lability of emotional reactions and their regulation in advance directed and maintained effective collaborative activities in the web-based learning environment. Further, students experienced a wide range of emotions while using the WBLE and especially the nature of interaction during the activities was 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, prevailing antecedent of the affective reactions experienced while using such learning environments.

Introduction

Use of networks as means for cooperation as a part of a learning process is increasing constantly, and students have to get accustomed to participating in collaborative activities in web-based learning environments (WBLE). Therefore, many of the recent studies on e-learning have focused on identifying the characteristics of the students that predict success in web-based learning environments (e.g., Federico, 2000; Lee, Hong, & Ling, 2002; Vuorela & Nummenmaa, 2004). Although there is evidence that attitudes, experience and satisfaction toward the technology are related to students' success in virtual learning environments (Federico, 2000; Lee, Hong, & Ling, 2002) they do not inevitable predict the actual activity (Vuorela & Nummenmaa, 2004) in the environment.

Further, several studies have focused on the student activity and the group communication in web-based learning environments and virtual communities (e.g., Chen, Wang & Ou, 2003; Henri & Pudelko, 2003) but these studies have not emphasized the implications of the characteristics of the *individual user* to the process of using a WBLE. A substantial amount of the students' activities in WBLE consist of collaborative group work, but each student interprets the learning situation differently depending on his or her individual experiences and acts according to these expectations and interpretations (Järvelä, Lehtinen, & Salonen, 2000). Therefore, it can be hypothesized that combining measurements of students' collaborative activity in a WBLE with measures of characteristics of the individual users would explain how different students use a WBLE for collaborative purposes.

Wide range of emotions play important role in every computer-related, goal-directed situation (Brave & Nass, 2002). Negative emotions calibrate psychological systems by calling for mental or behavioural adjustment, and positive emotions serve as a cue to explore the environment (Cacioppo & Gardner, 1999). Therefore the emotions people experience while using a WBLE can be hypothesized to direct the actions people take in the environment. The purpose of the present study was to determine how emotions experienced in a web-based learning environment, emotion regulation strategies and computer self-efficacy are related to student collaborative activity i.e., the intensity to participate in task-related group activities in the WBLE, and what events cause emotional reactions when using the environment.

Emotional reactions and computer using

Emotions occur when individuals encounter situations that have affective properties (e.g., 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 affect also their motivation (Atkinson, 1957) and perceived capabilities to perform various tasks (Bandura, 1997). 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 can be hazardous to health (Suinn, 2001), interpersonal relations, and learning and work performance (Compas, Connor-Smith, Saltzman, Harding Thomsen, & Wadsworth, 2001; Gallo & Matthews, 2003; Kiecolt-Glaser & Newton, 2001).

Although emotions are important determinants of individuals' actions, little attention has been paid to the affective causes and consequences of the users' behavior in computer-based environments. Most of the previous studies on affective processes and computer-related performance have focused on trait-like individual differences in affective reactivity, e.g., computer anxiety (see e.g., Brosnan, 1998; Chua, Chen, & Wong, 1999). Moreover, 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 (see e.g., Picard, 2000). Computers are, however, also used to mediate interactions between people. This is especially evident when using network environments for collaborative purposes. Therefore individual differences in users' affective reactivity toward computers might not be sufficient predictor of their actions in such environments. Other antecedents of users' emotions such as interactions between people should also be considered in research.

Emotions in web-based learning environments

Making learning tasks more cooperative and increasing the use of web-based learning environments may increase the complexity of learning situations. For a learner a learning situation is not merely a mental performance, but also a motivational challenge and an emotional coping situation. Emotions occur while individuals asses how the events occurring in their environment are relevant to their needs and goals (Brave & Nass, 2002; Lazarus, 1991). Students enter a WBLE hoping to achieve goals e.g., finding information, participating in discussions and composing documents. Therefore the degree to which the WBLE facilitates or hinders these goals can be hypothesized to have a direct effect on students' emotional state.

