PROBLEMS WITH AND WITHOUT CONNECTION TO REALITY AND STUDENTS' TASK-SPECIFIC INTEREST

André Krug, Stanislaw Schukajlow-Wasjutinski

University of Paderborn, Germany

In this study 192 ninth and tenth graders from 8 German classes were asked about their interest concerning tasks with and without connection to reality. The students were randomly assigned to two experimental groups. The first group was asked about their task-specific interest after and the second group before task processing. The study aimed to answer the following questions: (1) Does students' task-specific interest differ according to the type of problem (intra-mathematical, "dressed up" word problems and modelling problems)? (2) Does task processing influence students' task-specific interest? The analysis showed that there are differences in students' interest regarding tasks with and without connection to reality and that task-specific interest across all types of problems decreases after task processing.

INTRODUCTION

The discussion about the types of mathematical tasks that should be treated in the classroom has a long tradition in mathematics education. Over the last decades there has been a strong plea for treating real-world problems in mathematics classroom (Blum & Niss, 1991). From treating reality-based tasks, an improvement in students' interest can be expected. However, recent empirical research studies do not always confirm the assumption that students prefer to solve real-world problems (Schukajlow et al., 2012). A further question remains: how does task processing influence task-specific interest? The present study refers to these points and examines the impact of different types of mathematical problems and task processing on task-specific interest.

THEORETICAL BACKGROUND

Interest

Interest is a motivational construct with great importance for learning. An interested learner, for example, engages more in solving problems than an uninterested one. "An interest represents or describes a specific relationship between a person and an object in his or her "life-space"" (Krapp, 2000), such as the relationship between a person and a mathematical task. A special feature of interest is its content-specificity. Content-specificity means that interest is closely related to specific topics, tasks and activities. Educational researchers usually differentiate interest as being either situational or individual. Individual interest is a relatively stable evaluative trait towards certain domains. Situational interest is an emotional, highly variable state aroused by specific features of an activity or a task with physiological, subjective, goal-orientated, and behavioural components. Mitchell (1993) distinguished between two levels of situational interest. First, a possible activity (e.g. an opportunity to solve a

2013. In Lindmeier, A. M. & Heinze, A. (Eds.). *Proceedings of the 37th Conference of the International Group for the Psychology of Mathematics Education*, Vol. 3, pp. 209-216. Kiel, Germany: PME.

mathematical problem) catches or initiates a person's interest. Second, this activity holds the person's interest with the likely result that deeper individual interest may emerge. The catch-level can be stimulated by content specific activity (Schraw & Lehman, 2001). For increasing situational interest activity, novelty, challenge, exploration intention, attention demand and interactive experience are crucial (Deci, 1992). Engaging in task processing can influence these factors, thus also influencing situational interest.

Mathematical problems

According to Niss, Blum, & Galbraith (2007) there are three types of mathematic problems: modelling problems, ("dressed up") word problems and intra-mathematical problems. The main difference between these types is their strength of connection to the real world.

Modelling problems. The core of modelling activities is the transfer process between the real and the mathematical world. An idealized process of solution for a modelling problem can be characterized as followed: (1) understanding the problem and constructing an individual "situation model"; (2) simplifying and structuring the situation model and thus constructing a "real model"; (3) mathematizing, i.e. translating the real model into a mathematical model; (4) applying mathematical procedures in order to derive a result; (5) interpreting this mathematical result with regard to reality and thus attaining a real result; (6) validating this result with reference to the original situation; if the result is unsatisfactory, the process may start again with step 2; (7) exposing the whole solution process.

Word problems. Another type of mathematical problem is the "dressed up" word problem. Although also related to reality, the mental activity for the solution of word problems is more simplified than that which is required for solving modelling problems.

- In a word problem the real model is already given in the task.
- The data for finding the solution are given in the text and no other data are needed for development of the solution.
- "Modelling loops" for validation of the real result are unnecessary.

Intra-mathematical problems. Mathematical problems without any connection to reality are termed intra-mathematical problems. The solution of intra-mathematical problems begins with the analysis of the situation model. The situation model in these types of tasks is equal to a mathematical model. The problem can be solved using appropriate mathematical procedures. Validation is limited to checking the mathematical activity.

Task-specific affect

In the last decades there have been strong pleas for the development of new measurement devices for the tasked-focussed and subject-specific investigation of affect (Zan, Brown, Evans, & Hannula, 2006). Recently, two studies were carried out where students' affect towards mathematical problems with and without reference to reality using task-specific questionnaires was investigated. "Dressed up" word problems more enjoyable and caused less anxiety for students than intra-mathematical ones (Pekrun et al., 2007). This result was not confirmed by the other study on this issue. Schukajlow et al. (2012) showed that there are no differences in students' enjoyment, value, interest and self-efficacy among tasks with and without connection to reality. As the results of both studies differ, there is still an open question as to whether students' task-specific affect varies according to the task's connection to reality. In this paper we focus on task-specific interest.

