ARE INTEREST AND ENJOYMENT IMPORTANT FOR STUDENTS' PERFORMANCE?

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We conducted an experimental study with 192 ninth graders in which we investigated a connection between performance and students' interest and enjoyment using task-unspecific and task-specific questionnaires. Students were randomly assigned to experimental group 1 or to experimental group 2. In group 1, they were asked about their affective measures after task processing, and in group 2, they were asked before task processing. In both groups, students who achieved higher scores on the performance test reported stronger interest and enjoyment. The connection of performance to the task-unspecific and task-specific affective scales did not differ significantly and ranged between .15 and .47 for problems with and without a connection to the real world.

INTRODUCTION

Affect is highly important for student learning and has been investigated intensively during the last few decades (Zan, Brown, Evans, & Hannula, 2006). The results of previous studies indicate that student achievement measured using students' grades is connected to students' interest and enjoyment. However, only a small number of studies have investigated correlations between students' performance and their affect. In the current study, we examine whether students' performance on problems with and without a connection to the real world is connected (1) to their task-unspecific affect in mathematics or (2) to their task-specific affect when they report on their affect before and after task processing. Further, differences in the correlations between performance and affect were investigated for problems with and without a connection to reality.

THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

Interest and enjoyment

Interest is a motivational variable that characterizes a relation between a person and an object and indicates an individual psychological state of engaging with this object over time (Hidi & Renninger, 2006). Interest develops from situational to individual interest and is important for students' learning. Compared to other motivational constructs, interest is strongly connected to academic achievement. Correlations in mathematics range from .0 and .5 for different achievement tests and tend to decrease from the early to middle secondary level (see summary by Heinze, Reiss, & Rudolph, 2005). Interest is closely connected to emotions such as enjoyment (Schukajlow et al., 2012).

Students' emotions predict their career aspirations and thus influence their current and future lives (Wigfield, Battle, Keller, & Eccles, 2002). A control-value theory of

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achievement emotions assumes that the value of learning materials and the controllability of learning activities are important for students` emotions (Pekrun, 2006). Although enjoyment is among the most frequently reported positive emotions in the classroom, there are only a few studies that have investigated its connections to academic achievement. Students' grades at school and at universities are positively connected to their enjoyment in mathematics (.22 and .46, respectively, Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; Pekrun, Goetz, Frenzel, Barchfeld, & Perry, 2011). However, we could not find studies that had investigated the relation between students' performance on an achievement test with their enjoyment. As a positive association between students' grades and their enjoyment has previously been found, we expected a positive correlation between performance and students' enjoyment.

Characteristics of affect measurement

Students' affect can be measured before (prospective affect), during (current affect), or after (retrospective affect) activities such as problem solving (Efklides, 2006). Students' prospective interest indicates their level of interest when they begin to solve a problem. Their current affect describes their level of interest while they are trying to solve the problem. Their retrospective affect provides information about their perceptions of mathematical activities after task processing. We argue that students' prospective, current, and retrospective perceptions are important indicators of their affect.

Recently, researchers have demanded several times that subject-specific aspects of affect be taken into account, that multimethod approaches be used, and that new instruments be developed to measure affective variables (Hannula, Pantziara, Wæge, & Schlöglmann, 2009; Zan et al., 2006). Thus, in this study, we used two instruments to measure affect: well-known task-unspecific affective scales that were validated in other studies and a new task-specific approach applied in the study by Schukajlow et al. (2012). In addition, we measured students' affect before and after task processing in order to compare the stability of the connection between performance and affect.

One characteristic of affective measures is their level of subject-specificity. A sample statement may be "I am interested in problem solving" or "I am interested in solving the equation 3 + 2x = -4x." Although task-specific measures allow researchers to obtain answers about affect with regard to specific topics or kinds of tasks and are more sensitive to the affective changes that occur after intervention programs, they have rarely been used—except for self-efficacy expectations—to measure affect. As task-unspecific and task-specific affect can be used to assess the same construct, we do not expect performance to be more or less strongly correlated with task-specific measures than with task-unspecific measures. However, because of the sensitivity of task-specific measures, correlations between task-specific measures and performance may have greater variability across different types of problems than correlations between task-unspecific measures and performance. Thus, it is possible that the connection between performance and task-specific affect will differ across different problem types.

Problems with and without a connection to the real world

Task-specific measures were used recently to investigate interest and enjoyment regarding to problems with and without a connection to reality (Schukajlow et al., 2012). These problem types were modelling, "dressed up" word and intra-mathematical problems, all three of which are typically distinguished in discussions about modelling and applications (Blum, Galbraith, Henn, & Niss, 2007). To solve modelling problems, students need to construct a situation model of the task, and then they need to simplify that model by structuring and mathematizing it in order to generate a mathematical model that can be solved using mathematical procedures. In the end, mathematical results have to be interpreted and validated. Solving "dressed up" word problems is much simpler because a mathematical model is merely "dressed up" by the situation, and students have to "undress" it, mathematize it, and apply mathematical procedures to solve this type of problem. Intra-mathematical problems are not connected to reality at all.

