Achievement Emotions of Boys and Girls in Physics Instruction: Does a Portfolio Make a Difference?

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Abstract: It is well documented in educational research that instruction in science – including Physics – is connected with rather negative emotions of students. It becomes especially apparent when considering the gender differences. Therefore, an important question is whether and how achievement emotions of boys and girls in Physics may be positively influenced. The aim of this study is to analyze firstly the differences regarding positive and negative emotions of boys and girls in Physics instruction. Secondly, a quasi-experimental intervention study has been carried out to test whether and how girls' and boys' emotions may be influenced by the application of a portfolio approach in Physics instruction. Covariance and multivariate analyses were carried out to test the hypothesized effects of the intervention. The Physics instruction focused on the topic of electricity. The research sample consisted of N = 161 students from eight 8th grade classrooms of three grammar schools in Germany which were divided into treatment and control groups randomly. Our study confirmed that boys generally experience more positive achievement emotions in Physics than girls, whereas girls showed higher level of anxiety and boredom than boys. The hypothesized effects of the portfolio intervention were only partly confirmed. The differences between boys and girls regarding their well-being in Physics instruction before the intervention have been slightly reduced by the application of the portfolio. Girls' well-being in the treatment group increased after the application of a portfolio compared to girls in the control group. As expected, self-concept and interest have been revealed as significant covariates influencing students' achievement emotions. Limitations of the study as well as implications for instruction are discussed. It is suggested that a portfolio represents a promising approach for the equalization of gender differences regarding achievement emotions in Physics.

Keywords: achievement emotions, well-being, gender, Physics instruction, portfolio intervention, quasi-experimental study, German Grammar School

1 Achievement emotions of boys and girls in Physics instruction

1.1 Achievement emotions and their influence on learning science in school

For a long time, research only focused on emotions induced by achievement outcomes, fear of failure and pride following performance feedback (Weiner, 1985).

Research in anxiety was dominating (Spielberger, 1966; Zeidner, 1998). To cope with anxiety, programs for students were developed and empirically tested (Strittmatter, 1993). Individual feedback on students' ability and transparent achievement demands were found to be reassuring (Sarason, 1984; Strittmatter, 1993). The assumption that students' emotions represent a significant factor influencing behavior and learning performance is meanwhile widely confirmed in psychological and educational research (e.g. Götz, 2002; Pekrun, Götz, Frenzel, Barchfeld, & Perry, 2011; Gläser-Zikuda & Järvelä, 2008).

Emotions are basic psychological systems regulating the individual's adaptation to personal and environmental demands. They are considered to be subjective experiences and multidimensional constructs with affective, cognitive, expressive, motivational and physiological components (Kleinginna & Kleinginna, 1981; Scherer, Schorr, & Johnstone, 2001). Emotions are closely related to cognitive, behavioral, motivational and physiological processes and they are therefore generally important for learning and achievement. They may initiate, terminate or disrupt information processing and result in selective information processing, or they may shape a recall (Pekrun, Götz, Titz, & Perry, 2002). For example, mood research determines that positive mood (as an enduring positive emotional state) promotes students' productive mental processes and creativity (Abele, 1995). Emotions particularly those experienced in an academic and achievement context may be characterized by criteria of valence (positive vs. negative) and activation (activating vs. deactivating). Positive-activating emotions, such as enjoyment, satisfaction and hope, positive-deactivating (relief, relaxation), negative-activating (anxiety, anger, shame/guilt) and negative-deactivating (boredom, hopelessness) are differentiated (Pekrun, 1992, 2006). Achievement emotions have an evaluational relation to learning, instruction and achievement. Positive-activating emotions are expected to have a positive influence on learning and achievement, while negative-deactivating emotions should have a negative impact. However, simple linear effects may not be assumed. Furthermore, emotions are experienced in specific situations (state-component) and they are biographically developed and enduring (trait-component). In contrast to mood, emotions are generally related to a specific event or more precisely caused by an event (e.g. feedback by teacher or parents).

It is assumed that not only instruction, parents' and teachers' value system, autonomy, expectancies and achievement goals, but also achievement feedback and it's consequences have an influence on students' achievement emotions (Pekrun et al., 2002). Pekrun (2000, 2006) suggested a control-value approach of achievement emotions based on appraisal theories (Smith & Lazarus, 1993), expectancy-value theories (Turner & Schallert, 2001), transactional approaches (Folkman & Lazarus, 1985), attributional theories (Weiner, 1985) and models of performance effects of emotions (Pekrun, 1992; Zeidner, 1998, 2007). The control-value approach of achievement emotions points out that subjective control of the learning and achievement situation as well as the subjective value of learning process and achievement are crucial for students' emotional experience. For example, achieving joy in learning presupposes that students experience their ability to master a task (control) and their interest in the task (value). Students experience a variety of instructional situations and they assess these situations depending on previous experiences, the social context, their personal goals, their abilities, their interests and other personality factors (Pekrun et al., 2002).

Emotions have an effect on learning and achievement mediated by attention, self-regulation and motivation (Pekrun et al., 2002), thus directing the person towards or away from learning matters in learning situations (Ellis & Ashbrook, 1989). It was shown that positive emotions also facilitate self-regulation in learning (Boekaerts, Pintrich, & Zeidner, 2000; Carver & Scheier, 1990). Students' perceived self-regulation is significantly positively correlated with positive emotions whereas perceived external regulation is correlated with negative emotions (Pekrun et al., 2002). The experience of competence and autonomy in learning has been stressed out to be important for self-regulation and self-determination (Deci & Ryan, 1985). Furthermore, emotions are related to interest. The positive impact of interest on learning has been confirmed for individuals, knowledge domains and subject areas (Hidi, Berndorff, & Ainley, 2002). Interest has value-related valence, as well as feeling-related valence (Krapp, 2002; Renninger, Hidi, & Krapp, 1992); it is highly correlated with intrinsic motivation and positive emotions, such as joy and it is closely linked to all self-determined activity. A significant factor determining achievement emotions is self-concept. Self-concept has an influence on how students estimate their personal learning skills and performance (Wodzinski, 2007). Self-concept is strongly related to students' interest and contributes to the students' learning effort and engagement in a school subject (Häußler, 2003). Beyond that, it may promote students' learning ambitions (Marsch, Byrne, & Yeung, 1999) and may cause the fact that students see themselves as talented in particular school subjects (Möller & Jerusalem, 1997). Students' self-concept was also related to an increase in achievement (Marsh & Hau, 2003). In contrast, students with lower self-concept tend to be more anxious in school instruction (Helmke, 1989).