Besides being an environment for learning and studying, the WBLE can be regarded as both a *technical* and a *social* environment. A WBLE can be studied as a technical environment, because using it is an interaction process between an individual and technology. The degree to which a WBLE as a technical environment answers to users' 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 task-related activities. For example, an unpractical environment or unstable technology could distract attention and cause frustration and disturb users (Brave & Nass, 2002; Picard, 2000).

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 is presumable that the affective reactions occurring while using the environment for collaborative purposes may not result only from using the computer but also from the interactions between the individual users in the environment. 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), it is not known whether the interactions in computer-mediated communications result in affective reactions similarly as in traditional face-to-face interactions.

Not all the affective reactions occurring while using a WBLE are advantageous for successful performance. Although emotions are usually adaptive reactions, they can also hinder performance. Negative emotions such as anxiety, frustration, or anger have disadvantageous consequences on individual's adaptation and well being in many situations (e.g., 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. Negative emotions can be either the cause or the consequence of the problems related to studying in web-based learning environments. For example, a recent study has shown that computer anxious students have negative expectations of the consequences of using the web-based learning environment in their studies (Vuorela & Nummenmaa, 2004). Moreover, anxiety has negative effects on cognitive performance (Eysenck, 1992), but not necessarily directly (Bandura, 1997). A number of recent studies have demonstrated that both anxiety experienced in a learning situation and individual's perceived capabilities to perform the learning task affect learning, but the effects of anxiety are mediated by the perceived capabilities (Chen, Gully, Whiteman, & Kilcullen, 2000; Compeau, Higgins, & Huff, 1999; Pajares, 1996). Additionally, 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 have also influence on how these emotions affect the learning process.

Regulation of emotional reactions

Though emotions may occur automatically due to changes in environment, individuals have also ability to manage their own emotionality. 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 to effective functioning (Gross & John, 2003; Morris & Reilly, 1987). Recently, many studies have focused on consequences of two emotion regulation strategies: cognitive reappraisal and expressive suppression (see Gross, 2002). Cognitive reappraisal is an antecedent-focused strategy, which is used before an emotion is elicited. By contrast, expressive suppression is a response-focused strategy, which is used to modulate emotions that have already been elicited.

The strategies an individual uses for emotion regulation have different consequences on physiological, experiential, and behavioral components of emotion. In a series of laboratory experiments it has been demonstrated that using both reappraisal and suppression decrease behavioral expression, but only using reappraisal decreases the intensity of experienced emotions (see Gross, 1998a; Gross & Levenson, 1993). Moreover, using suppression increases physiological activity whereas reappraisal does not (Gross, 1998a). Furthermore, while reappraisal has no impact on memory, suppression impairs it (Richards & Gross, 2000).

Individuals differ in their use of emotion regulation strategies, and the strategies individuals use can affect their 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 behavior.

It can be hypothesized that emotion regulation is important to effective functioning also 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 and instead try 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) skillful emotion regulation can be hypothesized to be beneficial for the interactions of the individuals while collaborating in a WBLE.

Efficacy beliefs and computer using

Experience of emotions and the regulatory skills, however, are not only factors that affect peoples' tendencies to perform different courses of action. 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 have also influence on how long people persist in the face of failure or other obstacles. Thus, the higher are the beliefs of personal competence, the greater are the effort and persistence. Self-efficacy beliefs have also influence on the nature and intensity of emotional experiences (Bandura, 1997). Anxiety, for example, has the most extensive influence on learning when 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. Computer self-efficacy refers to 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 computer can have positive influence on their self-efficacy.

The present study

The purpose of the present study was to determine: (1) what events cause emotional reactions in students while students use a web-based learning environment for collaborative learning and (2) how the emotions experienced while using the WBLE, emotion regulation strategies and computer self-efficacy are related to students' collaborative activity in the environment?