We assume that there should be no significant differences between correlations of performance and affect for problems with and without a connection to the real world. Students who achieve higher scores on tests should be more interested in the solutions to the problems and should enjoy solving the problems more.

Research questions

The research questions we addressed were:

1. Is students' performance connected to task-unspecific and task-specific interest and enjoyment in mathematics measured before and after problem solving?
2. Is students' performance connected more strongly to task-specific than to task-unspecific affect?
3. Are correlations between performance and task-specific affect different for different types of problems (modelling problems, "dressed up" word problems, and intra-mathematical problems)?

METHOD

One hundred and 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) were asked about their task-unspecific interest, enjoyment, and boredom as well as about task-specific affect regarding various types of problems. The students were randomly assigned to two experimental groups. Students in group 1 solved problems first and then reported on their task-unspecific affect and on their task-specific interest, enjoyment, and boredom regarding these problems. In group 2, students reported on their task-unspecific and task-specific affect first and then solved tasks that were used in the task-specific part of the questionnaires (see Figure 1). Students in both groups worked on the same tasks and had the same amount of time to solve the problems and to complete the questionnaires.

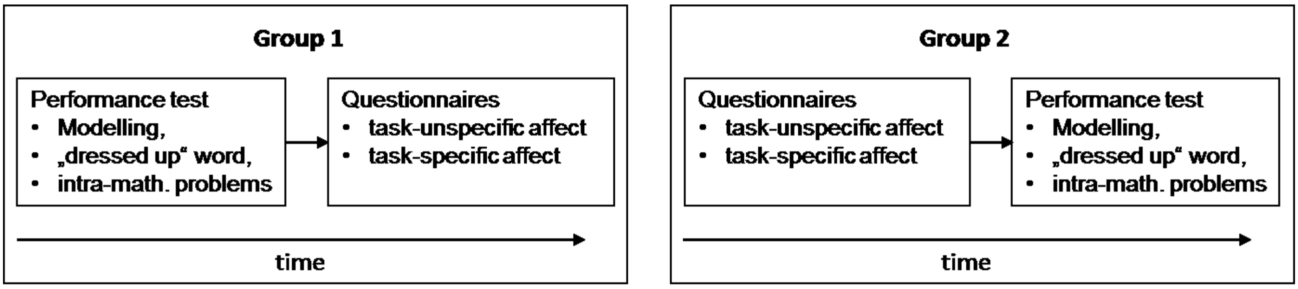


Figure 1: An overview of the study.

Sample problems

Twenty-three problems on the topics Pythagoras' theorem and linear functions—eight modelling, eight word, and seven intra-mathematical ones—were selected for this study and were used to examine students' performance and their task-specific affect. Sample tasks on the topic Pythagoras' Theorem are presented below.

Maypole

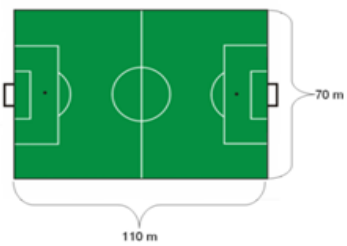
Every year on Mayday in Bad Dinkelsdorf there is a traditional dance around the maypole (a tree trunk approx. 8 m high). During the dance the participants hold ribbons in their hands and each ribbon is fixed to the top of the maypole. With these 15 m long ribbons the participants dance around the maypole, 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 2: Modelling problem "Maypole".

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).

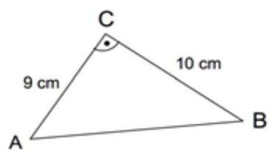
Football Pitch



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 3: "Dressed up" word and intra-mathematical tasks "Football Pitch" and "Side c".

Performance tests

Three tests with 8, 8, and 7 tasks each were constructed to measure students' performance in solving modelling, "dressed up" word, and intra-mathematical problems, respectively. All tasks that we used were examined in 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 (different contexts and/or different mathematical procedures).

Task-unspecific interest and enjoyment

Task-unspecific interest and enjoyment were assessed with scales used in other studies (e.g. Pekrun et al., 2011) and consisted of 6 and 4 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" and "I enjoy being in class." The Cronbach's alpha reliabilities were .88 for interest and .80 for enjoyment.

Task-specific interest and enjoyment

On the task-specific questionnaire, each of the 23 problems was followed by a statement about students' interest and enjoyment. The instructions for both groups (cf. Fig. 1) were: "Read each problem carefully and then answer some questions. **You do not have to solve the problems!**" After task processing, students in group 1 were asked to rate the extent to which they agreed or disagreed with the statements "It was interesting to work on this problem" and "I enjoyed solving the problem shown". Students in group 2, on the other hand, were asked before task processing to rate the statements "It would be interesting to work on this problem" and "I would enjoy solving the problem shown" A 5-point Likert scale was used to record their answers (1=not at all true, 5=completely true). A total of 6 scales that measured either task-specific interest or enjoyment were formed across eight modelling problems, eight "dressed up" word problems, and seven intra-mathematical problems. The Cronbach's alpha reliabilities for the 6 scales were all higher than .83.

