L-Università ta' Malta
Centre for Resilience & Socio-Emotional Health

International Journal of Emotional Education
ISSN: 2073 7629

Volume 11, Number 2, November 2019 pp 3 - 16

www.um.edu.mt/ijee

Fostering students' emotion regulation during learning: Design and effects of a computer-based video training

Petra Engelmann and Maria Bannert[1]

School of Education, Technical University of Munich, Germany

Emotions have an essential impact on students' learning outcome. Empirical findings show negative correlations between negative emotions and learning outcome. Negative emotions during learning are quite common and become more frequent over the course of an academic career. Thus, regulating these emotions is important. Existing studies indicate that university students lack the ability to successfully regulate their emotions during learning. However, interventions to foster university students' inherent emotion regulation during learning are missing. In an attempt to identify interventions, this study investigates the effect of a video-based emotion regulation training for university students on emotion regulation strategies, emotions, and learning outcome. One hundred and sixteen university students either received training in emotion regulation (n = 60) or in workplace design (n = 56) before learning in a computer-based learning environment about probability theory. The emotion regulation training lead to improved emotion regulation (more cognitive reappraisal, less suppression) and less frustration and anxiety, but did not affect learning outcome. The results confirm that university students experience significant emotion regulation difficulties and suggest that they need intensive training in emotional regulation.

Keywords: emotion regulation; training; cognitive reappraisal; control-value-theory; computer-based learning

First submission 18th December 2018; Accepted for publication 18th June 2019.

Introduction

Emotions, emotion regulation, and learning

By now, the importance of emotions in learning is well acknowledged in educational science (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). Emotions are an essential element of every person's life and previous work has shown that they play a crucial role in students' learning outcome (Pekrun & Linnenbrink-Garcia,

1 Corresponding author. Email address: maria.bannert@tum.de

2012). They affect cognitive processes that are relevant for learning, such as attentional resources, memory storage and retrieval, problem solving and the use of learning strategies (Pekrun, Goetz, Titz, & Perry, 2002). Most empirical findings indicate negative correlations between negative emotions and cognitive processes and learning outcome (Pekrun, 2017). These findings have also been confirmed in computer-based learning environments (Artino & Jones, 2012; Bosch & D'Mello, 2017). In computer-based learning, so-called epistemic emotions were found to be especially meaningful (D'Mello, 2013; Pekrun, 2017).

Epistemic emotions are those emotions that are related to knowledge acquisition and are elicited by cognitive information processing during learning activities (Pekrun, Vogl, Muis, & Sinatra, 2017). Learners experience epistemic emotions as when processing new learning material and matching it with existing knowledge (Lehman, D'Mello, & Graesser, 2012). Unexpected information, complex, or contradictory learning material, and difficulties in understanding the learning material, promote epistemic emotions as the learning phase is disrupted (Arguel, Lockyer, Kennedy, Lodge, & Pachman, 2018; D'Mello, Lehman, Pekrun, & Graesser, 2014). Examples of typical epistemic emotions include surprise, curiosity, confusion, frustration, and boredom (D'Mello, 2013; Pekrun, 2017).

In computer-based learning environments, evoking negative emotions like confusion, frustration or boredom, is inevitable due to technical limitations and a lesser flexibility in monitoring learners' emotional state (Malekzadeh, Mustafa, & Lahsasna, 2015). Moreover, negative emotions during learning become more and more frequent in the course of an academic career, and many learning situations and activities cannot be chosen or structured according to one's own interest (Nett, Goetz, & Hall, 2011). As negative emotions during learning impair the learning outcome, researchers underline that these should be regulated (Azevedo et al., 2017; Jarrell & Lajoie, 2017). By regulating their emotions, people can change the quality, intensity, or duration of their emotions through cognitive or behavioural strategies (Gross, 2015). Gross (1998) defines emotion regulation as the "processes by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions" (p. 275).

Several investigations concluded that emotion regulation deficits are related to reduced academic achievement (Graziano, Reavis, Keane, & Calkins, 2007; Kwon, Hanrahan, & Kupzyk, 2017). In addition, studies indicate that students from school to university do not systematically apply emotion regulation strategies, and that their strategies are dysfunctional (Azevedo et al., 2017; Strain & D'Mello, 2015). Although researchers point to the necessity of developing interventions that foster university students' emotion regulation during computer-based learning (Azevedo et al., 2017; Jarrell & Lajoie, 2017), corresponding empirical studies are lacking. Whilst Strain and D'Mello (2015) showed a positive effect of an emotion regulation instruction on university students' emotions and performance in a computer-based learning environment, training aimed at improving students' own emotion regulation ability during learning is missing (Pekrun & Stephens, 2010). Existing research concerning the enhancement of student's emotional state during computer-based learning mostly neglects promoting students' inherent emotion regulation. Therefore, the goal of the present study was to develop an evidence-based training to foster university students' emotion regulation during learning in a computer-based learning environment, and to empirically investigate the training's effect on emotion regulation strategy use, emotions and learning outcome.

