EFFECTS OF ENJOYMENT AND BOREDOM ON STUDENTS' INTEREST IN MATHEMATICS AND VICE VERSA

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Enjoyment, boredom, and interest are important for students' learning. To clarify the interplay between these affective variables, data from an interventional study of 119 ninth graders were analysed. Interest was assessed before and after, and emotions (enjoyment and boredom) were assessed during the five-lesson teaching unit. The results showed that (1) students who enjoyed their lessons were less bored than students who did not enjoy their lessons (2) enjoyment, but not boredom, during a teaching unit depended on students' initial interest in mathematics, and (3) students' initial interest and enjoyment during the teaching unit predicted their interest at posttest, but boredom did not influence students' interest at posttest.

INTRODUCTION

Emotions and motivational orientations such as interest are important for students' learning (Zan, Brown, Evans, & Hannula, 2006) and are related to students' performance in mathematics (Schukajlow, accepted; Schukajlow & Krug, 2014a). However, we do not know much about the development of interest or the role of emotions in this process. In the current study, I address this research gap by examining the interplay of interest, enjoyment, and boredom in the framework of a short-term intervention with regard to the teaching of modelling competency. The research questions were about the relation between students' enjoyment and boredom in mathematics classes, the importance of students' initial interest for enjoyment and boredom in mathematics classes, and the influence of initial interest, enjoyment, and boredom on interest at posttest.

THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

Interest

Interest characterises a relation between a person and an object such as mathematics. Interested learners engage with the object of their interest over time (Hidi & Renninger, 2006). Models of interest development assume that this motivational variable develops from the situational interest that can be captured, for example, in the so-called interest-dense situations of a given moment (Bikner-Ahsbahs, 2004) by individual (or personal) interest. Individual interest is comprised of cognitive and affective aspects. Cognitive aspects include the attribution of personal significance to object-related activities and feelings of competence in the target domain. Emotions refer to the affective aspects of interest. Positive emotions occur when a person engages with an object of interest, whereas negative emotions do not accompany such an engagement. According to this conception, interested students enjoy doing

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mathematics and are not bored when solving mathematical problems.

Students' interests change during the school years. In most studies, students tend to report a decline in their interest in mathematics and science from primary to secondary school. In Frenzel et al.'s (2012) study, which assessed the cognitive and affective aspects of interest in student interviews, students in grade 5 frequently verbalised the affective aspects and rarely verbalised the cognitive aspects of interest in comparison with students in grade 9. This finding is in line with the four-phase theory of interest development (Hidi & Renninger, 2006). In the initial phase, which often occurs in the early grades, positive feelings are crucial for triggering interest. In the second and third phases, other variables such as knowledge and reengagement in the domain accompany interest development. Finally, students achieve a self-generated phase of interest and can regulate their interest-related activities on their own. We know from research in other domains that only a few students attain a well-developed level of interest in school. Thus, initiating situations that stimulate positive, and prevent negative, emotions during mathematics lessons is important for improving students' interest in both primary and secondary school.

Enjoyment

Enjoyment is one the most frequently reported positive emotions in the classroom. Students' enjoyment was found to be related to effort and performance (Schukajlow & Krug, 2014a) and was found to predict self-regulation skills and academic achievements (Ahmed, van der Werf, Kuyper, & Minnaert, 2013). According to the control-value theory of achievement emotions (Pekrun, 2006), enjoyment is a positive activating emotion and can affect whether students will engage and reengage with the enjoyable content. In this way, enjoyment might not only accompany interest development but may also have a positive influence on it. Self-concept has been identified as an important predictor of students' enjoyment (Goetz, Frenzel, Hall, & Pekrun, 2008). Another valuable factor for the development of students' academic enjoyment may be the solving of demanding, authentic problems or cooperation during the learning process (Pekrun, 2006).