Although computer anxiety is a widely acknowledged phenomenon (see e.g., Brave & Nass, 2002; Brosnan, 1998), we hypothesized that in addition to the computer, technology, or environment, also the presence of other students in the environment causes emotions in the WBLE. We also hypothesized that effective regulation of affective impulses in forehand e.g., using reappraisal as emotion regulation strategy, and positive affectivity during the course will increase collaborative activity in the learning environment. Further, we hypothesized that students' high computer self-efficacy would have positive influence on their motivation to use the WBLE and participate to computer-mediated communication, because individuals tend to prefer activities for which they have capabilities (Bandura, 1982, 1997).

Methods

Participants and the learning 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 program in educational use of information and communication technologies. Participants were from seven Finnish universities and majored in various subjects. All the students enrolled on the course were contacted by a pre-test questionnaire before the course, and they completed an on-line questionnaire repeatedly during the course. The response rate was 66% (*N*=93, 64 females, 29 males) for the pre-test questionnaire. Participants' ages ranged from 18 to 52 years (*M*=27, *SD*=6.95) and they had studied in university for 0 to 9 years (*M*=3, *SD*=2.12). The total number of answers to on-line questionnaire was 1037 (*N*=104). Sixty-four participants responded to both the pre-test questionnaire and the on-line questionnaire.

The course was organized through a web-based learning environment called WorkMates that was not familiar to 80% of the participants. WorkMates is a web-based collaborative learning environment developed at the Educational Technology Unit in University of Turku. The WorkMates supports collaborative group work through the web by asynchronous text-based commentary and discussions. Participants' comments in the environment form threaded discussions. In this study the participants engaged in three tutored discussions related to the course material and assignments: an orientation discussion (getting acquaint with the environment and members of own group) and two group work discussions (discussing about the course literature according to given instructions and writing collaboratively a short essay based on the literature). The orientation period lasted for one week and the first and second group work discussions 1,5 and 2,5 weeks, respectively. Participating in these discussions was an obligatory part of the course.

Measures

Pre-test measures. Participants' emotion regulation strategies (suppression and reappraisal) and computer self-efficacy were measured with questionnaires before the course. *Emotion regulation* was measured with a Finnish translation of the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003). In ERQ participants were asked to rate with a scale ranging from *strongly disagree* (1) to *strongly agree* (7) how they regulate their emotions. There were ten items measuring two emotion regulation strategies: reappraisal (6 items, e.g., "When I want to feel less negative emotion, I change the way I'm thinking about the situation.") and suppression (4 items, e.g., "I keep my emotions to myself."). A pilot testing for the Finnish translation of ERQ (*N*=54) was conducted in autumn 2003. In pilot testing the reappraisal scale demonstrated moderate internal consistency (α=.65). All the items correlated with the total score, *r*s ranging from .44 to .72 (all *p*s<.05). The reliability of the suppression scale was moderate (α=.71). All the items correlated with the total score, *r*s ranging from .75 to .82 (all *p*s<.05). In the present study (*N*=94) the reliability of reappraisal scale was also moderate (α=.68). All the items correlated with the total score, *r*s ranging from .45 to .73 (all *p*s<.05). The suppression scale demonstrated also moderate internal consistency (α=.79). All the items correlated with the total score, *r*s ranging from .68 to .90 (all *p*s<.05). The reliabilities of the scales were acceptable considering the lengths of the subscales (4 and 6 items) and similar to those reported by Gross and John (2003). Therefore the psychometric properties of the Finnish translation of the ERQ were considered to be appropriate. A mean of the answers for items in both the scales was computed to form scores of *suppression* and *reappraisal* variables for each participant.

Computer self-efficacy was measured with a Finnish version of the Computer Self-Efficacy Scale (Compeau & Higgins, 1995). Level, strength and generality (Bandura, 1997; Compeau & Higgins, 1995) of the computer self-efficacy were measured in with 10 items. Participants were asked to evaluate with a scale ranging from *not at all confident* (0) to *totally confident* (10) how confident they felt about performing the behaviors described in the questionnaire. Questionnaire items were task-specific, varied in difficulty and captured degrees of confidence (e.g., "I can get over with a given assignment even if I have not used to program before" or "I can get over with a given assignment even if I can get help when needed"). The reliability of the scale (*N*=94) was acceptably high (α=.90). All the items correlated with the total score, *r*s ranging from .55 to .87 (all *p*s <.05). A mean of the answers for all the scale items was computed to form a score of *computer self-efficacy* variable for each participant.