Emotions are an important dimension of well-being which is crucial for human life in general. Well-being refers to the individual emotional and cognitive evaluation of the social context (Diener, 2000). Enjoyment and satisfaction as well as the absense of negative emotions and psycho-physiological stress are crucial dimensions of well-being. In the last years some studies were carried out to analyze well-being in school and instruction. Well-being correlates for example with the learning process, motivation and achievement of students (Hascher, 2007, 2012). Teachers' didactic competencies, students' academic achievement and interest, and social interactions have an impact on well-being in school as well (Hascher, 2003). Therefore it is an important issue to analyze students' emotions and well-being.

1.2 Physics instruction, students' emotions and gender

In school context not all topics and subjects are favoured by students. Frenzel, Götz and Pekrun (2009) describe significant differences for students' emotions in Mathematics, German Language, English Language and other subjects. Mathematics and Physics in particular seem to repel many students during adolescence (Kessels & Hannover, 2008). Physics in Germany usually starts in the 8th grade and is seen as a difficult exact science subject which makes it very unpopular (Hoffmann, 2002). Students dislike Physics especially in lower secondary schools (Hoffmann, Häußler, & Lehrke, 1998). Beyond, it was shown that the value of school decreases amongst many students during adolescence (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006).

Attitude towards math and science play an important role when considering learning processes and achievement. Osborne, Simon and Collins (2003, p. 1053) defined attitudes as „the feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society or scientists themselves". In an extensive study with students from 7th and 8th grades on the determination of gender differences in relationships of attitudes toward science and achievement (Mattern & Schau, 2002) was shown that there was no significant effect of achievement in science on attitudes among girls. In contrast, there was an effect of achievement in science on attitudes among boys.

In his meta-analysis of 18 different studies, Weinburgh (1995) described that positive attitudes of all students caused higher achievement in the subjects of science. In the subjects of Biology and Physics, the correlations were positive for both boys and girls, but stronger for girls than for boys.

One possible explanation is how a subject is taught in school. For example Physics instruction in Germany may be characterized by quite strong teacher-centering and high density of knowledge presentation. Typical instruction combines a narrow step-by-step procedure with a high density of knowledge transfer characterized as a *questioning-developing* classroom discussion style (Seidel et al., 2007, p. 86). Teachers focus on specific topics and only a few aspects of a topic are presented and explained in one lesson or teaching unit. Teacher experiments are typical instructional elements in Physics and in all other science subjects (Tesch & Duit, 2004). It may be assumed that a more student-oriented instruction or learning-oriented teaching (Darling-Hammond & Bransford, 2006; Hiebert et al., 2005) may enhance students' positive emotions.

Student-oriented instruction focuses on modelling, guiding and scaffolding students' learning to create a deep understanding of learning contents and a positive attitude towards domains (Collins, Brown, & Newman, 1989). Learning-oriented teaching aims at changing the role of the teacher from a knowledge transmitter to a coach and moderator of students' individual learning (Reusser, 1996) and emphasizes opportunities for active student engagement and self-regulated learning (Boekaerts & Corno, 2005; Collins et al., 1989; Slavin, 1995), providing positive and constructive feedback (Ryan & Deci, 2000) and scaffolding student learning processes in a way that students can solve problems independently (Collins et al., 1989). In addition, numerous studies identified cooperative learning as a very effective characteristic of learning-oriented teaching (Slavin, 1995). Students learn teamwork, how to give and receive criticism and how to plan, monitor and evaluate their individual and joint activities with others (Hertz-Lazarowitz & Miller, 1992). Some studies showed that student- and learning-oriented teaching is associated with more positive emotions than teacher-centred instruction (Gläser-Zikuda & Fuß, 2008; Gläser-Zikuda & Schuster, 2005; Götz & Frenzel; 2010, Pekrun et al., 2002). A theoretically guided approach explicitly focusing on instructional strategies to influence learners' emotions is the FEASP-approach (Astleitner, 2000), indicating, for example, that instructional strategies should be regarded to reduce fear, envy and anger, and to enhance stafisfaction and joy. In relation to this approach and based on findings of research on emotion, motivation and instructional quality, the ECOLE-approach (Emotional-Cognitive Learning) in its quasi-experimental intervention study revealed strong effects on students' achievement but also effects on students' emotions and well-being in Physics (Gläser-Zikuda, Fuß, Laukenmann, Metz, & Randler, 2005).

Especially gender effects have to be regarded when analyzing learning and instruction in science. Differences between boys and girls in terms of their emotions are well documented in the domain of Mathematics. Frenzel, Pekrun and Götz (2007) confirmed that boys and girls achieve similar performance in Mathematics but girls usually report on significantly less enjoyment, more anxiety and more hopelessness. The situation is similar in Physics. Girls experience more negative and less positive emotions than boys in Physics instruction (Gläser-Zikuda & Fuß, 2003). Physics is traditionally perceived (and sometimes even realized) as a male domain. Several studies describe that girls and even female university students rate their abilities and performance on a lower level compared to boys and male students (Milhoffer, 2000). Girls' interest in Math, Science and Technology is relatively low compared to boys (Roisch, 2003).