Boredom

Similar to enjoyment, achievement boredom is an activity-related emotion that accompanies learning. Feelings of boredom are not simply a lack of interest or enjoyment. If students are not interested in mathematics or do not enjoy mathematics classes, they may feel very different negative emotions such as anger or frustration, but they are not always bored with it. Self-perceived levels of boredom depend to a large extent on students' general experiences in school and in particular on their experiences in specific school subjects (Jablonka, 2013). Boredom is one of the negative deactivating emotions and is reported more frequently during learning than anxiety, anger, frustration, hopelessness, and shame (Ahmed, van der Werf, Minnaert, & Kuyper, 2010). Boredom results from a lack of controllability over actions (Pekrun, 2006) and in most studies has been found to be negatively related to

performance in mathematics (see summary by Schukajlow, accepted).

Affect measurement

One important characteristic of measures of affect are their trait-like vs. state-like nature. Trait-like scales assess the construct in general, that is, over time. A sample item representing enjoyment as a trait is: "I enjoy mathematics." State-like scales collect data with regard to a specific point in time: "I enjoyed mathematics class *today*." The two potential ways to assess affect differ in their stability and sensitivity. The trait-like scales are more stable and show low sensitivity with regard to interventional programs, whereas the state-like scales show minor changes in the affective measures and are sensitive to treatment.

Items that measure affect assess different dimensions of the constructs such as cognitive or emotional ones for interest and describe typical situations or activities. For mathematics, one of the key activities is problem solving. Thus, self-reported items for the measurement of affect often refer to the solving of problems, to mathematical reasoning, or recently – in task-specific questionnaires – even demonstrate sample problems for students (Krug & Schukajlow, 2013; Schukajlow et al., 2012).

The relationships between interest, enjoyment, and boredom

Most studies have found a positive relationship between interest and enjoyment. The value of correlations between interest and enjoyment for young secondary school students depends on the measures used to assess the affective constructs and ranges from low for task-unspecific questionnaires (Ahmed, Minnaert, Van der Werf, & Kuyper, 2008), to high, for task-specific questionnaires (Schukajlow et al., 2012).

The subjective psychological state of disinterest in response to low levels of arousal accompanies the state of boredom (Vogel-Walcutt, Fiorella, Carper, & Schatz, 2012). Because of its aversive and avoidance-oriented nature, boredom is incompatible with interest or enjoyment. Thus, a negative relationship between boredom and interest or enjoyment can be expected. A low, but statistically significant negative correlation between enjoyment and boredom, was reported for 7th graders (Ahmed et al., 2010). For university students studying the social sciences, boredom during lessons was negatively related to intrinsic motivation, which is closely related to interest (Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010). No results were found that addressed this issue in school students in the mathematics domain.

Research questions

The research questions derived from the theoretical framework I addressed were:

1) Is students' boredom during mathematics classes related to their enjoyment?
2) How important is students' initial interest for enjoyment and boredom during mathematics classes?
3) To what extent do students' initial interest, as well as enjoyment and boredom during mathematics classes, influence interest at posttest?

METHOD

One hundred and nineteen German ninth graders from 6 middle-track school classes (62% female; mean age=15.2 years) were asked about their initial interest before a 5-lesson-long teaching unit, about their enjoyment and boredom during the teaching unit, and about their interest after the teaching unit (see Fig. 1). During the teaching unit, students solved modelling problems with, vs. without, missing information in group work and were asked to find one vs. two solutions for each problem. At least one person from the research group was present to administer the tests and to observe the implementation of the treatment. All students' solutions were collected. Analyses of the reports and solutions showed that students worked on the modelling problems as intended (for more information, see Schukajlow & Krug, 2014b).