On-line measures. Previous studies on the relationship between emotions and computer using have mainly focused on studying the effects of self-reported individual differences in affective reactivity, mainly computer anxiety (see e.g., Gaudron & Vignoli, 2002; Vuorela & Nummenmaa, 2004) instead of differences in actual affective reactions occurring while using a WBLE. However, memory-based reports of affective reactions must be distinguished from on-line reports. People often report different emotions when they experience them than when they are *recalling* or *predicting* experiencing them. 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. Therefore this study implemented a strategy for measuring affective reactions repeatedly *during* a WBLE use. Affective reactions resulting from using the WorkMates environment were measured with the valence and arousal 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. 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). The valence scale of five figures ranges from *pleasant* (1) to *unpleasant* (5) and the arousal scale ranges from *excited* (1) to *calm* (5).

In order to assess what events caused emotional reactions while working in the environment, participants were also asked to report the antecedents of their affective state in free form each time they filled the SAM. The html-formatted on-line questionnaire consisting of the SAM and the above-mentioned free form field was presented automatically to participants each time they logged out from the WorkMates. For each participant, *mean* and *standard deviation of valence*, and *mean* and *standard deviation of arousal* were computed from his/her responses to the SAM scales. The mean scores were used to measure the average level and the standard deviations the lability of the dimension. Altogether 104 participants completed the SAM questionnaire at least once during the course. The total number of answers ranged from 1 to 40 responses per participant.

To distinguish the causes related to different aspects of technology and interaction, two researchers classified the reported causes of emotional reactions into five categories. The categories were constructed in accordance of the content of the reported causes. The inter-coder reliability was .86. The categories were: (1) causes relating to WorkMates environment (e.g., "The WorkMates environment is very clumsy." or "This time WorkMates runs correctly."), (2) causes relating to functionality of technology (e.g., "The computer disobeys!" or "My home computer works again!"), (3) causes relating to the course as a whole (e.g., "I can't get a grip of this course." or "Next exercise seems to be interesting and challenging."), (4) causes relating to the interaction in the environment (e.g., "Nobody has commented my texts." or "Finally, the discussions are flowing.") and (5) causes relating to external factors (e.g., "I'm very busy right now." or "I had a nice and restful weekend.").

Activity. Analysis of participants' *activity* in the WorkMates was based on the archived comments in the three tutored discussions and was conducted after the course. Two researchers classified the participants' comments (altogether 1017 comments by 98 individual participants, an average of 10.37 comments per participant) into nine types in accordance of their content: (1) proposing or suggesting, (2) supporting or agreeing, (3) opposing or disagreeing, (4) sharing own experience, (5) giving information, (6) summarizing, (7) inquiring, (8) answering or specifying and (9) organizing the exercise. The classification was based on the system presented in Vuorela and Nummenmaa (2004), and complemented with three content types (4, 6 and 9). One comment could include multiple content types (1-9). The inter-coder reliability was .80.

The total number of participants' comments in the WBLE can be regarded as an insufficient indicator of student activity because it lacks information about the content and type of the activity (Vuorela & Nummenmaa, 2004). Because a single comment can include multiple content types we constructed the *total activity score* by multiplying total number of comments with total number of contents in the comments. This measure reflects both the activity in commenting and versatility of the contents in the comments. The skewness of the distribution was balanced with al natural logarithm transformation.

Results

Associations between computer self-efficacy, emotion regulation and affective reactions

Due to the violation of the normality assumption in the tested variables, a nonparametric approach was used in statistical testing. Table 1 presents the descriptive statistics of participants' computer self-efficacy, reappraisal and suppression strategies, and mean and standard deviation of valence and arousal. In general, participants had very high levels of computer self-efficacy. Additionally, they reported to use more reappraisal than suppression as emotion regulation strategy (Z=-8.00, p<.01). Participants who experienced more positive affects during the course were less aroused than those who experienced more negative affects, as participants' mean valence was negatively correlated with mean arousal (r_s=-.55, p<.01, n=101).