Development of a video-based emotion regulation training

So far, research on the effects of different emotion regulation strategies has focused on comparing cognitive reappraisal and expressive suppression. Cognitive reappraisal means to reinterpret the meaning of an emotional stimulus to modulate its impact (Gross, 2015). Studies repeatedly showed that cognitive reappraisal is positively and suppression is negatively related to both the emotional state (Jacobs & Gross, 2014; Webb, Miles, & Sheeran, 2012) as well as cognitive performance and learning outcome (Davis & Levine, 2013; Strain & D'Mello, 2015). Suggestions of how to improve emotion regulation during learning mostly address one specific form of cognitive reappraisal, that is, the modification of learners' subjective control and value (Boekaerts & Pekrun, 2016; Jarrell & Lajoie, 2017; Pekrun, 2017). According to control-value-theory (Pekrun, 2006, 2017), learners' academic emotions arise on the one hand from judgements of their competence and ability to master a learning task (control), and from judgements of personal importance and relevance of the learning activity (value) on other hand. Subjective value can either be intrinsic (value of learning per se) or extrinsic (expectation of benefits from learning, like good grades) (Pekrun, 2006, 2017).

Empirical studies support a positive relationship between high perceived control and value with positive emotions and a negative relationship with negative emotions (Artino & Jones, 2012). That is why the present study investigates a training targeting cognitive reappraisal in terms of influencing control and value appraisals during learning. Furthermore, a number of publications recommend to impart knowledge of emotions and emotion regulation in general and their significance in learning (Pekrun & Perry, 2014). Hence, the training in this study consisted of two parts: an informative aspect (information about emotions and emotion regulation in general and in learning) and a practical part (imagination of an autobiographical learning situation, examples of proper cognitive reappraisals, generation of own cognitive reappraisals regarding control and value). In order to be economically efficient and easily applicable in different settings, the training consisted of an animated video of about 20 minutes (Figure 1).

Research questions and hypotheses

The present study investigated the influence of a video-based emotion regulation training on university students' emotion regulation strategies, emotions, and learning outcome during computer-based learning compared to a control condition learning. Research has shown that cognitive reappraisal – in contrast to suppression –is positively related to the emotional state and learning outcome (Strain & D'Mello, 2015; Webb, Miles, & Sheeran, 2012). The study sought to address the following three research questions:

1. What is the effect of the video-based emotion regulation training on the application of cognitive reappraisal and suppression during learning?
2. What is the effect of the video-based emotion regulation training on emotions during learning?

3. What is the effect of the video-based emotion regulation training on learning outcome?

We hypothesised that the experimental group will apply more cognitive reappraisal and less suppression (H1), to have more positive and less negative emotions (H2) and to have a higher learning outcome than the control condition (H3).