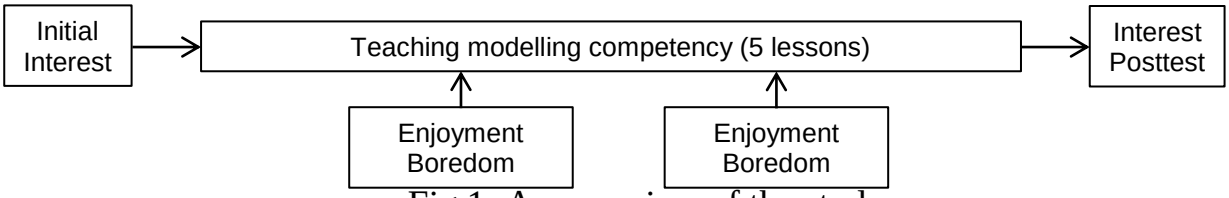

Fig.1: An overview of the study

Measures

Interest, enjoyment, and boredom were assessed with scales used in other studies and each consisted of 3 statements that were answered on 5-point Likert scales ranging from 1 (strongly disagree) to 5 (strongly agree). Sample items are "I am interested in mathematics," "I enjoyed task processing," or "Task processing was boring." The Cronbach's alpha reliabilities were .80 and .74 for interest (on the pretest and posttest), .84 and .82 for enjoyment, and .85 and .86 for boredom (at the first and second measurement points during the teaching unit) (cf. Fig. 1). Enjoyment and boredom were measured twice during treatment and were aggregated into a mean value.

RESULTS

The means and standard deviations for interest, enjoyment, and boredom are presented in Table 1. Students' interest in mathematics at pretest and posttest was slightly under and students' enjoyment during the teaching unit was slightly above the theoretical mean of 3. Most of students were not bored during instruction.

	initial interest	interest at posttest	enjoyment	boredom
Mean (SD)	2.56(.940)	2.71(.94)	3.40(.87)	1.95(.81)

Table 1: Means and standard deviations for interest, enjoyment, and boredom.

The first research question was about the relation between boredom and enjoyment during the teaching unit. The analysis supported my expectation of a negative relation between the two emotions: The correlation between enjoyment and boredom was moderate and negative (-.51, see Table 2). Thus, students who enjoyed the task

processing did not feel bored when solving the problems.

	initial interest	interest at posttest	enjoyment	boredom
initial interest	1	.60*	.24*	.07
interest at posttest		1	.36*	.00
enjoyment			1	-.51*
boredom				1

Note: *p<.05

Table 2: Pearson correlations between interest, enjoyment, and boredom.

Second, the effects of initial interest on students' enjoyment and boredom during the teaching unit were analysed. As initial interest was measured before the teaching unit, the correlations between initial interest and emotions might be interpreted as regressions. This analysis partially confirmed expectations about the impact of initial interest on emotions - there were positive effects of initial interest on enjoyment but not on boredom. Thus, students with higher initial interest in mathematics enjoyed the task processing more than students with low interest did. However, interested and uninterested students showed equal amounts of boredom during task processing.

The third research question concerned the effects of initial interest, enjoyment, and boredom on students' interest at posttest. To answer this question, a linear regression analysis with interest at posttest as the dependent measure and initial interest, enjoyment, and boredom as the independent measures was applied. Forty one per cent of the variance in students' interest at posttest was explained by the hypothesised regression model (R^2=.41). Students' initial interest was revealed to be the most powerful predictor of interest at posttest (β=.52, p<.05). Furthermore, enjoyment but not boredom during the teaching unit affected interest at posttest (enjoyment: β=.30, p<.05; boredom: β=.11, p>.10). This result was partly in line with the theoretically derived assumptions. The analysis indicated the importance of students' initial interest and their enjoyment during task processing for students' interest at posttest. Students' boredom while solving mathematical problems did not negatively influence their interest at posttest.

SUMMARY AND DISCUSSION

The current paper investigated the interplay between interest, enjoyment, and boredom using student questionnaires administered before, during, and after the teaching unit with regard to the enhancement of students' interest in solving real-world problems.

Descriptive findings revealed a high level of enjoyment and a low level of boredom during the teaching unit. Enjoyment measured in other studies was clearly under 2.5 (between 1.98 and 2.36 by Ahmed et al., 2013) and boredom was over 2.0 (between 2.19 and 2.64 by Ahmed et al., 2013). One possible explanation for this finding may be the processing of cognitively stimulating tasks with a connection to the real world

and cooperative group work during the teaching unit (Schukajlow & Krug, 2014b).