Associations of reappraisal, suppression and computer self-efficacy with the mean and standard deviation of valence and arousal were also examined. Participants' computer self-efficacy was positively correlated with the mean arousal (r_s=.31, p<.01, n=77). Participants with high computer self-efficacy were less aroused during the course than participants with low efficacy. There were no association between emotion regulation strategies and mean and standard deviation of valence and arousal.

Table 1

Means and standard deviations of computer self-efficacy, emotion regulation strategies and affective reactions

	N	*Min*	*Max*	*M*	*MD*	*SD*
Computer self-efficacy	93	5.20	10.00	8.10	8.10	1.12
Reappraisal	93	1.71	6.00	4.50	4.60	.85
Suppression	93	1.00	5.30	2.70	2.30	1.04
Mean valence	101	1.30	5.00	2.70	2.80	.77
Mean arousal	101	1.00	5.00	3.60	3.50	.73
Standard deviation of valence	101	0.00	2.10	.50	.50	.42
Standard deviation of arousal	101	0.00	2.10	.50	.40	.49

Emotions, regulation, self-efficacy and activity in the WBLE

Binary logistic regression analysis (see Table 2) was conducted to predict dichotomized activity in the environment with computer self-efficacy, emotion regulation strategies, mean and standard deviation of valence, and mean and standard deviation of arousal. The first model including all the predictors fit the data well (Hosmer-Lemeshov $\chi^2(8)=8.31$, $p=.40$), but it was not significantly better than the intercept model [$\chi^2(7)=12.98$, $p=.07$]. Only the likelihood ratio of reappraisal was statistically significant, and the variables with the smallest predicting power were removed stepwisely in the following order: (1) standard deviation of arousal, (2) mean valence, (3) computer self-efficacy, (4) suppression, and (5) mean arousal. This resulting model fit the data well [Hosmer-Lemeshov $\chi^2(8)=5.49$, $p=.70$] and was also significantly better than the intercept model [$\chi^2(2)=10.63$, $p=.01$]. Because the model classified correctly 72.1% of the observations, and the adjusted coefficient of determination was moderate (Nagelkerke $R_2=.21$), this was considered to be the final model.

Table 2

Summary of binary logistic regression models for variables predicting activity in the environment (N=61)

Variable		*Exp(B)*	*Wald*	*df*	*p*
Step1	CSE	.86	.31	1	.58
	Reappraisal	2.30	3.89	1	.05
	Suppression	1.26	.55	1	.46
	SD Valence	3.33	1.35	1	.25
	SD Arousal	1.50	.15	1	.70
	M Valence	1.20	.15	1	.70
	M Arousal	2.13	1.56	1	.21
Final model	Reappraisal	2.08	3.79	1	.05
	SD Valence	4.52	4.22	1	.04

What events cause emotional reactions in the WBLE?

Altogether 575 of the 1037 answers to the SAM included an antecedent of respondent's current emotional state (see Table 3). The course as a whole was mentioned as cause of emotions more often than the causes relating to the WorkMates environment ($Z=-4.24$, $p<.01$) or the functionality of technology ($Z=-5.84$, $p<.01$). Similarly, the causes relating to the interaction in the environment were reported to bring about emotions more often than the causes relating to the WorkMates ($Z=-4.52$, $p<.01$) or to the functionality of technology

(*Z*=-5.70, $p<.01$). The interaction was also reported more often than the causes relating to the course as a whole (*Z*=-2.00, $p<.05$). The amount of the causes relating to the external factors was also significantly higher than that of the causes related to the WorkMates (*Z*=-4.31, $p<.01$) or to the technology (*Z*=-6.12, $p<.01$).