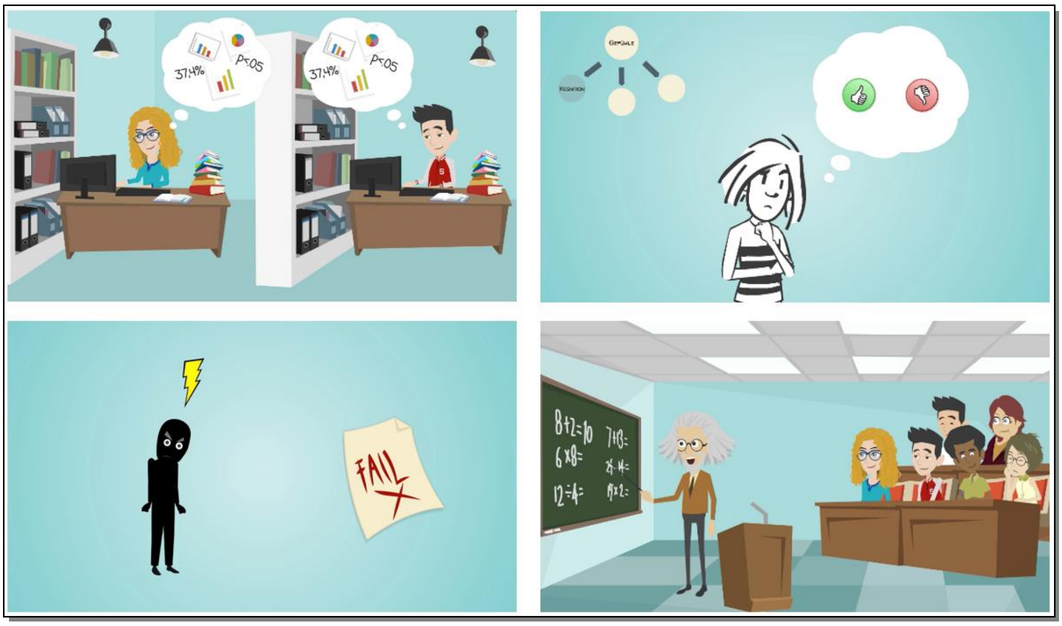

Figure 1. Scenes from the animated emotion regulation training.

*N*B. In the upper picture on the left and the lower picture on the right, typical learning situations of students are displayed. The upper picture on the right visualizes the process of appraisal, whilst the lower picture on the left depicts the negative effect of emotion regulation deficits on learning outcome. The unpublished training was created by the authors with the video animation software “GoAnimate” (meanwhile: “Vyond”).

Methodology

Sample and design

Data was collected data from 121 participants. An outlier analysis of the knowledge test lead us to remove 5 participants from the sample. The final sample included 116 German-speaking university students (M_{age} = 21.39 years, *SD* = 3.34, 56.9% female). Based on a power of 80% and a medium effect size (*d* = 0.50), we aimed for a sample size of at least 102 participants. The participants came from a wide range of academic majors: 34 students (29.3%) were enrolled in agricultural sciences, 32 students (27.6%) in forestry science and resource management, 17 students (14.7%) in nutritional science, 13 students (11.2%) in brewing technology, 12 students (10.3%) in agricultural and horticultural sciences, 6 students (5.2%) in biology, and 2 students (1.7%) in bioprocess engineering.

The data was collected in an experimental study with a between-subject design, and consisted of two sessions. The first session was conducted to assess prior knowledge and different learner characteristics that are not reported here (groups did not differ significantly in terms of prior knowledge and relevant learner characteristics). Three to seven weeks later, the learning session was conducted in groups with up to 20 participants. All participants of one group session belonged to the same condition (experimental or control condition). Assignment to the conditions took place beforehand by systematically allocating each group session alternately to one of the two conditions. Students in the experimental group (n = 60) were supported by the emotion regulation training, whereas students in the control group (n = 56) received a comparable training on workplace design for learning (Bannert, Sonnenberg, Mengelkamp, & Pieger, 2015). Except for the content, the control group training was created in the same way as the ER training.

Procedure

The learning session took place during the second session, which lasted approximately two hours (see Figure 2 for an overview of the procedure). After having been introduced to the procedure and the learning environment as well as answering the short version of the *Epistemically-Related Emotion Scales* (*EES*; Pekrun et al., 2017) for the first time, participants received a video-based emotion regulation training. During the training, participants in the experimental condition were asked to generate their own cognitive reappraisals of control and value. They were told to silently repeat their own reappraisals to themselves whenever they experience negative emotions during learning. The training was followed by a 10-minute break. Afterwards, participants were asked to judge the probability of being able to apply cognitive reappraisal during the upcoming learning phase from 0 to 100% (probability judgment). They were asked to fill out the short version of the *EES* at the beginning of the 45-minute learning phase, every 10 minutes during learning, and after the knowledge test (7 times overall). After the learning phase, the participants had to rate the perceived effectiveness of their applied emotion regulation strategies ("By the use of my strategies my negative feelings decreased") on a Likert scale (1 = *not at all*, 5 = *very much*). Finally, the knowledge test was administered and the *EES* was presented for the final time.

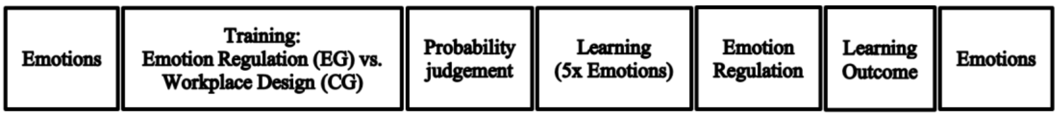

Figure 2. Procedure of the learning session.

