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Exploring the relationship between emotions and the acquisition of computer knowledge

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Abstract

Most computer users have to deal with major software upgrades every 6–18 months. Given the pressure of having to adjust so quickly and so often, it is reasonable to assume that users will express emotional reactions such as anger, desperation, anxiety, or relief during the learning process. To date, the primary emotion studied with respect to computer knowledge has been anxiety or fear. The purpose of the following study was to explore the relationship among a broader range of emotions (anger, anxiety, happiness, and sadness) and the acquisition of nine computer related skills. Pre- and post-surveys were given to 184 preservice education students enrolled in 8 month, integrated laptop program. Happiness was expressed most of the time – anxiety, anger, and sadness were reported sometimes. Anxiety and anger levels decreased significantly, while computer knowledge increased. All four emotions were significantly correlated with all nine computer knowledge areas at the beginning of the program, but happiness and anxiety were the only emotions significantly related to change in computer knowledge.

Keywords: Emotion; Measure; Computer knowledge; Laptop

1. Overview

The use of technology infiltrates almost every aspect of Western society and the order of the day is change (Bannert, 2000; Lambrecht, 1999; Oblinger & Maruyama, 1996). Most computer users have to deal with major software upgrades every 6–18 months (Bellis, 2004; Franzke & Rieman, 1993). The most typical response to this change is to enrol in some form of training program (Mahaptra & Lai, 2005; Niederman & Webster, 1998; Olfman, Bostrom, & Sein, 2003), although many users attempt to learn new software own their own (Bartholomé, Stahl, Pieschl, & Bromme, 2006; Dryburg, 2002). Given the pressure of having to adjust so quickly and so often, it is reasonable to assume that users will express emotional reactions such as anger, desperation, anxiety, or relief during the learning process (Case, Hayward, Lewis, & Hurst, 1988; Neisser, 1963; Oatley & Johnson-Laird, 1987; Simon, 1967). The frustration of not being able to escape from a seemingly straightforward error or, the relief of finally gaining some control over a software package, has probably been experienced by

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most computer users at one time. It is conceivable, then, that emotions play a role in the learning process and ultimately in the range of computers skills acquired.

To date, the primary emotion studied with respect to computer related behaviour has been anxiety or fear (e.g., Bronsan & Lee, 1998; Gaudron & Vignoli, 2002; Wilfong, 2006). The purpose of the following study was to examine a broader range of emotions that could effect the acquisition of computer related skills.

2. Literature review

2.1. Emotion and cognition

A number of theorists identify emotion and cognition as clearly separated constructs (Goleman, 1995; Lazarus, 1991a, 1991b). Others view emotion and cognition as integrated and intertwined (Frijda, 1986; Gray, 1990; LeDoux, 1989; O'Regan, 2003; Simon, 1967). LeDoux (1989), for example, claims that emotion and cognition are mediated by separate but integrated systems of the brain. Gray (1990) adds that the brain systems mediating emotion and cognition overlap. Finally, O'Regan (2003) notes that emotion and cognition are not polar opposites, but rather inextricably linked. The current perspective, then, is that emotion and cognition are more connected, than separate.

2.2. Emotion and everyday cognitive activity

Several studies have examined the role of emotion in everyday cognitive activity. Emotion is considered critical in the process of adapting to unpredictable environments or juggling multiple goals (Case et al., 1988; Neisser, 1963; Oatley & Johnson-Laird, 1987; Simon, 1967). An emotional reaction is likely when one is in danger of harm, being threatened, challenged, or, conversely, if one is in a situation of benefit or readiness (Lazarus, 1991b). Emotion could be activated by a number of factors, including motivation, communication, or survival (Rolls, 2000). These studies suggest that emotional reactions are used to adapt to unpredictable and changing environments.

2.3. Emotion and formal learning

While research on emotion, and informal or everyday cognition has flourished (e.g., Frijda, 1986), the role of emotion in formal learning has been largely ignored (Gardner, 1983; Oatley, 1987; Simon, 1967). However, there has been some interest in how emotions affect the formal learning process. Isen (1990) examined the impact that feelings have on cognition and social behaviour, and found that positive feelings facilitate the recovery of positive material. Izard, Kagan, and Zajonc (1984) argued that when studying one's cognitive processes, one must consider biological preparedness, emotional threshold, and temperament, as moderating influences. That is, one's emotional state before learning may affect one's cognitive results. Emotions, though, often develop throughout the learning process. The learning process almost certainly has an end goal, and emotions typically occur when this end-goal is interrupted (Mandler, 1984). This interruption could be a positive or negative experience, resulting in a suitable emotion, such as frustration, happiness, or relief. Throughout the learning process, then, emotions tend to shift a person's prior goals to something new (Fischer, Shaver, & Carnochan, 1990). It is reasonable to assume that emotions play a role in determining how much knowledge is attained. Excessive negative emotions, for example, may hinder and slow down the learning process. Positive emotions, on the other hand, may build confidence and self-efficacy, and encourage users to seek out, attempt, and persist in new and fruitful software learning opportunities (Bandura, 1982).

