Is boredom important for students' performance?

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This experimental study of 192 ninth and tenth graders was conducted to investigate a connection between performance on different types of problems and boredom using task-unspecific and task-specific questionnaires. Students were randomly assigned to one of two groups and were asked about their boredom either before (Group 1) or after (Group 2) task processing. In Group 1, the relation between performance and boredom was different for different types of problems. In Group 2, students who achieved higher scores reported lower boredom across different types of problems. The connection between performance and task-unspecific and task-specific boredom did not differ significantly and ranged from 0 to -.36.

Keywords: Emotions, performance, boredom, modelling.

INTRODUCTION

In the current study, I focused on students' boredom and on the connection between boredom and performance as students solved different types of problems. The problems that were selected as content for the current study either had or did not have a connection to reality and could be solved by applying linear functions or Pythagoras' theorem. The research questions pertained to (1) the connection between performance and boredom, (2) the correlation between students' performance and task-unspecific boredom in comparison with the correlation between performance and task-specific boredom, and (3) the relation between performance and boredom compared across three types of problems.

THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

Boredom as a negative emotion

In educational research, emotions are defined as complex phenomena that include affective, cognitive, physiological, motivational, and expressive parts (Pekrun & Linnenbrink-Garcia, 2014). One important dimension of emotions is their valence. Researchers have often distinguished between positive and negative emotion/affect without specifying the kind of emotion they were interested in. Hannula and colleagues (2009) underlined the importance of overcoming such a simplistic view on emotions and suggested that researchers should identify which positive or negative emotions they are focusing on. For example, anxiety, frustration, and boredom have a negative valence and enjoyment and happiness have a positive valence. Another dimension that illustrates the importance of specifying emotions is the degree of activation or deactivation. This dimension describes the psychological states (activating excitement vs. deactivating relaxation) that humans report about emotions (Pekrun & Linnenbrink-Garcia, 2014). Negative activating emotions include anger, anxiety, and frustration. Hopelessness, and boredom are typical negative deactivating emotions.

Students' emotions influence their career aspirations and thus also their current and future lives. Self-perceived levels of boredom depend to a large extent on students' general experience at school and in particular on their experiences in specific school subjects (Jablonka, 2013). A control-value theory of achievement emotions assumes that the value of learning materials and the controllability of learning activities are important for students' emotions (Pekrun, 2006).

Boredom is one of the most frequently reported negative emotions in the classroom, and some researchers see boredom as a key problem of modern society (Klapp, 1986). For several decades, research efforts in education were focused on the negative emotion of anxiety, whereas the role of other negative emotions (e.g., boredom) in educational contexts and their relations to other emotions, learning goals, motivational variables, and performance were not yet well understood. However, in the last 20 years, theoretical models of emotions have been improved considerably. As boredom is a deactivating emotion that decreases human activity, a negative connection between boredom and performance or academic achievements can be expected. The few studies on the connection between boredom and performance often used students' final grades as an indicator of performance. These studies identified negative correlations between boredom and grades at school and at university (-.24 and -.64, respectively) (Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007). Similar results were also found for the relation between boredom and grades or performance in elementary school (Sparfeldt, Buch, Schwarz, Jachmann, & Rost, 2009). However, as far as I am ware, in the only study conducted on students in early secondary school to investigate the connection between boredom and performance, no significant correlations between boredom and ninth-graders' argumentation, reasoning, or proof were found (Heinze, Reiss, & Rudolph, 2005). These contradictory results indicate the importance of enhancing research on the relation between boredom and performance using different approaches to the conceptualization of boredom in order to clarify the value and valence of this relation.