Wodzinski (2007) states that teachers' organization of instruction in Physics is predominatly related to the learning demands of boys; this may cause that girls feel rather insecure in Physics lessons and perceive Physics as a "feared" school subject. This may also have an impact on the girls' underestimation of their learning achievement in Physics. In contrast, boys have a tendency to overestimate their learning achievement. Nevertheless, girls are often interested in Physics (Hoffman et al., 1998) but their interest in Physics is more context-related and depends on activating instructional methods such as experiments and group work. It has also been found that the participation of girls increases significantly when instructional topics are taught with respect to allday life topics such as, for example, medical topics and functioning of a human body (Häußler & Hoffmann, 1995).

To explain why there are differences in emotional experiences of boys and girls in Physics (and other science school subjects), psychological, biological and social theories may be mentioned. One of the approaches which has pertained for quite a long time explains that gender differences regarding emotions may be explained by the different level of the boys' and girls' cognitive skills (Baumert, Gruehn, Heyn, Köller, & Schnabel, 1997). Recent research, however, found only small or rather declining differences between boys and girls regarding their cognitive skills and achievement in Physics and other science school subjects (Baumert et al., 1997; Kotte, 1992).

Another attempt to explain the differences in emotional experiences of boys and girls is to argue that there are dissimilarities in their cognitive interpretations of learning situations and events. Up to now, the control-value theory of achievement emotion (Pekrun, 2000, 2006; Pekrun et al., 2002) has been primarily used to explain gender differences in achievement emotions in Mathematics (Frenzel et al., 2007). According to the control-value theory, gender differences in emotional experiences and the fact that girls usually report more negative emotions in Mathematics and Physics lessons than boys could be explained on the basis of gender-linked stereotypes. It was argued that girls have a tendecy to underestimate their competencies (Lupart, Cannon, & Telfer, 2004; Milhoffer, 2000) but at the same time they recognize the value of Physics (for everyday life) and they are also aware of the importance of achieving good grades in the school subject. Following the control-value approach, the reason why girls are experiencing rather negative emotions in Physics may be seen in these discrepancies between their underestimation of their competencies and the high value of the school subjects (in this case of Physics) (Frenzel et al., 2007).

1.3 Influencing achievement emotions of boys and girls by applying a portfolio in Physics

We argue that a portfolio-based learning environment should enhance girls' positive achievement emotions especially. It is argued that in comparison to boys, girls appreciate more a social, communicative and reflective learning environment. Furthermore, girls are more interested in written reflection and feedback. For example, a well known result in PISA (the Programme for International Student Assessment, of the Organisation for Economic Co-operation and Development [OECD]) is that girls show significantly higher mean achievement in reading literacy than boys in all OECD countries. The girls also have a higher level of interest and engagement in reading outside school. Whereas boys often dislike almost all school writing, most girls enjoy writing at school and girls even choose to write themselves at home (Millard, 2001). They write diaries very often or they keep in touch by writing letters to friends in foreign countries (Seiffge-Krenke, 1987). Clark & Dugdale (2009) showed that students generally enjoy writing for family and friends more than for schoolwork. Girls enjoy writing very much (Clark & Douglas, 2011) and they consider themselves good writers in comparison to boys (Clark, 2012).

A portfolio could meet these preferences of girls. It is usually characterized as an individualized learning tool – a collection of students' learning materials which are carefully selected (mainly by students and sometimes by teachers) to document, reflect and evaluate students' learning progress and outcomes (Paulson, Paulson, &

Meyer, 1991). A portfolio is also regarded as a learning environment which facilitates competence-oriented learning and supports its reflection (Ziegelbauer, Noack, & Gläser-Zikuda, 2010). Moreover, in comparison to other instruments of self-reflection (e.g. learning diaries, learning protocols) a portfolio comprises characteristic features influencing students' achievement emotions and learning outcomes – discussion with classmates and teachers as well as their feedback and assessment (Gläser-Zikuda & Hascher, 2007; Häcker, 2007).

As stated by Hattie and Timperley (2007) and shown by Hattie (2012), feedback is an important dimension for successful learning and achievement. Feedback is conceptualized as information provided by a person (e.g. teacher, classmate, oneself) or a medium (e.g. book, audio information) regarding aspects of one's understanding or performance. For example, a teacher or parent can provide corrective information, a classmate can provide an alternative learning strategy and a book can provide information to clarify ideas. Feedback is one core element of the portfolio.

Compared to other instructional approaches, the portfolio approach represents an educational concept which focuses on a more individualized instruction – to enable students to learn in a more self-regulated and self-determined way. In Physics (as well as in other science subjects) the cultivation of students' self-regulated and self-determined learning represents an important educational principle which may significantly influence performance in both its cognitive and the affective aspects. This presumption was already empirically confirmed by Sander and Ferdinand (2013) who examined whether self-regulated learning environment may improve students' learning achievement and interest in natural sciences by evocing higher cognitive activation in Austrian schools. The results of the study with 141 ninth graders from three middle schools (middle school, called "Realschule" in Austria and Germany) showed that students who learned in the self-regulated learning environment understood the instructional topic deeper and were able to make better use of acquired knowledge when solving a problem-oriented learning situation compared to their classmates from the teacher-oriented classroom. Furthermore, students in the experimental group (self-regulated learning environment) showed higher level of interest in science instruction and were more internally motivated. However, it was been found out that the positive effect of the self-regulated and self-determined learning may depend on the level of students' pre- knowledge – self-regulated and self-determined learning seem to be more beneficial for students with greater pre-knowledge.

In recent decades, the portfolio has been analysed as a promising educational concept which may foster cognitive and affective dimensions of students' learning (e.g. Gläser-Zikuda & Hascher, 2007; Gläser-Zikuda, Lindacher, & Fuß, 2006; Limprecht & Gläser-Zikuda, in development). The portfolio has also been regarded as an attempt to switch from teacher-based instruction to student-centered learning (Berendt, 2005) enabling students to learn in a more self-regulated way (Gläser-Zikuda, Fendler, Noack, & Ziegelbauer, 2011). In this study we tried to test the effects of a portfolio on the academic emotions of boys and girls.