Materials

Learning environment. Students learned in a computer-based learning environment about probability theory (see Figure 3 for an example of a page). The learning environment consisted of 27 pages, including a page summarizing the learning goals for the participants, four worked examples and 21 content pages of relevant information (approximately 2500 words). On the remaining pages, instruments and instructions were presented. Initially, the participants could navigate the learning environment by using the next-page button on the bottom of each page. After having visited every page, the participants could freely navigate the learning environment by using a menu bar on the left side of the computer screen. Below the menu bar, participants could see their remaining study time and the remaining time until they were asked to report their current emotions again.

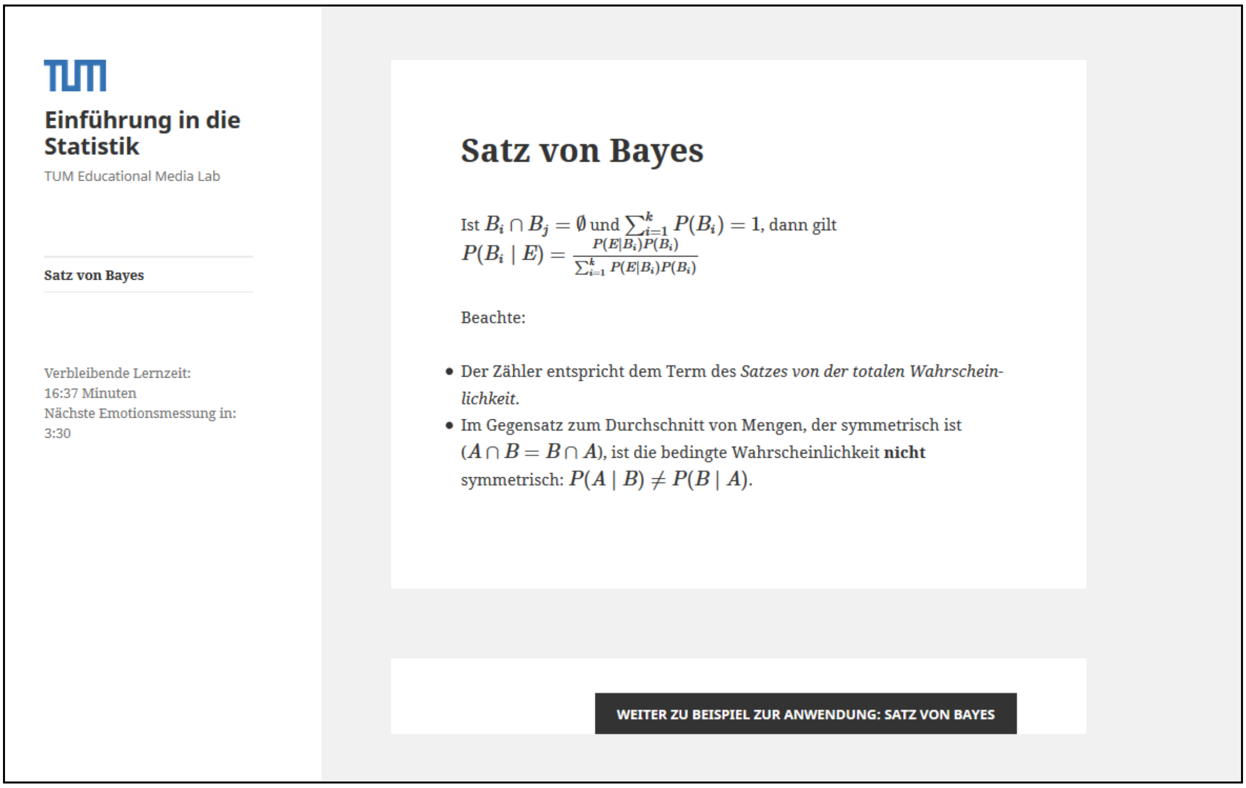

Figure 3. Example of a page of the learning environment.

NB. On the left, the remaining study time as well as the remaining time until the next emotion measurement, are displayed. In the centre of the learning page, the learning content (Bayes's theorem) is described. The unpublished learning environment was created by the authors.

Knowledge test. We measured knowledge gain by calculating the difference between the pre- and post-test scores. The test comprised of three multiple-choice items and nine open-ended questions. The test was composed of two problem statements, each followed by several test items. Descriptive statistics are presented in Table I.