Table 3

Frequencies, number of respondents and means and standard deviations of resulting valence and arousal of different causes of emotional reactions

Causes relating to	*f*	*%(f)*	*n*	*%(n)*	*M(Val)*	*SD(Val)*	*M(Aro)*	*SD(Aro)*
WorkMates environment	58	10	39	38	2.99	1.01	3.27	1.22
functionality of technology	25	4	19	18	3.21	1.06	2.91	.88
the course as a whole	127	22	56	54	2.65	1.01	3.45	.82
the interaction in the environment	174	31	55	53	2.34	.96	3.45	.85
external factors	191	33	58	56	2.81	.81	3.71	.84

Note. *f*=frequency of responses, *n*=number of participants reporting the cause (*N*=104).

As the course was divided into three discrete periods (orientation discussion, group work 1 and group work 2), we also analyzed whether progression of the course resulted in changes in affective reactivity. It was found that participants experienced more positive affects (*Z*=-3.94, $p<.01$) and were less aroused (*Z*=-2.62, $p<.01$) during the orientation period of the course than during the first group work period. However, mean valence and arousal reported during the second group work period were similar to those of reported during the orientation period and the first group work discussion.

Discussion

The data demonstrated that the standard deviation of valence and using reappraisal as emotion regulation strategy predicted the students' collaborative activity in the web-based learning environment. This suggests that both lability of emotional reactions and their effective regulation affect student participation in collaborative activities in a WBLE. However, although we hypothesized that positive affectivity would result in collaborative activity in the environment the hypothesis was not supported as such. The mean valence for all participants was approximately 3, which is very close to the midpoint of the scale. Therefore it is not surprising that the variance of valence rather than the valence itself explained students' activity. Small affective variance typically means that a participant has been in a neutral affective state for most of the time. Large variances, however, indicate that the affective state has deviated from the neutral valence to 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 variance of valence predicted the collaborative activity in the environment. Moreover, the results confirmed that using reappraisal as emotion regulation strategy led to increased activity in the environment. This supports the hypothesis (see Gross, 1998a; Gross & John, 2003) that the ability to anticipate and manipulate own emotional reactions in advance is advantageous for effective functioning. However, the suppressive emotion regulation was not negatively associated with activity. 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.

Contrary to our predictions, the data did not support the hypothesis that high computer self-efficacy would increase students' motivation to use the WBLE and 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. The result may indicate that high efficacy beliefs function as a calming feature when working in a WBLE, which suggests that efficacy beliefs also are related to the self-regulation of affective states as Bandura (1982, 1997) has suggested. However, the results of this and other studies (e.g., Vuorela & Nummenmaa, 2004) indicate that generally university students have very high efficacy beliefs of their own capabilities of using computers, and 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.

We also found that a wide range of emotions were experienced while using the WBLE and, as predicted, not only the technical environment caused emotional reactions. The course as a whole and especially the interaction in the environment was mentioned as cause of emotions more often than the technical environment. This supports the hypothesis that when a WBLE is used for collaborative purposes, the affective reactions occurring during the activity do not result only from using the environment, but also from the interactions between students in it. This suggests that while the presence of others influences students' interaction in a virtual environment (Tu & McIsaac, 2002) it is also an important antecedent of students' affective reactions in a WBLE as it is in face-to-face learning situations. However, the number of reported causes of emotions relating to the external factors was also remarkably higher than the number of those relating to technical aspects. Therefore it is likely that even if the environment and used technology are functional, the course is well designed and the interaction within student group is effective, it is almost impossible to control all the events that influence the emotions students experience during the activities in the WBLE. These results also lend support to the view that the widely studied computer anxiety might not be a sufficient predictor of collaborative activity when studying consequences of affective reactions in a WBLE, as technology is not the sole antecedent of the emotional reactions.