2 Aim and research questions of the study

The study focused on girls' and boys' achievement emotions in Physics. We were interested in analyzing differences between boys' and girls' emotions in Physics instruction on the one hand while developing, implementing and evaluating a portfolio intervention to reduce gender differences in achievement emotions in Physics instruction. The idea was to implement a portfolio approach and to create a more student-oriented learning environment supporting students', especially girls', self-regulation and self-reflection in learning Physics. The aim was to enhance girls' positive achievement emotions and to reduce their negative achievement emotions in Physics instruction.

In orientation to these considerations, we expect that implementing such a learning environment should particularly enhance girls' positive achievement emotions. It is argued that in comparison to boys, girls prefer a social, communicative and reflective learning environment. Furthermore, it is expected that they are more interested in written reflection and feedback which should have a positive impact on their achievement emotions.

The following research hypotheses were tested:

1. Boys experience more positive achievement emotions in Physics than girls in general.
2. The application of a portfolio has a positive effect on achievement emotions of girls, or more precisely the differences between positive and negative achievement emotions of girls and boys may be reduced by a portfolio intervention.

3 Method

In the following section the method of our study is described. Firstly, the portfolio approach applied in the quasi-experiemntal intervention study is presented. Secondly, the research design and sample of the intervention study are described. Finally, the applied instruments and statistical procedures are explained. It should be noted that this paper only reports on a small part of the results we gained in this intervention study. Futher details and results are presented and discussed in other publications.

3.1 Portfolio approach applied in the intervention study

In this study we developed a portfolio approach based on a *working portfolio* aiming at continuos observation of and reflection on the individual learning process (Gläser-Zikuda & Hascher, 2007; Gläser-Zikuda et al., 2011). The portfolio-based learning environment included problem and competence oriented learning tasks, interactions between students and teachers including consultations and peer- and teacher-feedback, cooperative and reflexive learning phases and a well balanced relation between instructional and self-regulated learning phases. The portfolio approach has been developed taking both context-related characteristics of Physics instruction and the elements of self-regulation, self-reflection, learning dialogues and feedback into account. The approach comprised a students' portfolio folder, prompts (Nückles et al., 2010) for a systematic reflection of the individual learning progress as well as feedback documents from discussions with classmates and the teacher. In particular, we focused on the approach of "learning through dialogues" (Ruf, 2008) to strengthen interaction and communication in instruction. Students reflected on specific topics and tasks during Physics instruction several times. Furthermore, all students participated in portfolio dialogues with classmates and also with the teacher three times. Finally, the students presented their learning results at the end of the teaching unit based on discussion of their portfolios.

3.2 Research Design and Sample

The study was based on a quasi-experimental design. The sample consisted of eight 8th grade classes from three grammar schools in Germany. In total, 161 students (56 boys and 78 girls) participated in the study[1]. To test the effects of our intervention the research sample was divided into treatment (N = 80; 48 girls and 32 boys) and control group (N = 81; 43 girls and 38 boys) randomly (Fig. 1). Two female Physics teachers and two male Physics teachers participated in the study; all of them had more than 10-year teaching experience. First, each teacher taught a control group, and after a specific training regarding portfolio-based instruction he/she taught the treatment group. The portfolio approach was implemented for a period of approximately four months in classrooms that had no experience of portfolio instruction.

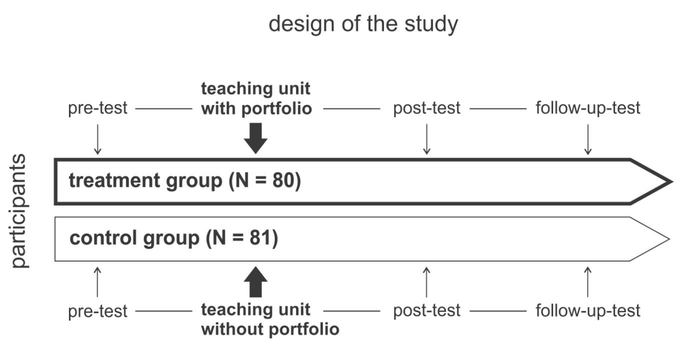


Figure 1 Quasi-experimental design of the study.

The same topic (electricity) was taught in both classrooms (treatment and control) for a comparable number of lessons (26–27 lessons in the treatment group and 26 lessons in the control group). In the treatment groups students were taught in a student-centered and problem-oriented instructional setting which included an

1 The real numbers of the participants may however slightly differ. This is because not all of the answers of the respondents could be taken into account as valid.

 application of a portfolio, whilst the control groups were taught in a more teacher-centered setting. Both groups were tested with the same instruments and tests. All reliability coefficients of the psychometric measures (Cronbach's alpha) ranged from 0.75 to 0.95 indicating that the internal consitency of these measures was at least satisfactory and in most cases either good or excellent (Table 1).

3.3 Instruments and Statistical Procedures

Based on the quasi-experimental design we carried out a pre-, post- and follow-up test (after six weeks and a holiday break). We applied the following standardized instruments (Table 1) in this study: three scales of a standardized short questionnaire about state emotions (anxiety, boredom and well-being [with enjoyment and satisfaction]) we developed in previous studies (Gläser-Zikuda & Fuß, 2008) were applied to measure students' achievement emotions.