2.4. Anxiety and computers

One emotion, anxiety, has been study extensively with respect to computers, however, precise and consistent definitions have been lacking. Constructs have included *confidence* (Heinssen, Glass, & Knight, 1987; Loyd & Gressard, 1984), *positive or negative feelings* (Beckers & Schmidt, 2001; Ceyhan, 2006; Loyd & Gressard, 1984; Nickell & Pinto, 1986), *intimidation* (Heinssen et al., 1987; Nickell & Pinto, 1986), *fear* (Bronsan &

Lee, 1998; Heinssen et al., 1987), *damaging anxiety* (Ceyhan, 2006; Russell & Bradley, 1997), *equipment anxiety* (Marcoulides & Wang, 1990), *learning or task performance anxiety* (Ceyhan, 2006; Rosen & Weil, 1995; Russell & Bradley, 1997), *observation anxiety* (Bronsan & Lee, 1998; Dyck, Gee, & Smither, 1998), *anticipatory anxiety* (Bronsan & Lee, 1998), *state-anxiety* (Gaudron & Vignoli, 2002; Wilfong, 2006), *fear of social embarrassment* (Russell & Bradley, 1997), *general or non-specific anxiety* (Hong & Koh, 2002; Todman & Day, 2006; Yaghi & Abu-Saba, 1998), *self-efficacy* (Beckers & Schmidt, 2001), and *cognitive beliefs* (Beckers & Schmidt, 2001). This range of constructs makes it difficult to build theory and a coherent knowledge base. The relationship between computer anxiety and computer ability or experience, for example, is tenuous at best (Beckers, Rickers, & Schmict, 2006; Honeyman & White, 1987; Koohang, 1987; Mackowiak, 1988; Smith & Caputi, 2001). However, longer courses of instruction appear to be effective in reducing computer anxiety (Honeyman & White, 1987; Maurer, 1994).

A consistent relationship between anxiety toward computers and computer knowledge has been reported (Chua, Chen, & Wong, 1999; Hong & Koh, 2002; Kay, 1993; Maurer, 1994; Tsai & Tsai, 2003). Higher computer anxiety is associated with lower levels of computer competence. Mixed results have been observed regarding the impact of computer training on decreasing levels of anxiety (see Maurer, 1994, for a review), although, in general, anxiety decreases as exposure to computers increases (see Chua et al., 1999, for a review).

2.5. Anger and computers

Only one study could be found looking at the role of another emotion, anger, with respect to computer related behaviour. Wilfong (2006) reported that computer anger was strongly related to self-efficacy, but not computer use or experience. Emotions such as sadness or happiness have yet to be formally evaluated in the context of learning new computer skills. In fact, considerable debate reigns on what constitutes a basic emotion. It is generally agreed upon that there are at least four basic emotions: happiness, sadness, anxiety (fear), and anger (Arnold, 1960; Ekman, Friesen, & Ellsworth, 1972; Izard, 1969; James, 1884; Oatley & Johnson-Laird, 1987; Plutchik, 1980; Tomkins, 1962).

The purpose of this study was to examine the relationship among four basic emotions (anger, anxiety, happiness, and sadness) and the acquisition of computer knowledge. Three research questions were addressed:

1. Can computer-related emotions be assessed reliably, and with validity?
2. To what extent are emotions present when software is being learned?
3. How are emotions related to computer knowledge acquisition?

3. Method

3.1. Sample

The sample consisted of 184 Intermediate-Senior (Grades 7–12) preservice teachers (123 females, 61 males) from a variety of cultural backgrounds (20% reported that their first language was not English), ranging in age from 23 to 58 years ($M = 33.4$; $SD = 8.7$). Eighty-one percent of the subjects reported having 10 or more years experience using computers.

3.2. Description of the program

The Bachelor of Education degree at this university is 8-month consecutive program, focusing on Computer Science, Math, and Science (Physics, Chemistry, Biology, and General Science) at the intermediate-secondary school level (grades 7–12). All students were required to have a B.A. with five full university courses in their first teachable area and three full university courses in their second teachable area.

Every student in the preservice teacher education program was given an IBM R51 ThinkPad at the beginning of the year, loaded with a wide range of educational and application-based programs. All classrooms were wired with high-speed Internet access through cable and a wireless network. In addition, students had access to a wireless network throughout the university campus.