Emotions. Epistemic emotions during learning were measured by the short version of the *EES* (Pekrun et al., 2017). The questionnaire measures the intensity of the seven emotions of curiosity, surprise, confusion, anxiety, frustration, excitement, and boredom on a Likert scale (1 = *not at all*, 5 = *very strong*). For each emotion, we calculated the means from the item scores of the seven measurement points (see Table I).

Emotion regulation. The *State Emotion Regulation Inventory* (*SERI*; Katz, Lustig, Assis, & Yovel, 2017) was used to measure cognitive reappraisal during learning. The questionnaire measures reappraisal with four items on a Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). To measure suppression during learning, we developed a scale consisting of two adapted items from the *Emotion Regulation Questionnaire* (*ERQ*; Gross & John, 2003) that deal with expressive suppression as well as two own items for physiological suppression and suppression of thoughts. Furthermore, we examined emotion regulation with an open-ended question ("If you had negative feelings during learning, how did you deal with them?"). Two trained evaluators rated the first 30 answers independently based on a self-developed coding scheme. As the inter-rater reliability was good (κ = .96), the remaining answers were coded by only one of the evaluators (see descriptive statistics in Table I).

Table I. Descriptive statistics of knowledge, emotion and emotion regulation measures.

Instrument	**Items**	***M***	***SD***	***MIN***	***MAX***	**Cronbachs α**
Prior knowledge	25	12.84	2.97	7.00	21.00	.47
Post knowledge	25	14.64	3.16	8.00	23.00	.59
EES (means)						
Curiosity	7	2.33	0.81	1.00	5.00	.90
Surprise	7	1.60	0.58	1.00	4.43	.80
confusion	7	1.75	0.67	1.00	3.86	.84
Anxiety	7	1.25	0.48	1.00	4.00	.90
frustration	7	1.63	0.71	1.00	4.29	.87
excitement	7	1.91	0.70	1.00	4.57	.90
boredom	7	2.03	0.91	1.00	4.71	.90
SERI						
cognitive reappraisal	4	4.92	1.34	1.00	7.00	.81
suppression	4	3.53	1.46	1.00	6.75	.69
Open question on emotion regulation						
cognitive reappraisal	1	0.31	0.47	0.00	1.00	1.00[a]
suppression	1	0.25	0.44	0.00	1.00	.91[a]
Probability judgment	1	58.55	23.89	0.00	100.00	–[b]

Results

Analyses of variance and independent samples t-tests were used to test the hypotheses. Since the hypotheses for all research questions were in favour of the experimental group, we used one-tailed t-tests. The alpha level was set to 5% for all analyses. Descriptive values and inferential statistics of all variables are presented in Table II.

Table II. Descriptive values and inferential statistics of knowledge, emotion and emotion regulation measure

	EG (*n* = 60)		**CG** (*n* = 56)		Statistics		
	M	*SD*	*M*	*SD*	*t*	*p*	*d*
Prior knowledge	12.67	2.86	13.02	3.09	0.64	.526	0.12
Post knowledge	14.48	3.15	14.80	3.18	0.54	.294	0.10
EES (means)							
curiosity	2.38	0.89	2.27	0.71	-0.71	.240	-0.14
surprise	1.67	0.68	1.52	0.44	-1.46	.074	-0.26
confusion	1.73	0.63	1.77	0.71	0.34	.369	0.06
anxiety	1.18	0.29	1.34	0.62	1.78	.040*	0.33
frustration	1.49	0.52	1.77	0.85	2.17	.017*	0.40
excitement	1.92	0.81	1.90	0.56	-0.14	.445	-0.03
boredom	1.97	0.91	2.10	0.91	0.47	.209	0.14
SERI							
cognitive reappraisal	4.99	1.45	4.85	1.22	-0.56	.289	-0.10
suppression	3.27	1.49	3.81	1.38	2.05	.022*	0.38
Open question on emotion regulation							
cognitive reappraisal	0.53	0.50	0.07	0.26	-6.27	<.001***	-1.14
suppression	0.10	0.30	0.41	0.50	4.04	<.001***	0.76
Perceived effectiveness of ER strategies (mean)	2.65	1.12	2.95	1.43	1.24	.110	0.24

Effect of the video-based emotion regulation training on the application of cognitive reappraisal and suppression during learning