Table 1 Instruments and scales of significant covariates and dependent variables

Covariates	Scales	Item example
Self-concept (Schöne et al., 2002)	Self-concept in school (individual): 6 Items; α = .91	Now, I perform worse in school than before.
	Self-concept in school (negative) 10 Items; α = .95	I'm not gifted enough to peform well in school.
	Domain specific self-concept: 7 Items; α = .94	**The school subject Physics does not appeal to me.**
Interest in Physics (Hoffmann et al., 1998)	**Leisure: Interest in Information: 6 Items; α = .85**	**I'm interested in watching TV programmes dealing with Physics and Technology.**
	Leisure: Interest in Practice: 5 Items; α = .75	**I'm interested in dismantling and repairing things.**
	Object related interest: 10 Items; α = .86	I'm interested in finding out more about the development and the effects of thunderbolt.
Dependent variables	Subscales	Item Example
Achievement State-Emotions (Gläser-Zikuda & Fuß, 2008)	Anxiety: 4 Items; α = .82	Physics instruction makes me anxious.
	Well-being: 4 Items; α = .91	I'm satisfied with Physics instruction.
	Boredom: 3 Items; α = .90	In Physics instruction I often feel bored.

Note: The scales in bold are significant covariates.

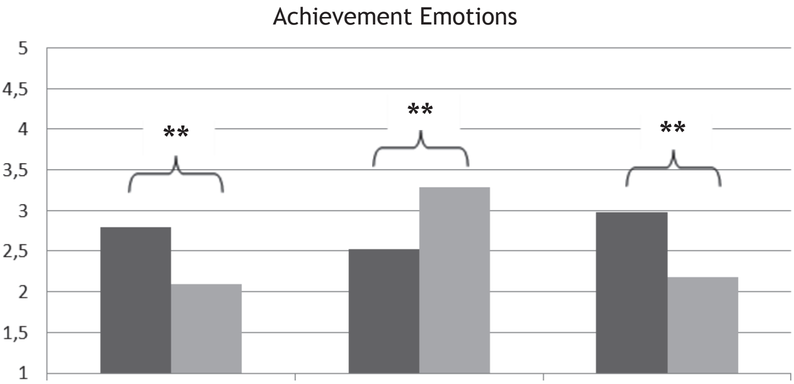
For the measurement of covariates, we used different standardized instruments such as well-being in school, classroom climate etc. However, we only report on the significant covariates in this paper. To test self-concept we applied an instrument with three scales (Schöne, Dickhauser, Spinath, & Stiensmeier-Pelster, 2002). For the measurement of interest in Physics we used three scales (Hoffmann et al., 1998).

4 Results

In this chapter the results of our study in orientation to the research questions are presented. Firstly, the descriptive results regarding gender differences of students' achievement emotions in Physics are presented (see 4.1). Secondly, the results based on covariance analyses to test the hypothesized effect the application of a portfolio had on positive and negative achievement emotions of boys and girls in Physics are presented (see 4.2).

4.1 Achievement emotions of boys and girls in Physics

The first aim of our study was to analyze whether there are significant differences between boys and girls regarding their positive and negative achievement emotions in Physics. We therefore carried out a t-test for the interrogation data before the intervention phase (pre-test). In Figure 2 the significant differences between the achievement emotions of boys and girls are illustrated. The results are based on a comparison of the total sample of girls and boys.



	Anxiety		Well-being		Boredom	
	Mean	SD	Mean	SD	Mean	SD
Girls (dark grey)	2.79	0.93	2.53	0.81	2.98	1.15
Boys (pale gray)	2.10	0.97	3.29	1.07	2.18	1.06

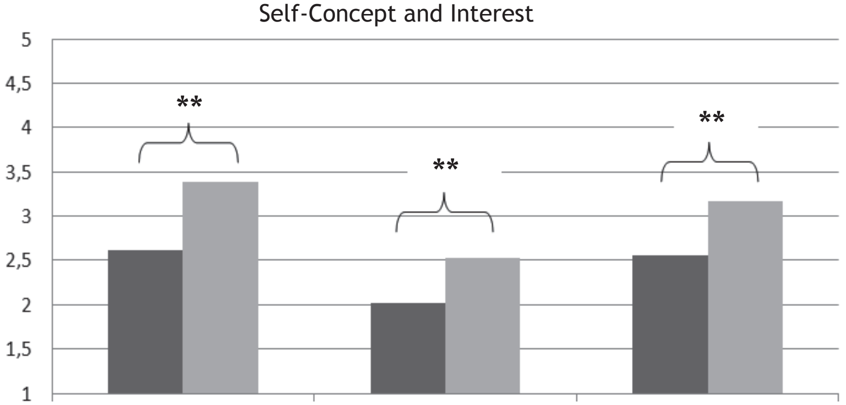
Respondents with valid answers: girls N = 78; boys N = 56; Levels of significance: $p < .01$ (*), $p < .001$ (**); Effect Sizes: Anxiety: $Eta^2 = .117$; Well-being: $Eta^2 = .141$; Boredom: $Eta^2 = .141$.

Figure 2 T-tests regarding gender differences in achievement emotions in Physics at pre-test measurement

Figure 2 illustrates that in the pre-test measurement girls experienced significantly higher levels of negative emotions (boredom and anxiety) in Physics instruction. Boys experienced significantly higher levels of positive achievement emotions (well-being) in Physics instruction.

4.2 Interest and self-concept of boys and girls in Physics

As a subsequent step of our analysis of gender differences in students' achievement emotions in Physics, the variables which could also have an influence on the achievement emotions were examined.



	Self-concept		Interest info		Interest practical	
	Mean	SD	Mean	SD	Mean	SD
Girls (dark gray)	2.61	0.93	2.02	0.65	2.56	0.75
Boys (pale gray)	3.39	1.05	2.53	0.78	3.17	0.79

Respondents with valid answers: girls N = 86; boys N = 56; Levels of significance: $p < .01$ (*), $p < .001$ (**); Effect Sizes: Self-concept: $Eta^2 = .130$; Interest info: $Eta^2 = .113$; Interest practical: $Eta^2 = .133$.