3.3. Model of technology use – integration

An integrated model was used to incorporate technology into the preservice education. In other words, students used their laptop computers in all courses offered, but did not take a stand-alone course in technology use. All students attended a 4-h introductory workshop at the beginning of the year to introduce them to the basic operations of laptop computers and connecting to the Internet. All students were offered voluntary 2-h workshops throughout the year that focused on specific software skills in Word, PowerPoint, searching the Web, Web Page Design, and Dreamweaver. Finally, there was one support person available 4 h per day, 5 days a week, to assist students with individual problems.

All faculty members created assignments and projects that required students to use the computer as a tool to solve meaningful, practical, and useful problems. Appendix A provides descriptions of the kind of activities that students engaged in with technology. A majority of the activities used were based on well-grounded, learning theory including cooperative learning (e.g., Johnson & Johnson, 1994, 1998; Kagan, 1997; Sharon, 1999), constructivism (e.g., Bruner, 1983, 1986; Scardamalia & Bereiter, 1996; Vygotsky, 1978), facilitation and coaching (e.g., Brown & Palinscar, 1989; Chi & Bassok, 1989; Collins, Brown, & Newman, 1989), incorporating a variety of learning styles (e.g., Gardner, 1983), problem-based learning (e.g., Albanese & Mitchell, 1993; Collins et al., 1989), higher-level thinking skills (e.g., Resnick, 1989), connecting concepts to real world knowledge (e.g., Lampert, 1986; Larkin, 1989; Sternberg, 1989), and actively applying knowledge (Carroll, 1990; Carroll & Mack, 1984).

3.4. Data sources

3.4.1. Survey

The survey consisted of two sections (89 items) focusing on emotions and computer skills (see Table 1).

3.4.2. Computer emotions

Four theoretically distinct constructs (anger, anxiety, happiness, and sadness) were used to assess emotions of preservice teachers "while learning a software package". Oatley and Johnson-Laird's (1987) four basic emotion categories were used in conjunction with a subset of their 590 emotional words to create appropriate emotional scale items (Appendix B). The internal reliability estimates for all construct were moderate, but acceptable (Kline, 1999; Nunnally, 1978), ranging from 0.65 to 0.73 (Table 1).

A principal components analysis was done to explore whether the four emotions formed four distinct factors. Since all communalities were above 0.4 (Stevens, 1992), the principal component analysis was deemed an appropriate exploratory method (Guadagnoli & Velicer, 1988). Both orthogonal (varimax) and oblique (direct

Table 1
Description of survey instruments used

Scale construct	Number of items	Range	Internal reliability
Emotions			
Anger	3	0–3	$r = 0.69$
Anxiety	4	0–3	$r = 0.73$
Happiness	3	0–3	$r = 0.70$
Sadness	2	0–3	$r = 0.65$
Ability			
Operating System	10	0–6	$r = 0.95$
Communication	10	0–6	$r = 0.94$
WWW skills	9	0–6	$r = 0.92$
Word Processing	10	0–6	$r = 0.95$
Spreadsheet	6	0–6	$r = 0.97$
Database	10	0–6	$r = 0.95$
Graphics	6	0–6	$r = 0.95$
Presentation	6	0–6	$r = 0.95$
Create Web Page	10	0–6	$r = 0.98$

oblimin) rotations were used, given that the correlation among potential strategy combinations was unknown. These rotational methods produced identical factor combinations, so the results from the varimax rotation (using Kaiser normalization) are presented because they simplify the interpretation of the data (Field, 2005). The Kaiser–Meyer–Olkin measure of sampling adequacy (0.827) and Bartlett's test of sphericity ($p < 0.001$) indicated that the sample size was acceptable.

The principal components analysis was set to extract the four factors (Table 2). The resulting rotation corresponded relatively well with the proposed emotion constructs with three exceptions. First, helpless was expected to load on the sadness construct, but it was grouped with the anxiety descriptors. Second, frustration loaded on both anxiety and anger constructs. Third, dispirited loaded with anger and sadness constructs. Overall, the structure was consistent with the proposed grouping of scale items listed in Appendix B.

Correlations among the four emotion constructs supported by the factor analysis were significant, but small enough to support the assumption that each emotion measured was distinct (Table 3). It also supports the notion that users experience more than one emotion while learning.