Measurement of emotions

The most commonly used measures of students' emotions are questionnaires, but analyses of self-reports given in interviews and analyses of students emotions during problem solving are also widely used in mathematics education (Jablonka, 2013; Pesonen & Hannula, 2014). Questionnaires used to assess students' emotions have shown high reliability and validity in previous research (Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011; Sparfeldt et al., 2009). Questionnaires allow researchers to access data from large samples and to distinguish between different emotions such as hope, enjoyment, pride, anger, anxiety, boredom, and others (Pekrun et al., 2011). However, because of the complexity of emotional reactions, a multi-method approach can be helpful for accessing affect (Hannula et al., 2009; Schukajlow et al., 2012; Zan, Brown, Evans, & Hannula, 2006). One way to increase the coverage of questionnaires may be to take object-specific aspects of affect into account. Following this idea, two types of questionnaires for the measurement of boredom were applied in the current study (c.f. for enjoyment and interest Schukajlow & Krug, 2014a): task-unspecific affective scales, which were validated in other studies (Pekrun et al., 2011), and a new task-specific questionnaire applied in recent studies (Schukajlow & Krug, 2014a; Schukajlow et al., 2012). Another important factor that may influence students' boredom is task processing. Thus, we measured students' boredom before and after they solved problems in two randomized groups in order to compare the stability of the relation between performance and boredom.

The development of task-specific questionnaires is based on distinguishing different objects (or subjects) of students' affect. Similar approaches can be found in educational psychology, where achievement, epistemic, social, and topic emotions are separated according to their object focus (Pekrun & Linnenbrink-Garcia, 2014) or in mathematics education in the beliefs area, where the question of the subject-specific structuring of beliefs was suggested by Törner (2002). Object-specificity varies from very general such as "learning" or "mathematics" to specific ones such as "mathematical topic" or even "mathematical problem" (cf. Figure 1).

Sample statements for boredom illustrating the different levels of object-specificity are: "I get bored in classes", "I get bored in mathematics classes", "I get bored solving equations", and "I get bored solving the equation $3 + 2x = -4x$", respectively. Measurements for which statements with a high level of object-specificity are used (1) provide exact information about the kind of mathematics the researcher is interested in, (2) allow the investigation of new research questions that focus on the comparison of affective measures regarding different mathematical topics or kinds of problems, and (3) reveal high sensitivity to the changes in students' affect that can emerge from interventional programs. Empirical research has shown the importance of the differentiation between different domains and thus indicates the importance of object-specificity in measuring emotions (e.g., differentiating between boredom in mathematics and physics classes) (Goetz et al., 2007). As task-unspecific and task-specific questionnaires assess the same construct, I did not expect

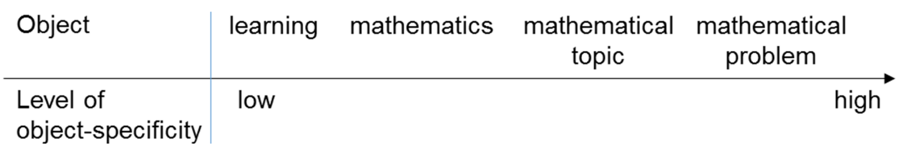


Figure 1: Objects and levels of object-specificity for affect

performance to be more or less strongly correlated with task-specific measures than with task-unspecific measures. This supposition was confirmed for interest and enjoyment (Schukajlow & Krug, 2014a), but it is an open question for boredom.

It is essential to distinguish between prospective affect (measured before task processing), current affect (measured during task processing), and retrospective affect (measured after task processing) (Ainley, 2006; Efklides, 2006; Schukajlow & Krug, 2014a). Each point of measurement reveals information about affect with regard to problem solving, and it can be important for past or future achievements.

