



University students' emotions, interest and activities in a web-based learning environment

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Background. Within academic settings, students experience varied emotions and interest towards learning. Although both emotions and interest can increase students' likelihood to engage in traditional learning, little is known about the influence of emotions and interest in learning activities in a web-based learning environment (WBLE).

Aims. This study examined how emotions experienced while using a WBLE, students' interest towards the course topic and interest towards web-based learning are associated with collaborative visible and non-collaborative invisible activities and 'lurking' in the WBLE.

Sample. Participants were 99 Finnish university students from five web-based courses.

Methods. All the students enrolled in the courses filled out pre- and post-test questionnaires of interest, and repeatedly completed an on-line questionnaire on emotions experienced while using the WBLE during the courses.

Results. The fluctuation of emotional reactions was positively associated with both visible collaborative and invisible non-collaborative activities in the WBLE. Further, interest towards the web-based learning was positively associated with invisible activity. 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.

Conclusion. The results highlight the distinct impacts that emotions and interest have on different web-based learning activities and that they should be considered when designing web-based courses.

Students experience a wide range of emotions in academic settings that are often associated with their learning and achievement (Pekrun, Goetz, Titz, & Perry, 2002). A student's emotional state can affect important aspects of the learning process

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including motivation (Atkinson, 1957), attention, memory and decision making (Cacioppo & Gardner, 1999). Studying in web-based learning environments (WBLEs) is becoming increasingly popular in universities. Interestingly, it has been shown that even the asynchronous student interaction in a WBLE elicits emotional reactions which exert an influence on how actively the students participate in the collaborative learning activities in the environment (Vuorela & Nummenmaa, 2004a).

The Vuorela and Nummenmaa (2004a) study assessed how emotions influenced students' activities that were visible to the other users of the WBLE (i.e. the students' collaborative, task-related on-line behaviour in the WBLE's on-line discussion forum). However, not all student actions in the learning environment are collaborative. It is known that a subset of the students enrolled in a course organized through the WBLE become inactive members of the learning group. These students might stay in the background and visit the WBLE frequently to see what others are doing, but they prefer not to participate in the joint learning effort. Thus, they are mainly engaged in non-collaborative activities that are not visible to the rest of the students. An important question is whether emotional reactions influence such non-collaborative behaviour as well as collaborative behaviour.

Web-based learning environments are a relatively new medium for studying, and students vary with respect to their interest in such learning. An individual's interest in certain activities or topics has a strong influence on cognitive and affective functioning, persistence and effort (Ainley, Hidi, & Berndorff, 2002; Schiefele, Krapp, & Winteler, 1992). Despite this, it has not been studied whether the interest in web-based learning is actually associated with student behaviour in the WBLE. The aim of the current study was to assess the impact of experienced emotions, interest in the course topic and interest in web-based learning on collaborative and non-collaborative behaviour in the WBLE.

Collaborative learning and lurking

Collaborative learning in a web-based learning environment is an interactive process among the students. As such, the WBLE can be studied as a social environment (Kirschner, Strijbos, Kreijns, & Beers, 2004; Lehtinen, 2003) where students participate in a collective learning project and knowledge construction. Learning in a WBLE can, therefore, be assumed to be associated with social activities such as participation in group discussions. However, this is not to imply WBLEs preclude independent learning. The collaborative learning activities in a WBLE include writing texts together and commenting on them. The outcomes of such activities are visible to all the students involved in the learning process. For example, when one student publishes an 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 with respect to the work. As such actions leave visible marks on the WBLE, they provide the students with an opportunity to appraise and assess the behaviour of other students in the WBLE and to use the WBLE as a means of collaboration.

On the contrary, some of the students' learning-related activities in a WBLE are invisible to the members of the learning group, and these activities are typically unrelated to collaborative learning. For example, when a student reads another student's essay in the WBLE but does not publish a comment on it, their involvement is invisible and, therefore, this cannot be considered collaborative. In this way, it is possible for a student to read and follow the discussions in the on-line learning groups

very actively without participating in the discourse. Importantly, other students do not benefit from such invisible learning behaviour in the WBLE so it is important to distinguish between these two types of student behaviour - collaborative visible and non-collaborative invisible activities.