3.4.3. Computer knowledge

Several researchers (e.g., Fulton, 1997; Kay, 1992, 1993) have noted that computer proficiency is an evolving concept based, to a certain extent, on who is learning and what technology is available. Perhaps the best one can do is to examine what skills are important in a given context. Recall that the context of this study includes the following key elements: preservice teachers (grades 7–12), ubiquitous access to a computer and the Internet, and a model that focuses on integration. It is reasonable, then, to develop a comprehensive assessment of computer ability based on the kind of tools that would be used in an educational setting. Therefore, a composite measure of 10 computer skills was developed from a content analysis of instruments designed to assess computer ability of beginning teachers (Albee, 2003; Bartlett, 2002; Bucci, 2003; Collier, Weinburgh, & Rivera, 2004; Fulton, 1997; Gunter, 2001; Seels, Campbell, & Talsma, 2003; Thompson, Schmidt, & Davis, 2003; Wepner, Ziomek, & Tao, 2003; Wilkerson, 2003). The specific skills identified in previous research included operating systems, communication, World Wide Web, word processing, spreadsheet, database, graphics, presentations, and web page creation. A new measure of computer ability was created because the majority of previous instruments did not report reliability or validity statistics (Albee, 2003; Bartlett, 2002; Bucci, 2003; Fulton, 1997; Gunter, 2001; Seels et al., 2003; Thompson et al., 2003; Wepner et al., 2003). The reliability estimates for the computer ability skills assessed in this study were high ranging from 0.92 to 0.98 (Table 1).

Table 2
Varimax rotated factor loadings on strategies used to incorporate technology

Emotion items	Factor 1	Factor 2	Factor 3	Factor 4
Insecure	0.79			
Nervous	0.74			
Helpless	0.70			
Anxious	0.59			
Excited		0.85		
Curious		0.72		
Satisfied		0.60		
Frustrated	0.50		0.47	
Angry			0.86	
Irritable			0.69	
Disheartened				0.87
Dispirited			0.47	0.55

Factor	Eigen value	Percentage of variance	Cumulative %
1	4.37	36.4	36.4
2	1.64	13.6	50.0
3	1.01	8.4	58.4
4	0.90	7.5	65.9

Table 3
Correlations among emotion constructs

	Angry	Anxious	Happiness	Sadness
Angry	1.00	0.52**	−0.37**	0.55**
Anxious		1.00	−0.23*	0.46**
Happiness			1.00	−0.39**
Sadness				1.00

* $p < 0.005$ (2-tailed).
** $p < 0.001$ (2-tailed).

3.5. Procedure and data analysis

Subjects were told the purpose of the study and then asked to give written consent if they wished to participate. The survey was administered online at the beginning of the year (September) and at the end of the year (April). It took 10 min to complete.

To examine the integrity of the computer emotion scale (Question 1), the following analyses were run:

1. Principal components factor analysis on the computer emotion scale.
2. Internal reliability estimates of the emotions factors.

To explore the prevalence of emotions reported while learning (Question 2), the following analyses were run:

3. Descriptive analysis of four basic emotions reported while learning.
4. Correlation among emotion constructs.

To investigate the relationship among emotions and the acquisition of computer knowledge (Question 3), the following analyses were run:

5. Paired *t*-test assessing change in computer emotions and computer knowledge.
6. Multiple analysis of variance (MANOVA) assessing the relationship between emotion constructs and computer experience levels.
7. Correlation among pre-laptop emotions and pre-laptop computer knowledge.
8. Correlations among change in emotions and change in computer knowledge.
9. Regression analysis using pre-laptop emotions to predict pre-laptop knowledge.
10. Regression analysis using change in emotions constructs to predict change in computer knowledge.

4. Results

4.1. Frequency of emotions expressed

Overall, happiness ($M = 1.83$; $SD = 0.52$) was the emotion that users claimed they felt most often while learning new software, followed by anger ($M = 0.70$; $SD = 0.45$), anxiety ($M = 0.65$; $SD = 0.48$), and sadness ($M = 0.55$; $SD = 0.47$). Translating from the scale (see Appendix B), this means that preservice teachers, on average, felt happiness (curiosity, satisfaction, and excitement) most of the time, and anger, anxiety, or sadness some of the time. With respect to individual emotion items, users felt curiosity, satisfaction, and excitement most, and helplessness, dispirited, and anger the least. Means for all individual emotion items are presented in Table 4.

4.2. Correlations among emotion constructs

From Table 3, at least two conclusions can be drawn regarding the relationship among emotions reported while learning. First, subjects who experienced happiness felt significantly less anxiety, sadness, or anger.

Table 4
Mean scores for emotion items (range 0–3)

Emotion item	Mean	SD
Curious (H)	2.03	0.69
Satisfied (H)	1.81	0.58
Excited (H)	1.66	0.72
Anxious (Anx)	0.98	0.72
Frustrated (Ang)	0.89	0.51
Irritable (Ang)	0.78	0.65
Disheartened (S)	0.67	0.56
Insecure (Anx)	0.59	0.62
Nervous (Anx)	0.52	0.63
Helpless (Ax)	0.51	0.60
Dispirited (S)	0.44	0.54
Angry	0.43	0.56

H, happiness emotion construct; Anx, anxious emotion construct; Ang, angry emotion construct; S, sadness emotion construct.