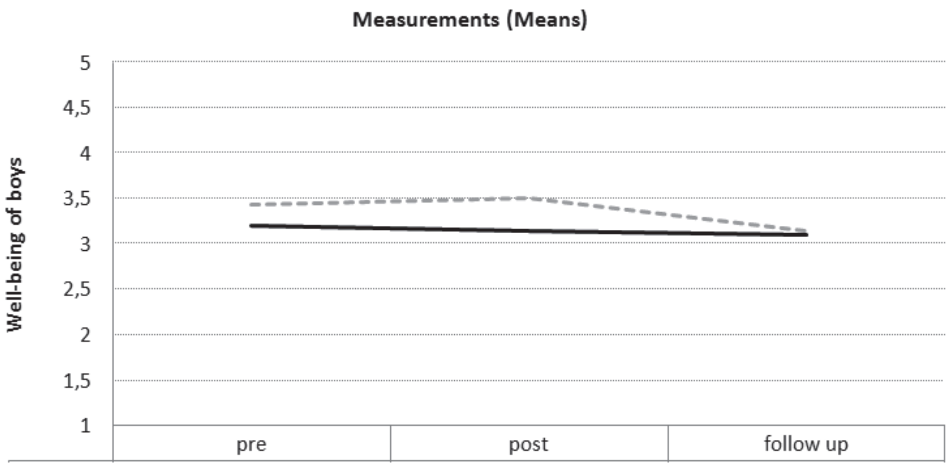
Figure 3 T-tests for interest and self-concept regarding Physics at pre-test measurement

As hypothesized, the t-tests for pre-test measurement revealed significantly higher levels of interest and self-concept of ability in Physics for boys than for girls (Fig. 3).

4.3 Effects of a portfolio on achievement emotions of boys and girls in Physics instruction

To test the effects of a portfolio on the achievement emotions of boys and girls, the data of the pre-, post- and follow-up tests in treatment and control groups were subsequently analyzed. We only present results for positive achievement emotions (well-being: enjoyment and satisfaction) in the following section because no significant effects of the portfolio intervention for the negative achievement emotions such as anxiety and boredom were determined.

At first, we describe the development of well-being of boys and girls separately and differentiate them with respect to treatment and control groups. The graph includes means for the pre-, post- and follow-up tests. Figure 4 describes the results of the measurements for the boys in treatment and control groups, figure 5 focuses on the results in the girls groups.

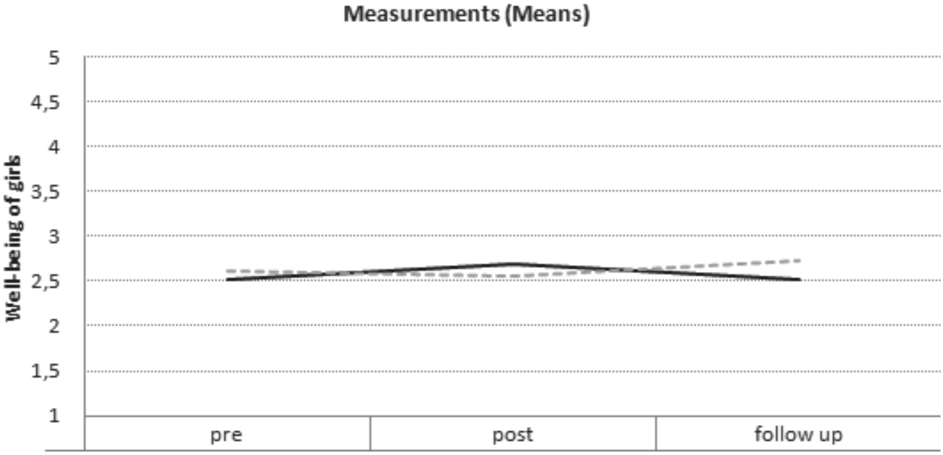


	Pre-test			Post-test			Follow-up test		
	Mean	SD	Eta²	Mean	SD	Eta²	Mean	SD	Eta²
TG (full line)	3.20	1.18	TG<CG n.s. .010	3.14	1.10	TG<CG n.s. .028	3.10	1.01	TG<CG n.s. .000
CG (dotted line)	3.43	1.06		3.50	0.96		3.15	1.13	

Respondents with valid answers: boys TG N = 24; boys CG N = 17; it has to be noted that not all participants were present at all three measurements.

Figure 4 Well-being of boys' in treatment and control groups

Figure 4 shows that before instruction (intervention phase; pre-test) the level of boys' well-being was smaler in the treatment than in the control group. After the intervention phase (post-test) the level of boys' well-being in the treatment group decreased slightly and this trend continued until the follow-up test. In the control boys' group (without a portfolio) the development was different. The level of boys' well-being grew up progressively until post-test but the level was decreasing then noticeably until the follow-up test. In general, the well-being of the boys in the two groups did not differ significantly.



	Pre-test			Post-test			Follow-up test		
	Mean	SD	Eta²	Mean	SD	Eta²	Mean	SD	Eta²
TG (full line)	2.53	0.89	TG<CG n.s. .002	2.70	0.80	TG>CG n.s. .008	2.53	0.74	TG<CG n.s. .017
CG (dotted line)	2.61	0.82		2.56	0.78		2.73	0.80	

Respondents with valid answers: girls TG N = 31; girls CG N = 25; it has to be noted that not all participants were present at all three measurements.

Figure 5 Well-being of girls' in treatment and control groups

Compared with the boys, the girls' well-being in treatment and control groups showed a rather different trend (Fig. 5). Whilst at the pre-test the levels of girls' well-being was rather similar in the treatment and control groups, after the intervention phase the level of girls' well-being rose in the treatment group (portfolio intervention), while it decreased in the control group. Between the post-test and the follow-up test, well-being in the treatment group decreased onto the same level as it had been before the intervention. Interestingly, the well-being of the girls in the control group increased at follow-up measurement and it oscillated on a higher level compared to the starting level before instruction.