Problems with and without a connection to the real world

To measure students' task-specific boredom, three types of problems that differ in their strength of connection to reality and are typically distinguished in research in modelling and application (Blum, Galbraith, Henn, & Niss, 2007) were selected. The types of problems were modelling, "dressed up" word, and intra-mathematical problems. All problems could be solved using the Pythagorean theorem or linear functions as mathematical procedures. To solve modelling problems, students need to understand the situation described in the task and must be able to construct a situation model of the task. Then they simplify the situation model by structuring and mathematizing, and they generate a mathematical model. The mathematical model can be transformed using mathematical procedures to create mathematical results, which have to be interpreted and validated. In the "dressed up" word problems, a mathematical model is "dressed up" by the situation; thus, students need to "undress" the problem, mathematize it, and use mathematics to solve it. Therefore, the problem solving process is not as complicated for this type of problem. As intra-mathematical problems are not connected to reality, students begin their problem solving process directly by using a mathematical model.

On the basis of the results of our previous study (Schukajlow & Krug, 2014a), we expected that there would be no significant differences in correlations between different measures of performance and boredom. Students with higher scores on performance tests were expected to be less bored when solving the problems.

Research questions

The research questions we addressed were:

1) Is students' performance connected to task-unspecific and task-specific boredom in mathematics measured before and after problem solving?

2) Is students' performance connected more strongly to task-specific than to task-unspecific boredom?

3) Are correlations between performance measures and task-specific boredom different for different types of problems (modelling problems, "dressed up" word problems, and intra-mathematical problems)?

METHOD

One hundred ninety-two German ninth and tenth graders from 4 middle-track and 4 grammar school classes (53.6% female; mean age=16.1 years, SD=0.86) participated on the present study. Students in each class were randomly assigned to two groups. In Group 1, the participants solved the problems first and afterwards reported on their task-unspecific boredom and on their boredom with regard to each problem. Students in Group 2 were asked about their task-unspecific and task-specific boredom and then worked on the performance test. The same tasks and questionnaires were administered to both groups (see Figure 2), and the students in these groups were given the same

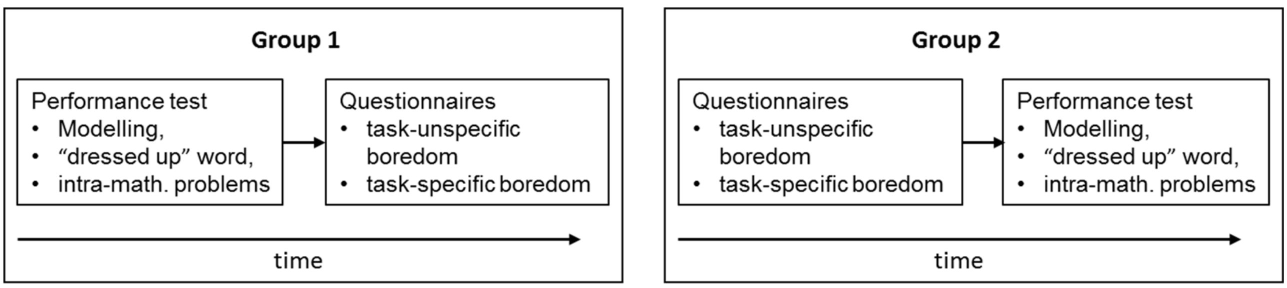


Figure 2: Design of the study

Maypole

Every year on Mayday in Bad Dinkelsdorf there is a traditional dance around the maypole (a tree trunk approx. 8 m high). During the dance the participants hold ribbons in their hands and each ribbon is fixed to the top of the maypole. With these 15 m long ribbons the participants dance around the maypole, and as the dance progresses a beautiful pattern on the stem is produced (in the picture such a pattern can already be seen at the top of the maypole stem).

At what distance from the maypole do the dancers stand at the beginning of the dance (the ribbons are tightly stretched)?

Figure 3: Modelling problem "Maypole"

amount of time to solve the problems and to fill out the questionnaires.

Sample problems

Eight modelling, eight word, and seven intra-mathematical problems were selected for this study. Sample tasks with and without a connection to the real world that could be solved using Pythagoras' theorem are presented in Figures 3 and 4. The maypole, football pitch, and side c were classified as modelling, "dressed up" word, and intra-mathematical problems, respectively (for more sample tasks and detailed analysis of classification see Krug & Schukajlow, 2013; Schukajlow et al., 2012).