Students who do not actively participate in collaborative learning in the WBLE are often referred to as 'lurkers' (Preece, Nonnecke, & Andrews, 2004). Lurkers do not, however, represent a homogenous group and there are various definitions for what constitutes lurking. At least two subsets of overtly inactive participants can be defined: (i) those who do not participate in the joint learning effort but visit the on-line environment frequently, and spend a considerable amount of time using the environment and following the discussions and (ii) those who neither participate in nor follow the discussions. For the purposes of this study, the first group of students are considered lurkers. Consequently, lurking in on-line learning groups is defined as a specific pattern of participation that utilizes the fact that students cannot see one another. The lurkers take advantage of teachers' and students' contributions, but do not themselves contribute to the learning of the group. It is not known whether the lurkers are engaged in the learning process, or whether they are 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 in the same way as are the participating students (Beaudoin, 2002). However, recent evidence suggests that a high level of visible (i.e. collaborative) activities in a WBLE is positively associated with course grade (Beaudoin, 2002; Vuorela & Nummenmaa, 2004a), implying that the inactive students might not be learning as effectively as the active ones.

There are many reasons why individuals might choose to lurk instead of participating actively in web-based learning. The belief that participation is not necessary, feelings of discomfort, perceiving the group dynamics as unsatisfactory, the need get acquainted with the group, shyness, and a desire to remain anonymous are possible reasons why a student might choose a non-collaborative approach (Beaudoin, 2002; Preece *et al.*, 2004). Two conclusions can therefore be drawn from the aforementioned studies that are relevant for our aims. First, visible and invisible behaviours in the WBLE have different causes and consequences for students' learning. Thus, when studying student behaviour in a WBLE, a distinction must be made between the collaborative visible and the non-collaborative invisible behaviours. Second, the possible reasons for lurking and non-participation 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 on-line groups as tools for knowledge construction. Hence, when studying student activities in a WBLE, one must try to assess simultaneously how both emotions and interest influence the visible and invisible behaviours to be able to predict why some students participate or do not participate in the joint learning effort.

Emotions in web-based learning

Emotions occur while individuals assess how the events in their environment are related to their needs, goals and well-being (Brave & Nass, 2002; Lazarus, 1991). There are numerous schemes for classifying emotional responses into discrete categories, ranging from definitions based solely on approach-avoidance behaviour, to diverse categories of complex social emotions (see Adolphs, 2002, for discussion). Emotions can also be

described as regions in a two-dimensional space defined by valence (pleasant-unpleasant) and arousal (the intensity of emotional reactions; Lang, 1995; Russell, 1980). This view was employed in the current study, as it describes emotions in terms of specific motivational systems (Lang, 1980; Lang, 1995), which are relevant to the aims of the study.

Emotions are experienced during computer-mediated interactions such as those occurring in a WBLE. When a WBLE is used for collaborative purposes, the affective reactions experienced while working in the environment result mainly from the interactions between the students (Vuorela & Nummenmaa, 2004a). This suggests that the presence of other students is as an important antecedent of students' affective reactions in a WBLE as it is in face-to-face learning situations. Further, high fluctuation of students' valence dimension while using a WBLE increases students' participation in the collaborative learning activities (Vuorela & Nummenmaa, 2004a). The fluctuation refers to changes in the valence and arousal, that is, the changes in the action tendencies related to pleasant and unpleasant events. There are stable, trait-like individual differences in emotional responding (i.e. fluctuation; Diener *et al.*, 1985), and these differences are related to both psychological and psychophysiological functioning (Carels, Blumenthal, & Sherwood, 2000). Small affective fluctuation implies that an individual is (or has been) in a neutral affective state for most of the time, whereas large fluctuation implies that the affective state has deviated from neutral in both pleasant and unpleasant directions. Both positive and negative affective states are likely to result in changes in action tendencies (e.g. Bradley, 2000) when compared to a neutral affective state. This explains why Vuorela and Nummenmaa (2004a) found that the fluctuation of valence predicted the collaborative activities in the WBLE. However, the Vuorela and Nummenmaa (2004a) study did not assess the impact of affective fluctuation on the invisible student behaviour in the WBLE. As emotions are usually elicited in different social interactions, it is likely that their fluctuation would exert a stronger influence on the social (visible) than on the non-social (invisible) behaviour in the WBLE. However, this hypothesis has not been explicitly tested.