Further, there were significant changes in students' affective reactivity during the different periods of the course. Students demonstrated decrease in valence and increase in arousal after the orientation period of the course. There are at least two possible explanations to this. Firstly, negative emotions occur often in situations in which people experience events that conflict with their goals and needs (see e.g., Nummenmaa & Niemi, 2004). The orientation period had no clear objective related to learning, and the participants might not have regarded the orientation period as relevant to their learning goals. This might have resulted in less negative affectivity during the orientation period. Secondly, negative emotions are likely to result in social conflicts (Frijda, 1986). The group work discussions required more intensive collaboration than the orientation. Therefore the social presence might have been more distinctive in the group work periods, which may have led to increased negative affectivity. However, the mean valence and mean arousal during the orientation period and the second group work discussion were similar. This is likely due to the fact that the students have been accustomed to working in the environment and each other during the first group work discussion, which may have resulted in increase of valence and decrease in arousal during the second group work discussion.

Some limitations of the results should be mentioned. Firstly, because of the technical problems, we were unable to use the log data of the environment, which would have enabled us to analyze more precisely the student' behavior (e.g., reading discussions, importing/exporting files) in the environment. Therefore we could predict only the observable activity i.e., the total number of students' comments multiplied with the contents in the comments. However, the activities in a WBLE consist also of invisible activity, 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. Such activity should be distinguished from observable activity that was measured in this study. However, in this study it proved to be reasonable to use the observable behavior (i.e., total activity score) as an indicator of the task-related group activity in the environment, because participants' course grade correlated positively with the total activity score (r_s=.37, p<.01, n=77). Active participants also got better grades than the inactive ones, which suggest that the used activity score is reasonable indicator of learning-related activity in the environment, though it probably reflects also other variables such as ability and interest. Despite of that, it would be meaningful to examine also the invisible behavior of non-participating students and see whether similar factors predict both invisible and observable action.

Secondly, the number of answers to SAM ranged from 1 to 40 responses and there were participants whose valence scores consisted only of one response, and the variance of valence for these participants was zero. Although the number of such participants was relatively small (n=10), the variance of valence is not totally robust estimate of actual variation in affective valence. Finally, the sample consisted of students who studied in a program in educational use of information and communication technologies (ICT). Although we did not measure participants' motivation or interest to use the WBLE and participate to computer-mediated activities in this study, their background of choosing the ICT program could indicate that they might have been more interested to use the WBLE and have had more positive feelings toward technology than the general student population. Because of that a similar pattern of results might not emerge on other student samples.

Conclusion

Students experienced emotions while using the WBLE, and the experience and regulation of the emotional reactions affected how actively the students participated in the collaborative discussions in the environment. This shows that both the emotional experiences and their regulation direct and maintain behavior in a WBLE as they do in face-to-face learning situations. It is also important to note that although the presence of technology is very obvious in web-based learning environments, it was not, however, prevailing antecedent of the emotions experienced while using such learning environments. The results of this study underline the importance of considering the social aspects of the learning situation when planning the use of a WBLE in instruction. The findings demonstrate that the nature of interaction is important antecedent of students' affective states in a WBLE. Teachers and tutors should especially be aware of this when they are planning and organizing highly intensive collaboration periods for online courses.

However, although these results provide useful explanations for students' collaborative activity in a WBLE, they do not deal with the *reasons* students have for engaging in learning activities. Individuals' *interest* about certain activity or topic has also a strong influence on their cognitive and affective functioning and persistence effort (Ainley, Hidi, & Berndorff, 2002; Schiefele, Krapp, & Winteler, 1992). That is why future research should also focus on students' motivated behavior and interest to engage in collaborative activities in web-based learning environments.

References

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

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

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 and Company.

Bandura, A. (2001). *Constructing self-efficacy scales*. Acquired 7.6.01 in html-format from http://www.emory.edu/EDUCATION/mfp/banduraguide.html.

Bradley, M.M. (2000). Emotion and motivation. In J.T. Cacioppo, L.G. Tassinary, & G.G. Berntson (Eds.), *Handbook of Psychophysiology* (2nd ed., 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 and Experimental Psychiatry, 25*, 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.J. (1998). *Technophobia. The Psychological Impact of Information Technology*. London: Routledge.