Second, the three negative emotions (anger, anxiety, and sadness) were strongly and significantly correlated with each other, indicating that multiple emotions are probably felt during the learning process.

4.3. Change in emotions and computer knowledge

After the 8 month, integrated laptop program, preservice teachers reported significantly less anxiety and anger while they were learning software (Table 5). Happiness increased and sadness decreased, but not significantly. Happiness may not have increased because of a ceiling effect. Computer knowledge significantly increased in each of nine ability constructs presented in Table 1 ($p < 0.001$).

4.4. Emotion and computer experience

A MANOVA (Table 6) examining differences in emotions expressed and years of computer experience revealed that anxiety expressed while learning a software package was significantly lower for subjects who had more than 10 years experience with computers ($p < 0.001$, Scheffé Post Hoc Analysis). No other significant differences among emotions and computer experience levels were observed.

4.5. Emotion and knowledge acquisition

4.5.1. Correlation among pre-laptop emotions and pre-laptop computer skill

There is a strong significant relationship among emotions reported while learning, and computer skill (Table 7). Happiness and anxiety showed the highest correlations with all nine computer skill measures. Negative emotions (anxiety, anger, and sadness) were negatively correlated with ability, whereas the one positive emotion, happiness, showed a positive correlation.

Table 5
Emotion construct scores before and after integrated laptop program

Emotion construct	Before program		After program		df	t
	M	(SD)	M	(SD)		
Anger	2.05	(1.34)	1.72	(1.23)	149	3.41*
Anxious	2.48	(1.93)	1.81	(1.64)	149	5.26**
Happiness	5.47	(1.58)	5.69	(1.63)	149	−1.42
Sadness	1.09	(0.92)	0.99	(0.87)	149	3.41

* $p < 0.005$.
** $p < 0.001$.

Table 6
MANOVA for emotions and computer experience level

Source	df	SS	MS	F	Post hoc analysis for years experience
Anxious	3	111.5	37.2	11.94*	10+ >6–9, 3–5, 0–2
Happy	3	18.5	6.2	2.57	No significant difference
Angry	3	8.4	2.8	1.56	No significant difference
Sad	3	7.8	2.6	2.98**	No significant difference

* $p < 0.001$.
** $p < 0.05$.

Table 7
Correlations among pre-laptop emotion constructs and pre-laptop computer skills

	Angry	Anxious	Happiness	Sadness
Operating System	−0.31**	−0.54**	0.44**	−0.33**
Communication	−0.30**	−0.46**	0.36**	−0.37**
World Wide Web	−0.27**	−0.43**	0.36**	−0.36**
Word Processing	−0.28**	−0.44**	0.41**	−0.36**
Spreadsheets	−0.30**	−0.48**	0.32**	−0.36**
Database	−0.28**	−0.44**	0.46**	−0.34**
Graphics	−0.31**	−0.44**	0.38**	−0.31**
Presentations	−0.31**	−0.43**	0.41**	−0.35**
Web Page Design	−0.33**	−0.36**	0.28**	−0.22*

* $p < 0.005$ (2-tailed).
** $p < 0.001$ (2-tailed).

4.5.2. Correlation among changes in emotions and change in computer knowledge

There are two notable findings with respect to how change in emotions related to change in computer knowledge acquired over the 8 month, integrated laptop program. First, positive increases in happiness expressed while learning are significantly correlated with increases in eight of the nine computer skills assessed (web page design was the exception). Second, a decrease in anxiety, is significantly correlated with increases in seven of the nine computer skills assessed (presentation and web page design skills were the exceptions). One could also say that a decrease in happiness and an increase in anxiety are associated with a decrease in computer skills, however, the patterns observed in this study revealed significant increases in happiness and computer skills, and significant decreases in computer anxiety. Overall, changes in anger and sadness were not significantly related to changes in computer skills (Table 8).

Table 8
Correlation among change in emotion constructs and change in computer skills

	Angry	Anxious	Happiness	Sadness
Operating System	−0.17*	−0.29***	0.26**	−0.07
Communication	−0.16	−0.27**	0.30***	−0.12
World Wide Web	−0.21*	−0.26**	0.30***	−0.11
Word Processing	−0.12	−0.24*	0.26**	−0.07
Spreadsheets	−0.07	−0.18*	0.17*	−0.01
Database	−0.03	−0.24**	0.21*	−0.07
Graphics	−0.13	−0.18*	0.18*	−0.06
Presentations	−0.08	−0.04	0.27**	−0.01
Web Page Design	−0.09	−0.08	0.10	0.03
Total ability difference	−0.14	−0.26**	0.28***	−0.07*

* $p < 0.05$ (2-tailed).
** $p < 0.005$ (2-tailed).
*** $p < 0.001$ (2-tailed).