Independent samples t-tests were run to test the first hypothesis (H1), namely that participants receiving an emotion regulation training apply more cognitive reappraisal and less suppression than participants receiving a training on optimal workplace design. Consistent with H1, calculations with the *SERI* showed that participants in the experimental condition applied significantly less suppression than participants in the control condition, $t(114) = 2.05$, $p = .022$, $d = 0.38$. Calculations with the open-ended question on emotion regulation confirmed and extended this result. Participants in the experimental condition applied significantly less suppression than participants in the control condition, $t(89.69) = 4.04$, $p < .001$, $d = 0.76$. Furthermore, participants in the experimental condition applied significantly more cognitive reappraisal than participants in the control condition, $t(89.69) = -6.27$, $p < .001$, $d = -1.14$. The mean perceived effectiveness of applied emotion regulation strategies was $M = 2.65$ ($SD = 1.12$) in the experimental and $M = 2.95$ ($SD = 1.43$) in the control condition with no significant difference between the groups, $t(103.95) = 1.24$, $p = .110$, $d = 0.24$.

Effect of the video-based emotion regulation training on the emotions during learning

Multivariate one-way ANOVA and independent samples t-tests were run to test the second hypothesis (H2), namely that participants receiving an emotion regulation training have more positive and less negative emotions than participants receiving a training on optimal workplace design. Contrary to H2, a multivariate one-way ANOVA showed that epistemic emotions in general did not differ significantly between the conditions, $F(1, 114) = 1.81$, $p = .092$, $\eta_p^2 = 0.11$. Still, independent samples t-tests revealed that participants in the experimental condition were significantly less frustrated, $t(89.70) = 2.17$, $p = .017$, $d = 0.40$, and significantly less anxious than participants in the control condition, $t(76.52) = 1.78$, $p = .040$, $d = 0.33$. Analyses regarding the other emotions showed no significant effects.

Effect of the video-based emotion regulation training on learning outcome

We ran a repeated-measures ANOVA to test the third research hypothesis (H3), namely that participants receiving an emotion regulation training show higher learning outcome than participants receiving a training on optimal workplace design (H3). The analysis showed a significant knowledge gain between the pre- and post-test, $F(1, 114) = 23.23$, $p < .001$, $\eta_p^2 = 0.17$, but – contrary to H3 – there was no significant difference between the conditions, $F(1, 114) = 0.61$, $p = .438$, $\eta_p^2 = 0.01$.

Discussion

The findings of the present study indicate that the training had a positive effect on participants' emotion regulation. This is in line with other interventions positively affecting students' emotion regulation (e.g. Strain & D'Mello, 2015). The training's effect on frustration and anxiety during learning supports other studies that show a significant reduction of negative emotions through the use of cognitive reappraisal (Jacobs & Gross, 2014; Webb et al., 2012).

Our inconclusive finding regarding the effect of the training on learning outcome neither confirms empirical research that found a connection between emotion regulation and learning outcome (Graziano et al., 2007; Kwon et al., 2017) nor findings on a positive correlation between cognitive reappraisal and

ISSN: 2073 7629

cognitive performance and learning outcome (Davis & Levine, 2013; Strain & D'Mello, 2015). One reason may be the intervention's intensity. Emotion regulation training used in clinical interventions intended to last for periods of at least several weeks (see Berking & Whitley, 2014; Linehan, 1993). We created a short training as we assumed that a healthy sample learns the use of cognitive reappraisal faster than a clinical sample. As the results show, this is not the case. Integrating a short training into students' curriculum seems not to be adequate to enable them to profoundly learn the application of cognitive reappraisal and to transfer it to a real learning situation. Researches from different disciplines suggest that a training transfer can only be achieved through repeated practice (Burke & Hutchins, 2016). Difficulties concerning the implementation of the strategy because of its low intensity could have contributed to the missing effect of the training on learning outcome. An effective training on cognitive reappraisal may need more practice sessions distributed over several weeks, in order to be able to successfully transfer the strategy application to the learning session.

Participants in the experimental condition rated their competence to apply cognitive reappraisal during learning as rather low and did not perceive their emotion regulation strategies as more effective than the control group. Therefore, we can assume that the participants in the experimental condition still felt insecure about the use of cognitive reappraisal. This is in line with findings suggesting that people find the application of cognitive reappraisal to be difficult (Suri, Whittaker, & Gross, 2015).

In the unsupported condition we found suppression to be the dominant emotion regulation strategy. This result matches the finding that people use suppression much more often than cognitive reappraisal in everyday life (Brans, Koval, Verduyn, Lim, & Kuppens, 2013). It suggests that students lack knowledge and skills to adequately state, let alone apply, emotion regulation strategies. This supports other studies showing that university students miss the ability to successfully regulate their emotions during learning (Azevedo et al., 2017; Strain & D'Mello, 2015).