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

Chen, G.D., Wang, C.Y., & Ou, K.L. (2003). Using group communication to monitor web-based group learning. *Journal of Computer Assisted Learning, 19*, 401-415.

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

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

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

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

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.

Eysenck, M.W. (1992). *Anxiety: The cognitive perspective*. East Sussex: Lawrence Erlbaum Associates.

Federico, P-A. (2000). Learning styles and student attitudes toward various aspects of network-based instruction. *Computers in Human Behavior, 16*, 359-379.

Frijda, N.H. (1986). *The emotions*. Cambridge: Cambridge University Press.

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*, 10-51.

Gaudron, J.-P., & 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*, 315-325.

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

Gross, J.J. (1998b). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*, 271-299.

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

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

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

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

Järvelä, S., Lehtinen, E., & Salonen, P. (2000). Socio-emotional orientation as a mediating variable in the teaching-learning interaction: Implications for instructional design. *Scandinavian Journal of Educational Research, 44*, 293-306.

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

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

Lazarus, R.S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Lee, J., Hong, L., & Ling, L. (2002). An analysis of students' preparation for the virtual learning environment. *Internet and Higher Education, 2*, 231-242.

Levenson, R.W. (1999). The intrapersonal function of emotions. *Cognition and Emotion, 13*, 481-504.

Morris, W.N., & Reilly, N.P. (1987). Toward the self-regulation of mood: Theory and research. *Motivation and Emotion, 11*, 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*, 325-344.

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

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

Robinson, M.D., & Clore, G.L. (2002). Belief and Feeling: Evidence for an accessibility model of emotional self-report. *Psychological Bulletin, 28*, 934-960.

Scherer, K. (1999). Appraisal theory. In T. Daleigsh & T. Power (Eds.), *Handbook of Cognition and Emotion* (pp. 637-659). Sussex: John Wiley & Sons.

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, & A. Krapp (Eds.), *The Role of Interest in Learning and Development* (pp. 183-212). Erlbaum, NJ: Hillsdale.

Suinn, R.M. (2001). The terrible twos – Anger and anxiety. *American Psychologist, 56*, 27-36.

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

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

Cet article présente une recherche visant à relever quels événements provoquent des réactions émotionnelles lorsque les étudiants utilisent un environnement d'apprentissage virtuel (web-based learning environment, WBLE) comme outil en leur études, et comment les émotions éprouvées pendant l'utilisation de l'environnement d'apprentissage virtuel, les stratégies de la maîtrise des émotions et le niveau de maîtrise des TIC (les technologies de l'informatique et de la communication) se rapportent aux activités collaboratives en cet environnement. Les variations des réactions émotionnelles et la régulation des réactions auparavant dirigeait et soutenait des activités collaboratives effectives en utilisant un environnement d'apprentissage virtuel. En outre, les étudiants éprouvaient des émotions très variées pendant l'utilisation de l'environnement d'apprentissage virtuel, et spécialement la nature de l'interaction pendant les activités était un antécédent important des réactions affectives. Ce résultat souligne que même si la présence du technologie est évidente dans un environnement d'apprentissage virtuel, elle n'est pas, quand même, un antécédent prédominant des réactions affectives éprouvées pendant l'utilisation tels environnements d'apprentissage.

Key words: Emotion, Emotion regulation, Self-efficacy.

Received: March 2004
Revision received: October 2004

Minna Vuorela. University of Turku, Educational Technology Unit, 20014 University of Turku, Finland; E-mail: minna.vuorela@utu.fi, Web site: www.utu.fi

Current theme of research:

Emotion, Regulation and interest in web-based learning environments.

Most relevant publications in the field of Psychology of Education:

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

Lauri Nummenmaa. University of Turku, Department of Psychology, 20014 University of Turku, Finland; E-mail: lauri.nummenmaa@utu.fi, Web site: www.utu.fi

Current theme of research:

Emotion, Regulation and interest in web-based learning environments.

Most relevant publications in the field of Psychology of Education:

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