Table 9
Stepwise regression equation using pre-laptop emotions constructs to predict total pre-laptop computer knowledge

Predictor	B Weight	SE[a]	SRC[b]	T
Anxiety	−16.05	2.18	−0.45	−7.36[*]
Happiness	15.16	2.68	0.34	5.67[*]

$R = 0.62$, $R^2 = 0.39$, standard error of estimate (SEE) = 54.4, $F = 55.8$, Durbin–Watson = 2.2, df = (1,175).
[a] SE, standard error.
[b] SRC, standard regression coefficient.
[*] $p < 0.001$.

Table 10
Stepwise regression equation using change in emotions constructs to predict change in total computer knowledge

Predictor	B Weight	SE[a]	SRC[b]	T
Happiness	7.78	2.17	0.26	3.59[*]
Anxiety	−8.24	2.53	−0.25	−3.26[**]

$R = 0.38$, $R^2 = 0.14$, standard error of estimate (SEE) = 48.7, $F = 12.1$, Durbin–Watson = 2.2, df = (1,175).
[a] SE, standard error.
[b] SRC, standard regression coefficient.
[*] $p < 0.001$.
[**] $p < 0.005$.

4.5.3. Regression analysis – pre-laptop emotion predicting pre-laptop total computer knowledge

A stepwise multiple regression analysis was done to examine the relationship among the four emotions constructs (anger, anxiety, happiness, and sadness) and total computer knowledge (sum of the nine computer constructs in Table 1). The stepwise method was chosen because there was no previous theory to guide selection of predictors. Happiness and anxiety were the only significant predictors of pre-laptop total computer knowledge (Table 9). The total amount of variance explained by these two variables was 0.39. Multicollinearity did not appear to be a problem because no VIF was over the acceptable level of 10 (Bowerman & O'Connell, 1990; Myers, 1990) and the average VIF ($M = 1.2$) was not substantially greater than one (Bowerman & O'Connell, 1990) when all variables were entered into the equation. The Durbin–Watson test produced a value of 2.2 indicating limited problems with respect to autocorrelation of errors (Durbin & Watson, 1951).

4.5.4. Regression analysis – change in emotions predicting change in total computer knowledge

A stepwise multiple regression analysis was done to examine the relationship among the change four emotions constructs (anger, anxiety, happiness, and sadness) and change in total computer knowledge. The stepwise method was chosen because there was no previous theory to guide selection of predictors. Anxiety and happiness were the only significant predictors of change in total computer knowledge (Table 10). The total amount of variance explained by these two variables was 0.14. Multicollinearity did not appear to be a problem because no VIF was over the acceptable level of 10 (Bowerman & O'Connell, 1990; Myers, 1990) and the average VIF ($M = 1.0$) was not greater than one (Bowerman & O'Connell, 1990) when all variables were entered into the equation. The Durbin–Watson test produced a value of 2.3 indicating limited problems with respect to autocorrelation of errors (Durbin & Watson, 1951).

5. Discussion

The purpose of this study was to examine the relationship among four basic emotions (anger, anxiety, happiness, and sadness) and the acquisition of computer knowledge. Three questions were to be addressed:

1. Can computer-related emotions be assessed reliably, and with validity?
2. To what extent are emotions present when software is being learned?
3. How are emotions related to computer knowledge acquisition?

5.1. Question 1 – measuring emotions while learning

A theoretically sound, reliable, valid measure of computer emotions needed to be developed since emotions have not been examined systematically in the context of computer related behaviour prior to this study. The four basic emotions addressed by the computer emotion scale were selected based on extensive research (Arnold, 1960; Ekman et al., 1972; Izard, 1969; James, 1884; Oatley & Johnson-Laird, 1987; Plutchik, 1980; Tomkins, 1962). The reliability of the emotion scales was acceptable (Kline, 1999; Nunnally, 1978), hovering around 0.70. That said, it might be advisable to refine and possibly add items for the sadness scale, which had the lowest reliability estimate. As well, a qualitative pilot test of items used should be done to determine if the descriptors suggested by Oatley and Johnson-Laird (1987) actually represented the intended constructs. A principal component factor analysis confirmed that the four emotions assessed were relatively distinct constructs. Moderate, but not excessively high correlations among the emotions constructs supported the factor analysis. In summary, one can be confident that measure of computer related emotions used was reasonably sound.