Performance tests

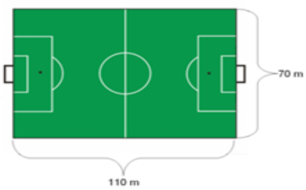
A performance test was developed for each type of problem. All tasks were examined within the framework of other projects. The Cronbach's alpha reliabilities were .59, .67, and .52 for the modelling, word, and intra-mathematical tests, respectively, and were acceptable for the small number of items and their diversity (across different contexts and/or different mathematical procedures).

Task-unspecific and task-specific boredom

Task-unspecific boredom was examined with a scale used in other studies (Goetz et al., 2007) and consisted of 4 statements that were answered on 5-point Likert scales ranging from (1=strongly disagree) to (5=strongly agree). A sample statement is "I am bored in mathematics classes". Cronbach's alpha was .85.

On the task-specific questionnaire, each of the 23 problems was followed by a statement about students' boredom. Both groups (cf. Figure 2) were instructed: "Read each problem carefully and then answer some questions." Group 2 was then told: "*You do not have to solve the problems"* because they were going to solve the problems after the boredom ratings, whereas Group 1 had already solved the problems, so they were told: "*You do not have to solve the problems (again)!*" After task processing, students in Group 1 were asked to rate the extent to which they agreed or disagreed with the statements "It was boring to work on this problem." Students in Group 2 were asked before task processing to rate the statements "It would be boring to work on this problem." A 5-point Likert scale was used to record their answers (1=not at all true, 5=completely true). 3 scales that measured task-specific boredom were formed across eight modelling problems, eight "dressed up" word problems, and seven intra-mathematical problems. The Cronbach's alpha reliabilities were .91 for boredom with the modelling and word problems and .85 for boredom with the intra-mathematical problems.

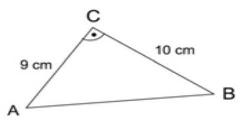
Football Pitch



Trainer Manfred would like to carry out a diagonal run with his team. To do so he would like to know how long the diagonal of the football pitch is. Can you help him?

Calculate the diagonal length of the football pitch.

Side c



Calculate the length of the side c = |AB|.

c= _________

Figure 4: "Dressed up" word and intra-mathematical tasks "Football Pitch" and "Side c"

Treatment fidelity
To examine the differences in the implementation of the treatment in Groups 1 and 2, a 5-point Likert item: "Before I agreed or disagreed with the statements (about task-specific boredom), I solved the problems" (1=not at all true, 5=completely true) was administered. Means and standard deviations were 4.3(1.17) for Group 1 and 2.19(1.01) for Group 2. The comparison of students' responses using an unpaired *t* test showed a significant mean difference between the two groups ($t(179)=13.07$, $p<.0001$, Cohen's $d=1.93$). This result shows that the students in Group 1 solved the tasks significantly more often than students in Group 2 *before* they reported their task-specific interest or enjoyment.

RESULTS

First, the connection between students' performance and boredom was analysed (correlations for Groups 1 and 2 are presented in Tables 1 and 2). As expected, students who solved the word problems better reported lower boredom on this type of problem. A similar result was also found for the relation between modelling and task-unspecific boredom. However, correlations of zero were observed for intra-mathematical problems and a weak and nonsignificant relation for the connection between performance and task-specific boredom on modelling problems.

In Group 2, in which students reported their boredom before solving the problems, negative correlations that ranged from -.24 to -.36 were found for all types of problems. Thus, students who felt low task-specific and task-unspecific boredom showed better results on the performance tests.