Interest in web-based learning

Although experienced emotions provide reasonably good predictors for students' collaborative activities in a WBLE, they are not the sole reasons individuals have for engaging in learning-related activities. Whereas emotions mainly modulate courses of action that have already started (Frijda, 1986, p. 460), interest in a specific action can already exist before the action is taken. Interest is a relatively transient psychological state that includes focused attention, increased cognitive functioning, persistence and affective involvement (e.g. Krapp, Hidi, & Renninger, 1992). Like complex social emotions, interest has no obvious functional relation to immediate adaptational crises (Fredrickson, 1998), but it is essential for the long-term adaptational process. Interest determines how individuals attend, select and persist in processing certain types of information in preference to others (Hidi, 1990). It has both motivational and goal-related components, particularly for learning, exploration and information seeking (e.g. Fredrickson, 1998; Izard & Ackerman, 2000; Krapp, 1999; Schiefele *et al.*, 1992; Silvia, 2001). Curiosity about new possibilities broadens individuals' experiences and, subsequently, supports the continuous development of knowledge and skills (Fredrickson, 1998; Silvia, 2001).

Individuals can, under certain circumstances, develop a close relationship with an object in the environment (Krapp, 1999; Krapp *et al.*, 1992) which will increase the likelihood of interest in the object. This tendency to experience interest in a certain activity or topic has a strong positive influence on cognitive and affective functioning, persistence, and effort (Ainley *et al.*, 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 on-line learning environments. It can be hypothesized that students' interest in the course topic and in web-based learning influences their activities and emotional states in WBLEs due to the fact that interest is an important determinant of academic motivation and learning (Schiefele *et al.*, 1992) and is associated with experience of positive emotions (e.g. Ainley *et al.*, 2002; Krapp *et al.*, 1992). Specifically, high levels of interest could be hypothesized to be associated with learning-related behaviour and experience of pleasant emotions.

Direct experience with a previously unfamiliar topic, content or situation, though not a prerequisite, can result in the development of interest (Hidi, 1990; Hidi & Anderson, 1992). However, awareness of, or exposure to, the situation is required for this development (Bergin, 1999). Such situational interest also directs learning (Hidi, 1990; Hidi and Anderson, 1992). The development of situational interest is, therefore, particularly important in courses employing WBLE if the students have no previous experience with the course topic or with the web-based learning. Individuals are often more interested in things that they already know something about, so students who have previous experience with the course topic or a WBLE might be more interested in the courses employing web-based learning than students who lack such experience. The situational interest can, however, develop into a relatively enduring individual interest (Hidi, 1990; Hidi & Anderson, 1992; Krapp *et al.*, 1992). Therefore, it is important to repeatedly measure students' interest as those who lack experience with the course topic or WBLE could develop interest in them through direct experience.

Some researchers classify interest as a basic positive emotion (e.g. Fredrickson, 1998; Nummenmaa, 1990). 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 a task usually results from some feature of a task stimulus, for example, novelty or complexity, whereas enjoyment results from good performance of the task (Reeve, 1989). Therefore, a student's interest in participating in a collaborative learning discussion is orthogonal to whether they derive joy from the experience.

The present study

The purpose of this study was to determine how emotions experienced while using a web-based learning environment, interest in the course topic and interest in web-based learning are related to students' visible collaborative and invisible non-collaborative activities in the environment.

Our specific hypotheses regarding the visible and invisible activities, emotions, interest and lurking behaviour were as follows. First, we expected to replicate the previous findings showing that the fluctuation in affective reactions while using a web-based learning environment has a positive influence on students' visible activities (e.g. how actively the students participate in collaborative discussions in a WBLE; Vuorela & Nummenmaa, 2004a). We also wanted to elaborate this issue by measuring the

associations of affect and interest variables with invisible, non-collaborative behaviour. As emotions typically result from, and are experienced in, social interactions, we hypothesized that the fluctuation of emotional reactions would *not* influence the invisible, non-collaborative activities in the WBLE.