5.2. Question 2 – presence of emotions while learning

Preservice teachers reported that emotions were present in varying frequencies while learning. Happiness (curiosity, satisfaction, and excitement) was experienced most of the time when subject were learning a new software package. This is not unexpected given that 80% of the subjects had 10 or more years of computer experience. Considering that (a) anxiety dropped significantly over 8 months in this study, (b) anxiety dropped significantly for subjects with 10 or more year computer experience, and (c) anxiety was a significant predictor of computer knowledge, the results may have been different with a less able population.

The negative emotions (anxiety, anger, and sadness) were experienced somewhere between never and sometimes while subjects were learning a new software package. It is worthy to note, though, that they were significantly and positively correlated. This is an indication that more than one emotion may be expressed during the learning process. Again, the relatively infrequent reporting of negative emotions is consistent with the high level of computer experience reported by the sample in this study.

5.3. Question 3 – relationship among emotions and computer knowledge acquisition

The six analyses run to examine the relationship among emotions and computer knowledge acquisition suggests that there is a significant interaction. First, pre-laptop estimates of emotions while learning were significantly correlated with all nine measures of computer knowledge. This is indirect evidence to support a pervasive connection among all four basic emotions and computer knowledge.

Second, the negative emotions of anxiety and anger significantly decreased over the 8 month, integrated laptop program, whereas computer knowledge significantly increased. Again, this is indirect evidence indicating that emotions and computer knowledge are related. This result is consistent with the results reported by Honeyman and White (1987) and Maurer (1994) who noted that computer anxiety levels drop, but only after longer course of instruction (e.g., over two terms).

Third, pre-laptop anxiety levels reported while learning new software are significantly related the number of years of computer experience and the cut-off appears to be 10 years. Subject with less than 10 years of computer experience report more significantly greater computer anxiety than those subjects with 10 or more years of computer experience. This finding indicates that anxiety may be a more influential variable than anger or sadness. The result is also consistent with Wilfong's (2006) report that anger was not related to computer experience. It is also interesting to note that while a reduction in anxiety levels appears to take 10 years without intervention, it takes only 8 months in an environment where meaningful and ubiquitous computer use is the norm.

Fourth, changes in anxiety and happiness were significantly correlated to changes in a majority of the computer knowledge scales. Specifically, an increase in happiness and a decrease in anxiety were positively correlated with an increase in seven to eight computer skills constructs. This is a correlation, so causation cannot be assumed, however, the result is consistent with emotions being connected to computer knowledge acquisition.

Finally, two regression equations, using emotions to predict pre-laptop knowledge and change in knowledge acquisition, were run. Happiness and anxiety were significant predictors in both analyses. Anger and sadness did not appear significantly linked to computer knowledge.

In summary, there appears to be relatively strong evidence suggesting a significant link between emotions reported while learning new software and the acquisition of computer knowledge. Happiness and anxiety appear to play a prominent role, while anger and sadness play a minor role. Previous literature, supports the enhanced role of computer anxiety (e.g., Beckers et al., 2006; Honeyman & White, 1987; Koohang, 1987; Mackowiak, 1988; Smith & Caputi, 2001), but is silent on the other three emotions.

5.4. Caveats

The results in this study, while suggestive of a meaningful link between emotions and computer knowledge acquisition should be treated with caution for following reasons. First, self-report measures were used, therefore the responses need to be validated, perhaps by checking actual emotions expressed while learning a new software package. Second, given moderate reliability estimates, it would be wise to interview a sample of future subjects to check if the items they select actually correspond to the intended emotion of a construct. Finally, the sample consisted of relatively advanced users, at least in terms of years of computer experience. A more diverse population with a wider range of computer experience is needed to be more confident in the results.

5.5. Implications for education

Since this is one of the first studies examining the relationship between emotions and computer knowledge, it would not be prudent to make any strong conclusions with respect to implications for education. Several conclusions, however, tentative, are worth noting.

First, exposing preservice teachers to an integrated laptop program, helped to significantly reduce reported anxiety and anger levels in just 8 months. It also helped to significantly improve computer related knowledge. While there are no comparison groups, ubiquitous access to computing appears to play a significant role in altering computer related behaviours.

Second, it is worth considering the full range emotions a new user feels while learning a new software package, not just anxiety levels. Many new users may experience emotions in private or may not show them externally, but clearly anger, happiness, and sadness are also present and important. Developing strategies to reduce excessively negative emotions, or to promote curiosity and excitement, might help to improve progress.

Third, emotions toward computers can be changed – they are not necessarily fixed, innate, pre-ordained, or inevitable. Without intervention, it may take 10 or more years. With a steady diet of integrated computer use, more successful emotional responses may be achieved in a much shorter time.