Consequently, even healthy students seem to need more guidance, support, and a well-structured training to regulate emotions in order to improve learning outcome. Future studies should therefore experimentally compare the presented training to a more intense emotion regulation training. As students lack emotion regulation competence, they might also need more time to regulate their emotions. This is why conducting a comparable study with a learning phase longer than 45 minutes is recommended.

Another possible factor in the lack of effect of the emotion regulation training on learning outcome could be the learning topic. As the means of negative emotions in this study were rather low, an even more complex learning topic might have led to higher negative emotions and thereby provided more potential for variety in emotion regulation and in learning outcome.

One limitation that must be considered when interpreting the results of the present study, is that emotions were solely measured via self-report as it is a common and economic method of emotion recognition. Unfortunately, self-report measures can only capture conscious emotional reactions leading to results that highly depend on students' ability to evaluate their own emotions. As students show deficits in emotion regulation, they might also have difficulties assessing their emotional states. Thus, the students in this study may have reported less negative emotions than they actually experienced, which could be another explanation for the low means of emotion scores in general (Harley, 2016). To draw more valid conclusions, future studies should combine self-report data with more objective measures, like facial expressions, body posture, speech or physiological parameters (Azevedo et al., 2017).

Furthermore, conducting solely self-report data may distort the emotional state, such as leading participants to deeper reflect on their emotions (Harley, 2016). The repeated questions on students' current emotions may then have functioned as an independent intervention in both groups. Due to the stimulation of reflecting on emotions, participants might already have initiated attempts of emotion regulation. This could explain the mentioned missing differences between the two groups.

Conclusion

This study sought to address the demand by various researchers to develop interventions that enhance university students' emotion regulation during learning (Azevedo et al., 2017; Jarrell & Lajoie, 2017) by manipulating control and value appraisals (Boekaerts & Pekrun, 2016; Jarrell & Lajoie, 2017; Pekrun, 2017). Overall, the results suggest that emotion regulation is an important factor in computer-based learning that can be fostered by specific interventions. The presented video-based emotion regulation training proved beneficial in improving students' emotion regulation. It seems worthwhile to investigate its effect on other student samples in different learning environments, with different learning topics and longer learning phases. Although the 20-minute training is an efficient intervention that can easily be used in different settings to introduce students to the topic of emotion regulation during computer-based learning, multiple sessions and more exercises could help to deepen students' knowledge of emotion regulation and the application of cognitive reappraisal. Thereby, university students could be enabled to regulate their emotions during computer-based learning even better, which should positively affect learning outcomes.

References

Arguel, A., Lockyer, L., Kennedy, G., Lodge, J. M., & Pachman, M. (2018). Seeking optimal confusion: A review on epistemic emotion management in interactive digital learning environments. *Interactive Learning Environments, 1–11.*

Artino, A. R., & Jones, K. D. (2012). Exploring the complex relations between achievement emotions and self-regulated learning behaviors in online learning. *The Internet and Higher Education, 15*(3), 170–175.

Azevedo, R., Taub, M., Mudrick, N. V., Millar, G. C., Bradbury, A. E., & Price, M. J. (2017). Using Data Visualizations to Foster Emotion Regulation During Self-Regulated Learning with Advanced Learning Technologies. In J. Buder & F. W. Hesse (Eds.), *Informational Environments: Effects of Use, Effective Designs* (pp. 225–247). Cham: Springer International Publishing.

Bannert, M., Sonnenberg, C., Mengelkamp, C., & Pieger, E. (2015). Short- and long-term effects of students' self-directed metacognitive prompts on navigation behavior and learning performance. *Computers in Human Behavior, 52*, 293–306.

Berking, M., & Whitley, B. (2014). *Affect Regulation Training*. New York, NY: Springer.

Boekaerts, M., & Pekrun, R. (2016). Emotions and Emotion Regulation in Academic Settings. In L. Corno & E. M. Anderman (Eds.), *Handbook of Educational Psychology* (pp. 76–90). New York, NY: Routledge.

Bosch, N., & D'Mello, S. (2017). The Affective Experience of Novice Computer Programmers. *International Journal of Artificial Intelligence in Education, 27*(1), 181–206.

Brans, K., Koval, P., Verduyn, P., Lim, Y. L., & Kuppens, P. (2013). The regulation of negative and positive affect in daily life. *Emotion, 13*(5), 926–939.

Burke, L. A., & Hutchins, H. M. (2016). Training Transfer: An Integrative Literature Review. *Human Resource Development Review, 6*(3), 263–296.