In line with the results of other studies (Ahmed et al., 2010; Pekrun et al., 2010), a negative relationship between enjoyment and boredom was found. Indeed, as expected according to the control-value theory of achievements emotions, the avoidant, aversive, and low-arousal psychological state of boredom is incompatible with students' enjoyment (Pekrun et al., 2010; Vogel-Walcutt et al., 2012). Thus, stimulating students' enjoyment decreases the level of boredom they feel during task processing and vice versa.

Students' initial interest in mathematics was expected to be an important factor that would positively influence enjoyment and negatively influence boredom because interested students enjoy engaging with their object of interest and are not bored with it. In line with theoretical considerations and previous empirical results on the correlation between the two variables (Ahmed et al., 2008; Schukajlow et al., 2012), initial interest in mathematics positively affected enjoyment during the teaching unit. One implication of this finding is that it is necessary to improve students' interest in mathematics so that they can achieve greater enjoyment while solving mathematical problems. Theories of interest suggest that interest-dense situations while students learn can capture their situated interest in the classroom, which can be developed into a stable individual interest in mathematics over time (Bikner-Ahsbahs, 2004). Stimulating learning materials and opportunities for students to engage in social interactions while solving mathematical tasks are important features of learning environments that offer opportunities for interest development. Experiences of competence while solving mathematical problems, which can be improved, for example, by teaching students to provide multiple solutions to real-world problems, has been revealed to be a crucial factor that positively affects students' individual interest (Schukajlow & Krug, 2014b).

An unexpected result of the present study was a zero correlation between prior interest and boredom. However, previous findings on the negative connection between the two affective variables have been based on samples of university students from the social science domain. Thus, the connection may be different for school students and in the domain of mathematics. Another explanation for the zero correlation between interest and boredom may be the specific kind of task (real-world problems) that was used in the current study. It is possible that students' interest in mathematics emerges from a positive relationship with intra-mathematical tasks, which are often solved in the regular mathematics classroom. Conversely, real-world problems are rarely solved in school. Students' interest in intra-mathematical tasks is connected with their interest in real-world problems, but the two are not identical (correlation of .68 by Schukajlow et al., 2012). Thus, the influence of initial interest on boredom may be different if intra-mathematical tasks are used in the classroom.

Finally, I found positive effects of initial interest and enjoyment but not boredom on students' interest at posttest. The positive effect of prior interest on interest at posttest

found in other studies was also confirmed in the present study and showed that interest in mathematics remains stable over time (Schukajlow & Krug, 2014b). Students' enjoyment while solving problems during the teaching unit was also found to be a valuable predictor of their interest. Students who enjoyed solving the mathematical problems reported higher interest than students who did not enjoy the task processing. As students' self-concept was previously shown to be an important factor for students' enjoyment (Goetz et al., 2008), fostering their self-concept can affect their enjoyment and by affecting their enjoyment, it may also positively affect students' interest. The use of authentic mathematical tasks, cooperation during the learning process, as well as teacher enjoyment and enthusiasm have also been found to be valuable factors that influence students' enjoyment (Pekrun, 2006), and according to the results of the present study, these factors could also affect their interest in mathematics. How to improve enjoyment and interest is an important open question for future studies.

The main limitations of the current study are that we applied an intervention with a short duration and that we used problems that differed from the specific kinds of problems that are usually solved in the classroom. Different results may occur in long-term studies and if students are asked to solve other kinds of problems that are more typically found in mathematics classrooms.

Summarising the results of the present study, I would like to emphasise that a close reciprocal connection between the positive emotion of "enjoyment" and interest was found. Initial interest influenced enjoyment during task processing, and enjoyment while learning mathematics affected students' interest after the teaching unit. The analysis of the students' negative emotion "boredom" revealed a different pattern. Boredom was related to enjoyment but was not related to interest. This result enhances the importance of overcoming a simplistic view of emotions with regard to their value as positive or negative (Hannula, Pantziara, Wæge, & Schlöglmann, 2009). More research on specific emotions using quantitative and qualitative methodology is essential as each emotion may have its own dynamic and might show different relations to other motivational and achievement factors.

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