Our second hypothesis was that interest in the course topic and interest in the web-based learning would increase collaborative visible activities, as well as invisible activities, in the learning environment, as interest is known to exert an influence on academic motivation and learning (Schiefele *et al.*, 1992). Our third hypothesis was that students' interest in the course topic and in the web-based learning would be associated with positive affective reactions resulting from studying in a WBLE. This was based on two findings. First, interest is defined as a psychological state including affective involvement (e.g. Krapp *et al.*, 1992; Silvia, 2001) and second, experience of interest is associated with positive affects (e.g. Ainley *et al.*, 2002; Krapp *et al.*, 1992).

We also wanted to examine the lurkers in more detail. This group was operationally defined as students whose activities are invisible to other students, but who are still actively using the WBLE. As mentioned above, students can be expected to lurk mainly due to the affective reactions resulting from the web-based activities and their lack of will and interest to use the on-line learning groups as tools for knowledge construction. Therefore, we aimed at determining the differences between the emotional states of lurkers and non-lurkers while using a WBLE. Additionally, we wanted to compare the lurkers' and non-lurkers' interest in the course topic and in the web-based learning before, during and after the learning experiences.

Methods

Participants

Data for this study were collected in 2004. A total of 99 volunteer students (64 females, 35 males; see Table 1 for number of participants in each measurement) were participated in the study. The participants were Finnish undergraduate students from five different university courses organized through a web-based learning environment. Participants majored in different university subjects. Participants' ages ranged from 20 to 42 years ($M = 25.6$, $SD = 4.44$) and they had studied at university for 1-8 years ($MD = 3.9$, $SD = 1.69$). The mean age of all Finnish university students is 24 years, and the median time taken to complete a degree is 6 years. Thus, the participants can be

Table 1. Means and standard deviations of interest and affect variables

| | N | M | SD |
|-------------------------|----|------|------|
| Course interest 1 (1-7) | 78 | 5.20 | 0.90 |
| Course interest 2 (1-7) | 44 | 5.00 | 0.92 |
| Course interest 3 (1-7) | 46 | 5.21 | 1.00 |
| Web interest 1 (1-7) | 78 | 4.25 | 1.43 |
| Web interest 2 (1-7) | 44 | 4.27 | 1.31 |
| Web interest 3 (1-7) | 46 | 4.45 | 1.25 |
| Mean valence (1-5) | 76 | 3.50 | 0.66 |
| Mean arousal (1-5) | 76 | 2.28 | 0.66 |
| Fluctuation of valence | 66 | 0.73 | 0.45 |
| Fluctuation of arousal | 66 | 0.68 | 0.40 |

considered as a representative sample of Finnish university students. Not all the students participating in the study completed all the questionnaires (see Table 1 for details). Thus, pairwise exclusion of missing values was employed for all the statistical testing to maximize power.

Web-based learning environment

The courses were organized through a web-based learning environment called WorkMates that was familiar to 72% of the participants. WorkMates is a web-based collaborative learning environment developed at the Educational Technology Unit at the University of Turku. WorkMates provides a technical structure and environment for learning and can be adapted to a wide variety of courses and contents. It enables students to share, view, modify files, communicate and comment on each other's work electronically. 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. Participants' written notes in the environment form threaded discussions. In this study, the participants engaged in 1 to 6 web-based collaborative discussions of different durations depending on the course. The discussions consisted of commenting on students' essays, as well as lectures and articles presented by the teachers. Participating in these collaborative discussions was an obligatory part of the courses.

Measures

Emotions

Affective reactions resulting from learning in the WorkMates environment were measured with the valence and arousal dimensions of the Self-Assessment Manikin (SAM; Bradley & Lang, 1994). In this instrument, a graphic human figure depicting values of the measured dimension on a continuously varying scale is used to indicate emotional reactions. For the valence dimension, SAM ranges from a smiling happy figure to a frowning unhappy figure. For the arousal dimension, SAM ranges from an excited, wide-eyed figure to a relaxed, sleepy figure. In the original instrument and in the instrument presented to the participants, the valence scale of five figures ranged from *pleasant* (1) to *unpleasant* (5), and the arousal scale from *excited* (1) to *calm* (5). In order to make results easier to interpret, the scales of the arousal and valence dimensions were recoded before analyzing the data. Thus, the recoded valence scale ranged from *unpleasant* (1) to *pleasant* (5), and the arousal scale from *calm* (1) to *excited* (5).