Treatment fidelity

To control the treatment fidelity in groups 1 and 2, a five-point Likert item: "Before I agreed or disagreed with the statements (about task-specific affect), I solved the problems" (1=not at all true, 5=completely true) was used. Means and standard deviations were 4.3(1.17) for group 1 and 2.19(1.01) for group 2. An independent t test showed a significant mean difference between the two groups ($t(179)=13.07$, $p<.0001$, *Cohen's* $d=1.93$). As intended, 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

Correlations between students' performance and task-unspecific as well as task-specific affect in groups 1 and 2 are presented in Tables 1 and 2, respectively. Students who achieved higher scores on the performance tests reported higher task-unspecific interest in mathematics and enjoyed mathematics classes more than students who received lower scores. Moreover, students who were interested in mathematics and in solving mathematical problems outperformed other students on the achievement tests. Despite finding a low correlation between performance on intra-mathematical problems and task-specific enjoyment in group one (.15) and a low correlation between performance on modelling problems and task-specific interest in group two (.16), a significant positive connection between performance and affect was found using task-specific and task-unspecific affect scales.

		interest			interest	enjoyment			enjoyment
		ma	w	mod	task-unspecific	ma	w	mod	task-unspecific
perfor-mance	ma	.18[a]			.25*	.15			.29*
	w		.39*		.39*		.47*		.45*
	mod			.31*	.40*			.27*	.45*

Note: *p<.05; [a]p<.10; ma intra-mathematical, w word, mod modelling problems; sample size N=100

Table 1: Pearson correlations between performance and task-specific and task-unspecific interest and enjoyment in group 1.

To answer the second research question, correlations between performance and task-specific affect were compared with correlations between performance and task-unspecific affect using Fisher's z-test. For example, in group 1, the correlation between performance on intra-mathematical problems and interest in these problems (.18) was compared with the correlation between performance on this problem type and task-unspecific interest (.25). Fisher's z-test showed that the correlations did not differ significantly (p=.61).

		interest			interest	enjoyment			enjoyment
		ma	w	mod	task-unspecific	ma	w	mod	task-unspecific
perfor-mance	ma	.19[a]			.21*	.38*			.34*
	w		.24*		.23*		.37*		.31*
	mod			.16	.33*			.37*	.27*

Note: *p<.05; [a]p <.10; ma intra-mathematical, w word, mod modelling problems; sample size N=92

Table 2: Pearson correlations between performance and task-specific and task-unspecific interest and enjoyment in group 2.

Similar results were also found for other correlations between performance and interest. The relations between students' performance and task-specific interest were comparable to the relation between performance and task-unspecific interest in both experimental groups. The comparisons of the correlations between performance and enjoyment revealed similar results. We did not find significant differences between performance on modelling/word/intra-mathematical problems and enjoyment regarding to the respective type of problem and between performance and task-unspecific enjoyment.

The third research question addressed the stability of the connection between performance and task-specific affect across different types of problems. Fisher's z-test did not show any significant differences in performance-interest correlations between groups 1 and 2 for different types of problems. Thus, the relations between students' performance and interest were comparable across intra-mathematical, "dressed up" word, and modelling problems. The connection between performance and task-specific enjoyment[1] was also comparable between problems with and without a connection to the real world. Thus, we could conclude that the relation between performance and affect does not depend on the type of problem.

SUMMARY

In this study, we investigated the relations between performance and students' interest and enjoyment using (1) task-unspecific and task-specific measures as well as (2) different perspectives (prospective and retrospective) in the measurement of affect. The results confirm the importance of interest and enjoyment for students' performance in mathematics. The range of the magnitudes of the correlations between performance and affect in our study was comparable to the range found in other studies (Goetz, Frenzel, Hall, & Pekrun, 2008; Heinze et al., 2005) in which performance was estimated via students' grades.

As expected, correlations between performance and affect were comparable for task-specific and task-unspecific scales. However, we assume that task-unspecific and task-specific measures provide information about different features of interest or enjoyment. Task-specific scales are more unstable than task-unspecific ones and depend on the mathematical topic, the described situation, students' prior knowledge, etc. This issue should be investigated further in future studies.

Finally, we compared correlations for problems with and without a connection to the real world. Although the magnitudes of the correlations between performance and affect varied widely, we found no significant differences in correlations for different types of problems. One open research question involves whether there are different "sources" of interest and enjoyment for different types of problems. We suppose that affect for problems with a connection to reality may depend not only on the mathematical nature of the task but also on the situation described in the task.

[1] As we conducted 12 tests to answer this research question, the significance level was adjusted from 0.05 to 0.005 by using a Bonferroni correction to take into account the accumulation of the alpha-error.

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