5.6. Future research

There are several suggestions for future research that would help build on the results obtained in this study. First, expanding the number of emotional descriptors in Appendix B, through qualitative interviews, would improve the validity and reliability of the computer emotion scale. Second, it would be helpful to validate emotional descriptors through an interview process. Third, it would be informative to observe users while they are learning a new software package and then interview them about the emotions they felt. Finally, a study of less experienced computer users is needed to compliment results presented in this paper.

6. Summary

This study examined the relationship among emotions reported while learning new software and computer knowledge acquisition. Happiness was expressed often – anxiety, anger, and sadness were reported sometimes. Anxiety and anger levels decreased significantly over 8 month, integrated laptop, preservice education program and computer knowledge increased. All four emotions examined were significantly correlated with nine computer knowledge areas, but only happiness and anxiety were significant predictors of computer knowledge change.

Appendix A

Description of technology related activities used in program

Typical activities	Description
Assessment	Students post the first draft of an assignment in a discussion board and feedback is posted by other students or the teacher.
Case studies	Students are presented with a case study and have to work in teams to develop and post a solution on a discussion board. Teams can then evaluate each others answers and post further suggestions online.
Discussion boards	Online discussions can be very effective or disastrous, depending on the kind of questions you ask, the size of your class, and the rules you establish for posting messages. If you ask focused questions, limit the number of people who can participate in a specific discussion (8–10), promote clear, short subject lines and concise 3–5 sentence postings, you can have very meaningful and lively discussions.
Electronic portfolios	Creating electronic portfolios, journals, or research logs can be an effective tool for students to showcase their work, as well as bring together a number of topics and skills in a culminating task.
Fast feedback	At the end of each class, students use an online evaluation tool (e.g., http://www.getfast.ca/) to respond to a brief evaluation asking them what they learned and any key questions they might have. The responses of this evaluation can be used as a lead in to the following class.
Java applets	The use of this activity depends on the specific discipline, but there are numerous java applets that can be used for practice, exploration, and demonstration. Using online exercises with immediate feedback can help solidify a number of key concepts, particularly in mathematics and science.
Labs	A subject-specific piece of software (e.g., Starry Night, Geometers Sketchpad) is used in lab setting that models the use of the software and allows students to learn how to use it.
Online debates	Students within a large lecture are divided into learning teams. A debate topic based on a current issue in education is presented and students have to research and post their arguments (as a team) on the discussion board.
Online questionnaires	Depending on the discipline, there may be interactive online questionnaires, tests, or exercises that students can complete leading them into a specific topic. Students are interested in learning about and evaluating themselves and this exercise helped them focus on the material presented after.
Research tasks	Students must first select a topic of interest, possibly within a given set of topics offered by the teacher, and then they must research the topic using the web OR ideally, an electronic library of formal journal articles and books.
Resource collections	Students collect, analyze, and annotate various web pages and then post online. This allows for the collection of immediate and valuable resources for the class and the students. Through the creation of a digital resource web site, students then take the listed web pages and collect, organize and synthesize them into meaningful topic areas.
Streamed videos	Streamed videos can be used inside or outside of class, but students should bring headphones. There are many videos that help bring a real-world context to a variety of disciplines. We have concentrated on the Annenberg collections where there are hundreds of exceptionally well done videos in Education, Science, and Mathematics.
Subject specific software	Student created and delivered a wide range of lesson using subject specific software including Geometers Sketchpad, Learning Objects, TI Interactive, and Fathom.
Video projects	Creating mini-video clips or digital pictures can be a powerful tool for engaging students in a variety of topics. It can also be an effective evaluation tool for presentations. Many students benefit considerably from watching themselves present information. The range of application is virtually endless – microteaching, mini-lessons on specific core topics, creating virtual research conferences, and teaching core concepts
Web Page Design	Learning teams (2–4) design web pages for a specific high school course. This promotes planning, understanding content, and organization. When the project is finished, a CD of all high school course and distributed to all students.

Appendix B

In general, when I am learning how to use a new software package, I feel:

	None of the time	Some of the time	Most of the time	All of the time
1. Satisfied[a]	0	1	2	3
2. Disheartened[b]	0	1	2	3
3. Anxious[c]	0	1	2	3
4. Irritable[d]	0	1	2	3
5. Excited[a]	0	1	2	3
6. Dispirited[b]	0	1	2	3
7. Insecure[c]	0	1	2	3
8. Frustrated[d]	0	1	2	3
9. Curious[a]	0	1	2	3
10. Helpless[c]	0	1	2	3
11. Nervous[c]	0	1	2	3
12. Angry[d]	0	1	2	3

[a]Happiness construct.
[b]Sadness construct.
[c]Anxiety construct.
[d]Anger construct.

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