The html-formatted on-line SAM was presented automatically to the participants each time they logged off from WorkMates. For each participant, *mean* and *standard deviation of valence*, and *mean* and *standard deviation of arousal* were computed from their responses to the SAM scales. The mean scores were used to measure the average level (typical experience) and the standard deviations of the fluctuation (variability) of the dimension. The total number of answers to the SAM questionnaire was 668. Altogether 76 participants completed the SAM questionnaire at least once during the courses. The total number of answers ranged from 1 to 41 resulting in an average of 9 responses per participant. As within-subject standard deviations of valence and arousal were used to assess the fluctuation of the respective dimensions, 10 participants with fewer than three answers to the SAM questionnaire during the course

were excluded from the sample to avoid artificially low fluctuation scores resulting from only one or two answers.

Interest

Participants' interests in the course topic (*course interest*) and in the web-based learning (*web interest*) were measured before, during and after the courses using a scale constructed for this study. In the Course Interest Scale, the participants were asked to evaluate items concerning the course topic (e.g. 'This course seems interesting' for the course interest and 'It would be nice if the course was more extensive' for the web interest) with 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 was more web-based learning in the course'), with a scale ranging from *Not at all true* (1) to *Completely true* (7).

Both the preliminary scales consisted of 16 items. A pilot testing for the Course Interest and the Web Interest Scales ($N = 22$) was conducted in spring 2004. Item-total score correlations were computed in order to remove inconsistently working items. Six items were dropped from both preliminary scales resulting in the final scales consisting of 10 items each. Both final scales consisted of similarly formatted items but with different content (e.g. 'This course seems interesting'/'Studying in the web seems interesting'). In the pilot testing, the Course Interest Scale demonstrated high internal consistency ($\alpha = .96$). All the items correlated with the total score, r values ranging from .81 to .91 (all p values $< .01$). The Web Interest Scale also demonstrated high internal consistency ($\alpha = .89$). All the items correlated with the total score, r values ranging from .60 to .83 (all p values $< .01$).

In the present study, the reliability of both the Course Interest Scale ($\alpha = .89$) and the Web Interest Scale ($\alpha = .95$) were also acceptably high. All the items in both scales correlated with the total scores, r values ranging in the Course Interest Scale from .61 to .80 (all p values $< .01$), and in the Web Interest Scale from 0.74 to 0.92 (all p values $< .01$). Mean scores of the answers to items in both scales before, during and after the courses were computed to form scores of *course interest 1, 2 and 3*, and *web interest 1, 2 and 3* variables for each participant.

Visible activities, invisible activities and lurking

Analysis of the participants' *visible activities* was based on the archived written notes in the on-line discussions and was done after completion of the course. The total number of participants' written notes in the WBLE can be regarded as an insufficient indicator of students' activities because it lacks information about the content or type of the activities (Vuorela & Nummenmaa, 2004a, b). Therefore, two researchers classified the participants' notes (altogether 704 notes by 84 individual participants, an average of 8.4 notes per participant) into nine classes according to their content. The inter-coder reliability was .88. The classification was based on the system presented in Vuorela and Nummenmaa (2004b). One note could include multiple content classes. 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. Previous studies have suggested that such a

variable can be effectively used to index visible activities in a WBLE, as it reflects both the activity in writing the notes and the versatility of the contents in the notes (Vuorela & Nummenmaa, 2004a, b). Additionally, the number of comments and number of contents have high positive correlation (here $r = .96, p < .01$). 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.

Analysis of participants' *invisible activities* in WorkMates was based on the log data 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 participants' written notes in the WBLE's discussion forum (see above) was subtracted from the total number of occasions the participant had accessed the discussion forum. Because 23 participants did not give permission to collect the log data of their invisible activities, the data were received from 76 participants. As the data for this study were collected from five individual courses of different durations, the aforementioned visible and invisible activity variables for each course were standardized before pooling the data to make the different courses comparable with each other.

In order to classify participants into *lurkers* and *non-lurkers*, the standardized invisible and visible activity variables were first dichotomized with a mean split. In the current study, the lurkers were defined as individuals who frequently visited the on-line environment but seldom participated in the discussions. Accordingly, a participant was classified as a lurker if their dichotomized invisible activity score was in the upper category (frequently visits the environment) and the dichotomized visible activity in the lower category (seldom participates in discussions). All the remaining participants were classified as non-lurkers. Only participants ($N = 76$) from whom both invisible and visible activity data were available were included in this classification.