D'Mello, S., Lehman, B., Pekrun, R., & Graesser, A. (2014). Confusion can be beneficial for learning. *Learning and Instruction, 29*, 153–170.

Davis, E. L., & Levine, L. J. (2013). Emotion regulation strategies that promote learning: Reappraisal enhances children's memory for educational information. *Child Development, 84*(1), 361–374.

D'Mello, S. (2013). A selective meta-analysis on the relative incidence of discrete affective states during learning with technology. Journal of Educational Psychology, 105(4), 1082–1099.

Graziano, P. A., Reavis, R. D., Keane, S. P., & Calkins, S. D. (2007). The Role of Emotion Regulation and Children's Early Academic Success. *Journal of School Psychology, 45*(1), 3–19.

Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology, 2*(3), 271–299.

Gross, J. J. (2015). Emotion Regulation: Current Status and Future Prospects. *Psychological Inquiry, 26*(1), 1–26.

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*(2), 348–362.

Harley, J. M. (2016). Measuring emotions: A survey of cutting edge methodologies used in computer-based learning environment research. In S. Tettegah & M. Gartmeier (Eds.), *Emotions, technology, design, and learning* (pp. 89–114). Amsterdam: Elsevier.

Jacobs, S. E., & Gross, J. J. (2014). Emotion Regulation in Education: Conceptual Foundations, Current Applications, and Future Directions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 183–217). New York, NY: Routledge.

Jarrell, A., & Lajoie, S. P. (2017). The regulation of achievements emotions: Implications for research and practice. *Canadian Psychology/psychologie Canadienne, 58*(3), 276–287.

ISSN: 2073 7629

Katz, B. A., Lustig, N., Assis, Y., & Yovel, I. (2017). Measuring regulation in the here and now: The development and validation of the State Emotion Regulation Inventory (SERI). *Psychological Assessment, 29*(10), 1235–1248.

Kwon, K., Hanrahan, A. R., & Kupzyk, K. A. (2017). Emotional expressivity and emotion regulation: Relation to academic functioning among elementary school children. *School Psychology Quarterly, 32*(1), 75–88.

Lehman, B., D'Mello, S., & Graesser, A. (2012). Confusion and complex learning during interactions with computer learning environments. *The Internet and Higher Education, 15*(3), 184–194.

Linehan, M. M. (1993). *Diagnosis and treatment of mental disorders: Skills training manual for treating borderline personality disorder*. New York, NY: Guilford Press.

Malekzadeh, M., Mustafa, M. B., & Lahsasna, A. (2015). A Review of Emotion Regulation in Intelligent Tutoring Systems. *Journal of Educational Technology & Society, 18*(4), 435–445.

Nett, U. E., Goetz, T., & Hall, N. C. (2011). Coping with boredom in school: An experience sampling perspective. *Contemporary Educational Psychology, 36*(1), 49–59.

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice. *Educational Psychology Review, 18*(4), 315–341.

Pekrun, R. (2017). Emotion and Achievement During Adolescence. *Child Development Perspectives, 11*(3), 215–221.

Pekrun, R., & Linnenbrink-Garcia, L. (2012). Academic Emotions and Student Engagement. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement* (pp. 259–282). New York: Springer.

Pekrun, R., & Perry, R. P. (2014). Control-value theory of achievement emotions. In R. Pekrun & L. Linnenbrink-Garcia (Eds.), *International Handbook of Emotions in Education* (pp. 120–141). New York, NY: Routledge.

Pekrun, R., & Stephens, E. J. (2010). Achievement Emotions: A Control-Value Approach. *Social and Personality Psychology Compass, 4*(4), 238–255.

Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary Educational Psychology, 36*(1), 36–48.

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research. *Educational Psychologist, 37*(2), 91–105.

Pekrun, R., Vogl, E., Muis, K. R., & Sinatra, G. M. (2017). Measuring emotions during epistemic activities: The Epistemically-Related Emotion Scales. *Cognition & Emotion, 31*(6), 1268–1276.

Strain, A. C., & D'Mello, S. K. (2015). Affect Regulation During Learning: The Enhancing Effect of Cognitive Reappraisal. *Applied Cognitive Psychology, 29*(1), 1–19.

Suri, G., Whittaker, K., & Gross, J. J. (2015). Launching reappraisal: It's less common than you might think. *Emotion, 15*(1), 73–77.

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin, 138*(4), 775–808.

ISSN: 2073 7629