4.4 Testing hypothesized effects of the portfolio intervention on boys' and girls' well-being in Physics controlling the covariates self-concept and interest

To identify the effects of variables which may also have an influence on students' achievement emotions, we carried out an analysis of covariance controlling students' interest and self-concept, as well as school and classroom climate (e.g. Rudolf

& Müller, 2004). The results of the analysis of covariance showed that only *self-concept* and *interest* were significant covariates.

To test the hypothesized effects of the portfolio intervention on students' emotions (well-being) regarding gender differences, analysis of covariance was conducted (controlling *self-concept* as covariate in the first step and then *interest* in the second step*)*. Means, standard deviations, level of significance and effect sizes as partial Eta^2 are presented in Table 2 and 3.

Table 2 Effects of the portfolio intervention based on covariance analysis for well-being of boys and girls (controlling the covariate self-concept)

Well-being		**Mean**	**SD**	**self-concept**		**Intervention Effect**	**Eta^2**
				sig	**Eta^2**		
Treatment group							
pre-test (t1)	girls (n=31)	2.53	0.89	.000	.34	girls<boys n.s	.03
	boys (n=23)	3.30	1.11				
post-test (t2)	girls (n=31)	2.70	0.80	.000	.40	girls<boys n.s.	.00
	boys (n=23)	3.24	1.02				
follow-up-test (t3)	girls (n=31)	2.53	0.74	.000	.54	girls<boys n.s	.03
	boys (n=23)	3.19	0.93				
Control group							
pre-test (t1)	girls (n=25)	2.61	0.82	.000	.30	girls<boys n.s	.05
	boys (n=16)	3.37	1.07				
post-test (t2)	girls (n=25)	2.56	0.78	.02	.13	girls<boys sig. =.024	.13
	boys (n=16)	3.47	0.99				
follow-up-test (t3)	girls (n=25)	2.73	0.80	.000	.29	girls<boys n.s	.00
	boys (n=16)	3.11	1.16				

Levels of significance: $p < .05$, $p < .01$ (*), $p < .001$ (**); Effect size (eta^2): low (> 0.01), moderate (> 0.06), high (> 0.14). It should be noted that not all participants responded to all items in the questionnaires. Therefore, sample sizes may differ sligthly.

Our analysis of the hypothesized effects of a portfolio intervention on girls' and boys' well-being by controlling the self-concept and interest covariates revealed some interesting results. Controlling the domain specific self-concept as a covariate has an impact on the calculation of the intervention effect. In both groups, self-concept has a moderate or even high impact on girls' and boys' well-being. In the pre-test, boys and girls do not differ significantly in their well-being in both control and treatment group. In the treatment group girls' well-being increases and boys' well-being decreases slightly. But there is no significant effect of the intervention at post-test. However, compared to the treatment group, girls' and boys' well-being in the control group differs significantly at post-test. A moderate effect size of 0.13 (sig. = .024) was stated. The effect occurs because girls' well-being decreases while the boys' well-being increases strongly from pre- to post-test. For the follow-up test, this effect disappears and no significant differences in girls' and boys' well-being may be observed there again. The hypothesized effect of the portfolio intervention

Table 3 The results for the effects of the portfolio intervention based on covariance analysis for well-being of boys and girls (controlling the covariate interest)

Well-being		Mean	SD	Interest		Intervention Effect	Eta²
				sig	Eta²		
Treatment group							
pre-test (t1)	girls (n=31)	2.53	0.89	Info 0,16	.04	girls<boys sig. = .01	.12
	boys (n=22)	3.40	1.02	Practical .10	.06		
post-test (t2)	girls (n=31)	2.70	0.80	Info .06	.07	girls<boys n.s.	.04
	boys (n=22)	3.34	0.92	Practical .23	.03		
follow-up-test (t3)	girls (n=31)	2.53	0.74	Info .04	.08	girls<boys sig. =.03	.10
	boys (n=22)	3.30	0.81	Practical .12	.05		
Control group							
pre-test (t1)	girls (n=25)	2.61	0.82	Info .03	.12	girls<boys sig. =.05	.10
	boys (n=16)	3.37	1.07	Practical .03	.12		
post-test (t2)	girls (n=25)	2.56	0.78	Info .08	.08	girls<boys sig. =.04	.11
	boys (n=16)	3.47	0.99	Practical .43	.02		
follow-up-test (t3)	girls (n=25)	2.73	0.80	Info .08	.08	girls<boys n.s.	.04
	boys (n=16)	3.11	1.16	Practical .04	.11		

Levels of significance: p < .05, p < .01 (*), p < .001 (**); Effect size (eta²): low (> 0.01), moderate (> 0.06), high (> 0.14). It should be noted that not all participants responded to all items in the questionnaires. Therefore, sample sizes may sligthly differ.

on students' well-being may be confirmed for the post-test. An enduring effect after the intervention cannot be determined.

Controlling interest (information and practice oriented interest in Physics) as a covariate has an impact on the calculation of the intervention effect as well. In both groups, interest has a moderate impact on girls' and boys' well-being. Including the covariate interest in the pre-test, boys and girls differ significantly in their well-being in both control (effect size 0.10; sig. = 0.05) and treatment groups (effect size 0.12; sig. = 0.01). In case of the post-test it is different. While the significant difference in well-being between boys and girls in the treatment group disappears (effect size 0.04; n.s.), it becomes even greater in the control group (effect size 0.11, sig. = 0.04). Girls in the treatment group show a noticeable higher level of well-being after the intervention, whereas boys' well-being decreases sligthly. For the post-test, no effect is observed for the control group. But in the treatment group, the effect size for the difference regarding well-being between boys and girls is compared to the pre-test level again relatively high (effect size 0.10; sig. = 0.03).