Procedure

Participants' background information, web interest and course interest were measured during the first lectures of the courses using paper-and-pencil versions of the questionnaires. Participants' experience of valence and arousal was measured repeatedly during the courses in the WorkMates. The html-formatted on-line SAM questionnaire was presented automatically to the participants each time they logged off from the environment. It was stressed that the participants should complete the questionnaire each time they encountered it. In the middle of the courses, the participants were instructed to complete html-formatted on-line versions of the web and course interest questionnaires in WorkMates. During the final lectures of the courses, participants' web and course interests were measured once again with the paper-and-pencil versions of the questionnaires. In the data analysis, the course and web interest measures were labelled with the numbers 1, 2 and 3 with respect to the order of the measurement. Course grades were assigned by the teachers approximately 2 weeks after the courses had ended.

Results

The means and standard deviations of the affect and interest variables are presented in Table 1. To assess whether the participants in the five courses differed with regard to

their interest, affect and activity variables, the between-group differences in these variables were compared with Kruskal-Wallis tests. There were significant differences between-groups in web interest 1, $\chi^2(4) = 22.44$, $p < .01$, and course interest 1, $\chi^2(4) = 13.48$, $p < .01$. However, none of the paired comparisons reached statistical significance after correcting for multiple comparisons, p values $> .05$. No differences in web and course interests 2 and 3, or in affect or activity variables were found between the courses.

To assess whether participants' course interest and web interest had changed during the courses, the interest variables were subjected to a 2 (Interest type: Course, Web) \times 3 (Time: Before, During, After the courses) \times 5 (Course) repeated measures ANOVA. There were no differences in participants' interests before, during and after the courses, $F < 1$. However, the analysis yielded a significant main effect for Interest, $F(1, 29) = 10.12$, $p < .01$, $\eta_p^2 = .26$, demonstrating that the participants were more interested in the course topic than in the web-based learning in the beginning, during and after the courses. The Interest \times Course interaction also proved significant, $F(4, 25) = 7.29$, $p < .01$, $\eta_p^2 = .54$. This interaction resulted from the fact that the difference between mean course and web interest was statistically significant in three out of five courses ($ps < .01$).

Are emotions and interest associated with invisible and visible activities in the WBLE?

A linear regression analysis (see Table 2) was conducted to predict both invisible and visible activities in the environment with the mean and fluctuation scores of valence and arousal, course interest 1 and 2, and web interest 1 and 2. The predictors with the lowest significance for the model were removed in a stepwise manner to obtain the final models.

Table 2. Linear regression models for invisible and visible activities in the learning environment

| Variable | β | Standard error | t | p |
|--------------------------------|---------|----------------|-------|-----|
| Model for invisible activities | | | | |
| Constant | -0.36 | 0.69 | -0.51 | .01 |
| Fluctuation of valence | 1.30 | 0.48 | 2.74 | .01 |
| Web interest 2 | 0.28 | 0.12 | 2.39 | .02 |
| Model for visible activities | | | | |
| Constant | 1.90 | 0.24 | 8.02 | .04 |
| Fluctuation of valence | 0.57 | 0.27 | 2.09 | .04 |

The final model for the invisible activities included the fluctuation of valence and the web interest 2 as predictors. The model was statistically significant, $F(2, 42) = 5.92$, $p < .01$, and the adjusted coefficient of determination was moderate, $R_a^2 = .26$. Inspection of the regression coefficients (Table 2) revealed that both high fluctuation of valence and web interest during the course were positively associated with invisible activities in the environment. The final model for the visible activities included fluctuation of valence as sole predictor. The model was statistically significant, $F(1, 70) = 4.37$, $p < .05$, and the adjusted coefficient of determination was low, $R_a^2 = .07$. Inspection of the regression coefficients (Table 2) demonstrated that high fluctuation of valence increased the visible activities in the WBLE. Additionally, to assess whether these results were due to differences among the five individual courses used for

the sample of the study, we also introduced the dummy-code course membership variables as predictors in the aforementioned models. However, none of these variables proved statistically significant in either of the models, demonstrating that the obtained results were not due to between-groups differences.