In order to answer the second and third research questions, Fisher's z transformation was applied, and then the z-scores were compared using a statistical procedure from Cohen & Cohen (1983, p. 54). This procedure provides information about the statistical significance of the difference between two correlations. The analysis of correlations for different types of problems presented in Table 1 and Table 2 showed that the largest difference between correlations was for the modelling problems in Group 1 (-.13 vs. -.33). However, the difference between correlations was not significant (*z*-score = 1.45, $p = .14$). Thus, students' performance was comparably related to task-specific and task-unspecific boredom.

The third research question addressed a comparison of correlations across different types of problems. The analyses of the values presented in Table 1 showed valuable differences between correlations for intra-mathematical and for "dressed up" word problems (0 vs. -.25) for task-specific boredom and between correlations for intra-mathematical and modelling problems (-.09 vs. -.33) for task-unspecific boredom. Both differences were significant at the 10% level (*z*-score = 1.74, $p = .08$; *z*-score = 1.72, $p = .08$, for task-specific and task-unspecific boredom, respectively). Thus, the correlation between performance and boredom with regard to the intra-mathematical problems tended to be weaker than the correlation between performance

		boredom			
		ma	w	mod	task-unspecific
performance	ma	0			-.09
	w		-.25*		-.29*
	mod			-.13	-.33*

Note: *$p<.05$; ma intra-mathematical, w word, mod modelling problems; sample size N=100

Table 1: Pearson correlations between performance and task-specific and task-unspecific boredom in Group 1

		boredom			
		ma	w	mod	task-unspecific
performance	ma	-.36*			-.34*
	w		-.30*		-.28*
	mod			-.24*	-.28*

Note: *$p<.05$; ma intra-mathematical, w word, mod modelling problems; sample size N=92

Table 2: Pearson correlations between performance and task-specific and task-unspecific boredom in Group 2

and boredom with regard to the word problems for students who solved the problems before reporting on their boredom. Similar differences were also found for the correlation between performance on the intra-mathematical problems and task-unspecific boredom and the correlation between performance on the modelling problems and task-unspecific boredom. However, another pattern of correlations was revealed for Group 2. Higher levels of boredom were connected with lower levels of performance across all types of problems for Group 2.

DISCUSSION

In this paper, the relation between performance and boredom was analysed using task-unspecific and task-specific scales. The results were not univocal. When students reported on their boredom before they solved the problems, their level of boredom was negatively connected to their performance (see similar results by Goetz et al., 2007). Somewhat different results were found for students who estimated their boredom after task processing. Students who achieved low scores on the intra-mathematical problems reported about the same value for boredom as students who achieved high scores. Similar results were found for the connection between performance on argumentation tasks and boredom (c.f. Heinze et al., 2005).

The correlations between performance and boredom were comparable between task-specific and task-unspecific boredom. The analysis of this question with regard to interest and enjoyment in the previous study showed the same result for enjoyment and interest (Schukajlow & Krug, 2014a). However, the correlations for task-specific boredom deviated across the different types of problems more than they did for enjoyment and interest. This result confirms the importance of differentiating between different affective measures as called for by Hannula and colleagues (2009).

The comparison of correlations across different types of problems showed that the correlations tended to be lower for intra-mathematical problems than for word or modelling problems in Group 1. Thus, the type of problems may be an important factor that has to be taken into account in future studies. According to our findings, teachers should put more effort into decreasing their students' boredom when presenting word or modelling problems because boredom on these tasks is negatively connected with students' performance.

One important future research question is about the direction of connection between performance and boredom. Longitudinal and interventional studies need to be conducted to answer this question. More research has to be done for the development and validation of research instruments for the measurement of boredom. An interesting approach may involve using software to identify students' emotions (Pesonen & Hannula, 2014). Research on developmental models of emotions is another future area of research. Such research should examine whether general affective changers emerges from changes in task- and situation-specific affect. Finaly, we need more research on instructional elements which could deacrease boredom. A promicing teaching approach could be prompting students to find multiple solution for problems with missing information, which found to affect students' expirience of competence and interest (Schukajlow & Krug, 2014b).

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