5 Discussion

The aims of the analyses of the presented study – that (1) boys experience more positive and less negative emotions in Physics instruction than girls and that (2) a portfolio intervention would have a positive impact on girls' and boys' achievement emotions – were partly confirmed.

Firstly, the expectation that boys have a higher level of well-being in Physics instruction than girls was confirmed by t-tests based on data at pre-test, before the instruction or the intervention started. It may be argued that girls and boys estimated their achievement emotions with respect to the same experience in Physics and in Physics instruction. As expected, girls showed a significantly higher level of anxiety and boredom than boys. It may be concluded that our first hypothesis was confirmed.

Secondly, the expectation that interest and self-concept would have an impact on girls' and boys' emotions, especially on their well-being, was only partly confirmed. Based on covariance analyses the effects of theses covariates were systematically proven.

Thirdly, the hypothesized effects of a portfolio intervention on students' emotions were only partly confirmed. We found no general effect of the portfolio intervention on girls' and boys' achievement emotions. Whereas we found no intervention effects on the negative achievement emotions, we were successful in reducing the differences betweem girls' and boys' well-being, at least at post-test. It was shown that in the control group girls' well-being was systematically decreasing from pre- to post-test. In contrast, girls' well-being in the treatment group was increasing and the differences between girls' and boys' levels of well-being were reduced from pre- to post-test, as expected. This was the case for both covariance analyses including interest and domain specific self-concept. It has to be noted that the effects are small to moderate and not systematical. These results should be interpreted very carefully as indicators for the potential of a portfolio-based instruction for a more emotionally sound instruction (Astleitner, 2000).

It can be therefore argued that the portfolio approach has the potential to influence emotional experience of girls rather than of boys in Physics. This presumption corresponds with the findings described in the study of Hoffmann et al. (1998). They found out that girls were more sensitive than boys when it came to teaching methods and instructional context. Girls also appreciated much more the teaching methods in Physics contributing to a stronger student orientation. The boys were less influenced by these instructional aspects because their emotions and interest in Physics are more related to person-related conditions as trait components (Hoffmann et al., 1998). We therefore assume that the portfolio approach offered various opportunities of self-regulated learning for girls including written reflection, learning dialogues and feedback. It may be concluded that this learning environment had a positive influence on girls' well-being in this Physics instructional unit.

Furthermore, we assume that girls in this portfolio-based Physics instruction felt more competent because first, they had the opportunity to choose different tasks (with respect to three different task levels). As girls may have a tendecy to underestimate their competencies (Lupart et al., 2004) it is assumed that the portfolio helped to get a more realistic and positive estimation of their competencies in Physics. Within the portfolio-based learning setting the girls received immediate and formative feedback on their learning process while discussing and reflecting on their learning process in small groups several times during the intervention phase. As shown in the review by Hattie and Timperley (2007), different types or levels of feedback should be taken into account to support learning and achievement: the task, the process, the regulation and the self. They conclude that feedback is more powerful when it helps create ideas and when it leads to the development of more efficient learning strategies for understanding a topic or learning material. Feedback that is focusing on self-regulation is powerful to the degree where it leads to further engagement and further effort made during the learning task. When feedback focuses on the self only, students try to avoid the risks, minimize their effort and have a high fear of failure; the goal is to minimize the risk to the self. We assume that the portfolio especially helped girls to get supportive feedback on these different levels, particularly on the task and regulation level. These types of feedback may have contributed to a lesser focus of the girls on themselves and their general underestimation of their own competencies, especially in science.

Following the control-value approach, the portfolio might therefore have contributed to the reduction of the discrepancies between girls' underestimation of competencies and the high value of school subjects (in this case of Physics) (Frenzel et al., 2007). In general, we also assume that student-centered instruction and cooperative learning activities which are usually not applied in Physics instruction may have increased girls' well-being (Hascher, 2003).

Finally, some conceptual and methodological limitations of the study have to be discussed. In contrast to our expectations, the intervention was not successful in reducing girls' negative achievement emotions. We found just a few and in most cases small effects. There are various possible explanations. Firstly, the sample of students was relatively small in this study; therefore the potential of the statistical analyses was limited. Secondly, a teaching unit including 26 lessons of instruction might have been too short to influence emotions which are strongly person- and subject-related (as trait-components), and thus difficult to influence. This hypothesis should be tested in a more extensive intervention. In this study, we did not control factors of the personality of the students, such as trait-anxiety or extraversion. Thirdly, the portfolio-based instruction may have been unfamiliar to most of the students. We know that students had no or insufficient experience of portfolio-based instruction and they were mainly not familiar with self-regulated and self-reflexive learning to fully benefit from the treatment. Using a portfolio requires a variety of strategies that need to be developed, applied and experienced in many different learning situations before they can be experienced as emotionally positive and valuable. These new ways of learning may have created insecurity. Furthermore, it is important that teachers accept this new type of instruction. Since the training for the teachers was relatively short they may have had difficulties with the intervention. At least, some teachers reported that they did not have enough time to really implement all elements of the portfolio-based instruction. Therefore, the intervention was carried out with some limitations.

Since students' emotions are generally strongly related to their experiences with school, instruction and teachers, they may rarely be influenced by short-term interventions without including the teacher. Therefore, the effects of the teachers' personalities and competencies need to be focused on. Further analyses indicate that well-being as well as anxiety and self-concept depend strongly on the teacher variable (Gläser-Zikuda & Fuß, 2008). In the ECOLE-intervention study the teacher variable explained up to 15% of the variance of emotion variables, whereas the experimental variable (ECOLE-instruction vs. traditional instruction) explained a maximum of 3% of the variance. Finally, the interaction between a teacher's emotions and students' emotions needs to be investigated more in depth as well (Frenzel, Götz, & Pekrun, 2008). To sum up, the portfolio approach may be characterized as a promising instructional approach to develop a more student-oriented learning environment that takes achievement emotions into account as well.

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