Association of interest and emotions

To assess whether students' interest in the course topic and in the web-based learning was associated with emotional reactions, the associations of the interest (course and web interests) and affect (mean and fluctuation in valence and arousal) variables were also examined. There was no association between any of the course interest and affect variables. Participants' web interest 2, $r_s = .38, p < .05, N = 44$, and web interest 3, $r_s = .45, p < .01, N = 43$, were positively correlated with the mean valence. Participants with high interest in the web-based learning during and after the courses experienced more positive emotions during the courses than participants with low interest. There were no associations between any of the participants' course interests and mean arousal and fluctuation of valence and arousal.

Previous experience and interest

To assess the effect of previous experience with the WBLE use on web interest, we compared the web interests of participants who were familiar/unfamiliar with the WorkMates environment. Participants who were familiar with the WorkMates learning environment were more interested in web-based learning before the courses than participants who were not familiar with it, $U = 430.5, p < .05$. However, this difference no longer existed in the web interest during and after the courses.

Lurking in the WBLE

Of the 76 participants who gave permission to collect log data, 11 were classified as lurkers and 64 as non-lurkers according to the classification presented in the Methods section. There was a significant difference between lurkers' and non-lurkers' mean valence scores, $U = 185.5, p < .05$. The lurkers experienced more unpleasant affective reactions, $M = 3.30, MD = 3.00, SD = 0.83$, during the courses than non-lurkers, $M = 3.60, MD = 2.50, SD = 0.63$. The mean arousal and fluctuation of valence and arousal were similar for lurkers and non-lurkers. Responses for all six interest variables (course interest 1, 2 and 3, and web interest 1, 2 and 3) were available from only two lurkers, so it was not possible to explore the Interest \times Lurkers and Time \times Lurkers interactions due to the small cell size in the model.

It is also possible that the participants who did not give permission to collect log data were actually lurkers. Though this could not be directly tested on the basis of the dataset (as lurking was defined partly on the basis of the log data), we employed an indirect approach and tested for *systematic loss* in the data. We compared the mean visible activity and valence scores between the non-lurkers and those participants who did not give permission for collecting the log data. The logic behind this comparison was that if lurking is associated with less visible activity and experience of more negative emotions as demonstrated above, differences between these two groups in the visible activity and mean valence variables would indicate that not giving permission to use log data could be related to lurking. However, U tests revealed no differences between the non-lurking and no-permission groups in either visible activity ($U = 281, p = .91$) or mean valence

($U = 178, p = .55$). Thus, it is fairly safe to assume that not giving permission to use log data was not related to lurking in the current study.

Achievement

Finally, we wanted to assess what facets of student behaviour and experiences would predict achievement. First, we standardized grades within each course to control for potentially different distributions of course grades among the different courses. We then employed a stepwise linear regression model to predict participants' course grades with interest, affect, and visible and invisible activity, as well as dummy-coded lurking (lurker vs. non-lurker) variables. The predictors with the lowest significance for the model were removed in a stepwise manner to obtain the final model. The final model including only visible activity as predictor ($\beta = 0.36, t = 2.76, p < .01$) was statistically significant, $F(1, 43) = 3.46, p = .02$, and the coefficient of determination for the model was moderate, $R^2 = .27$. Thus, the data demonstrated that the level of visible activities was positively associated with achievement.

Discussion

Our main finding was that interest and emotions experienced while studying in a WBLE had distinct associations with the activities in a WBLE. Contrary to our hypothesis, the data demonstrated that the fluctuation of valence predicted both visible collaborative and invisible non-collaborative activities in the web-based learning environment. The fluctuation of emotional reactions while using the WBLE was positively associated with *all* student activities in the environment, not just the visible ones. Our initial hypothesis regarding the influence of emotions on visible activities was based on the assumption that emotions are usually elicited in social interactions, in this case visible activities in the 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 consider both their visible and invisible activities comparable in terms of presence of others in the environment. As a previous study (Vuorela & Nummenmaa, 2004a) has demonstrated that interaction in the WBLE is a significant cause of emotions, this could explain why the fluctuation of valence was associated with both visible and invisible activities in the current study.

Many researchers (e.g. Fredrickson, 1998; Izard & Ackerman, 2000; Silvia, 2001) have conceived interest as an emotion associated with curiosity, exploration and information seeking. This notion is corroborated by our finding that a high level of interest in the web-based learning during the course was positively correlated with students' invisible activities. Specifically, 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. Contrary to our predictions, the data did not support the hypothesis that interest in the web-based learning would increase the amount of visible collaborative activities. Thus, the interest in web-based learning neither enhanced nor deteriorated students' contribution to collaborative learning processes in a WBLE. This suggests that students can take advantage of the collaborative on-line discussions regardless of their interest in the web-based learning itself. Accordingly, students with various experiences and opinions regarding the WBLE can adapt to such an environment and use it efficiently.

The students experienced more interest in the course topic than in web-based learning before, during and after the courses. This demonstrates that learning a specific subject matter, not the medium used for studying, was of more interest to the students. Contrary to our expectations, the interest in the course topic predicted neither visible collaborative nor invisible 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 university students usually have high extrinsic motivation for completing courses to get their degree. Extrinsic motivation refers to performing activities for their instrumental value, rather than for the enjoyment or interest in the activities themselves (Ryan & Deci, 2000). Thus, such motivation could make students eager to participate in learning in the courses regardless of their interest in the course topic.

Students' interest in the web-based learning was associated with their experience of positive emotions. Consequently, though web interest did not influence achievement, it may have made studying a more pleasant experience. These results converge with the hypothesis that interest is associated with experiencing positive affects (see Ainley *et al.*, 2002; Krapp *et al.*, 1992). Interest can be considered beneficial, as positive emotions broaden people's momentary thought-action repertoires, and build their physical, social and intellectual resources (Fredrickson, 2000). Students who were familiar with the WBLE were more interested in the web-based learning before the courses than were the students who were not familiar with the environment. This result is in line with the hypothesis that awareness of, or exposure to, the situation is necessary for the development of interest (Bergin, 1999). This suggests that, albeit not necessary, it is beneficial to expose university students to the learning environments used in their departments as soon as possible in order to enable the development of interest in the web-based learning.

In this study, every sixth student was classified as a lurker. Some authors (e.g. Preece *et al.*, 2004) identify lurkers as individuals who never contribute to the discussions. We operationally defined lurking as a low number of visible and a high number of invisible activities. Thus, lurkers in this study were students who seldom participated in discussions but frequently visited the on-line environment. This definition does not imply that the lurkers were totally ignoring the collaborative on-line learning task. In fact, in this study, each participant classified as a lurker had contributed to the discussions at least once. The analysis of the valence and arousal of this subgroup 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 on-line groups because of affective reactions (e.g. discomfort or unsatisfactory group dynamics). This would support the former explanation. However, as our study was based on a correlative design, we cannot draw strong conclusions about whether the experience of negative emotions was a cause or a consequence of lurking.

When designing web-based courses, it is important to know whether those students who do not participate in the collaborative learning actually benefit from the course. 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). However, this does not imply that the visible

collaborative activities would not be beneficial for learning. Prior studies have provided evidence that the students who are actively involved in the discourse in the WBLE get better grades than the non-participating students (Beaudoin, 2002; Vuorela & Nummenmaa, 2004b). We replicated this result in the current study, suggesting that non-participating students might not learn as effectively as students who participate. Accordingly, when one is designing web-based courses, it is important to try to engage all students in the collaborative learning task. This notion also converges with the sociocultural view that learning is participation in a social process of knowledge construction rather than an individual endeavour (Vygotski, 1978). However, we cannot 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 component of effective learning.

Conclusion

The results of the present study underline the importance of affective processes in web-based learning activities. Students experience emotions while they are using a WBLE, and these emotions are associated with their activities in the learning environment. The results also indicate that interest in web-based learning may increase students' concern with the WBLE, but it might not heighten their participation in collaborative activities in such environments. Although neither interest in the web-based learning or interest in the course topic was associated with students' contribution to collaborative learning activities in the WBLE, it was shown that the interest in the web-based learning was associated with experience of pleasant emotions. What is more, the lurkers experienced more negatively valenced emotions during the courses than other students. These somewhat negative experiences may make the lurking individuals less eager to participate in other WBLE courses. Moreover, for a learner group, these socially inactive students can be seen as wasted resources who are not participating in the collaborative learning process. Accordingly, further research should focus more precisely on the factors that make individuals lurk in on-line learning groups, and the development of learning tasks that do not encourage or permit lurking or inactivity.

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