An essential limitation of both studies is the way in which the questionnaire was applied. The studies have in common that they inquired about task-specific affect before task processing. Students were asked to appraise their own enjoyment, interest, self-efficacy etc. without actually solving the problems. Thus their perception of affect was based only on their first impression of the problems. If students were to solve the task before answering the questions they may be able to appraise differences between types of problems more accurately. To prove this assumption we asked students to evaluate their task-specific interest before and after solving problems with and without connection to reality.

RESEARCH QUESTIONS

This study was designed to answer the following research questions:

- Does students' task-specific interest differ according to the type of problem (intra-mathematical, "dressed up" word problems and modelling problems)?
- Does task processing influence students' task-specific interest?
- Does the influence of types of problems on task-specific interest depend on task processing?

METHOD

Design und sample

192 German ninth and tenth graders from 4 middle-track and 4 grammar school classes (53.6% females; mean age=16.1 years, SD=0.86) were asked about their interest regarding various types of problems. The students were randomly assigned to two experimental groups. Students of group 1 solved problems first and then reported on their task-specific interest regarding these problems. In group 2, students reported on their task-specific interest first and then solved tasks that were used in the questionnaires (see Fig. 1). Students of both groups worked on the same tasks and had the same amount of time to answer the questions about task-specific interest.

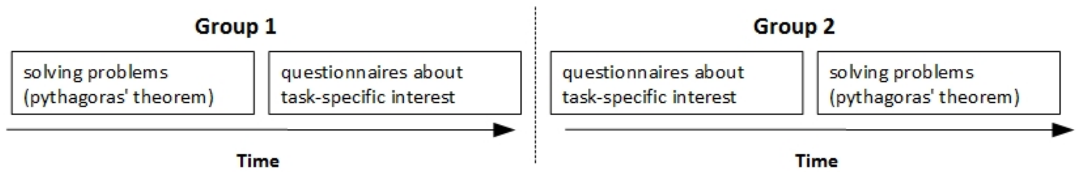


Fig.1: An overview to the study

Sample problems

Twelve problems on the topic Pythagoras' theorem - four modelling, four word and four intra-mathematical ones - were selected for this study. Sample tasks are presented below.

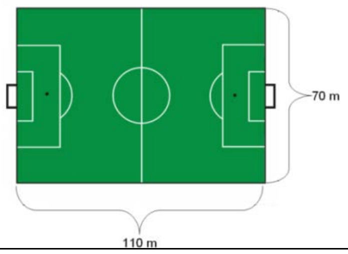
Maypole

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)?

Fig. 2: The "maypole" problem

The maypole problem can be classified as a *modelling problem*. An individual mental model of the given situation has to be constructed when the problem is read and the picture is viewed. In the situation model important data like the distance from one end of the ribbon to the ground are missing and have to be assumed for constructing the real model. The problem solver can assume that the dancers hold the ribbons at 1 m high. An idealised ribbon is 15 m long and the stem is 8 m high. The real model has to be mathematized using a right-angled triangle as a mathematical model. The distance from the dancers to the maypole corresponds here to one leg of the triangle and has to be calculated using Pythagoras' theorem. The calculated distance can be validated using the information from the picture of the dance around the maypole.

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?

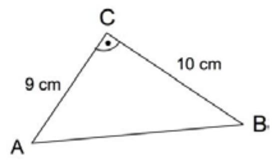
Calculate the diagonal length of the football pitch.

Fig. 3: The "Football Pitch" problem

The task "Football Pitch" is a "dressed up" *word problem*. The situation is pre-structured by the data presented in the picture and the formulation of the task. Thus, simplifying and structuring the situation model is not essential for solving this problem. As a right-angled triangle in the task "Football Pitch" can be recognised, a direct translation into a mathematical model is possible. Calculating the diagonal using Pythagoras' theorem and the interpretation of mathematical results are activities that are necessary for the solution of this task.

The solution of the *intra-mathematical task* “Side c” can be developed using the same mathematical activities as the problem “Football pitch”.

Side c



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

Fig. 4: The “Side c” problem

Interest scales

In the questionnaire each of the twelve problems was followed by a statement about students’ task-specific interest. The instruction for both groups was: “Read each problem carefully and then answer some questions. **You do not have to solve the problems!**” In group 1 students were asked after task processing to what extent they agreed or disagreed with a statement (“It was interesting to work on this problem”). In group 2 students were asked before task processing with a statement (“It would be interesting to work on this problem”). For recording their answers a 5-point Likert scale was used (1=not at all true, 5=completely true). The statement we used represents a main feature of the construct “interest”. Each of 3 scales for the measurement of task-specific interest was formed across four problems. The reliabilities (Cronbach’s alpha) for the 3 scales were all higher than .81.

Treatment fidelity

To control the treatment we used a five-point Likert item: “Before I agreed or disagreed with statements (to task-specific interest), I have solved the problems” (1=not at all true, 5=completely true). Means and standard deviations were for group one and two 4.3(1.17) and 2.19(1.01) respectively. An unpaired t test showed that there were significant mean differences between both groups ($T(179)=13.07$, $p<.0001$, *Cohen’s* $d=1.93$). As intended in the study, students of group 1 solved the tasks significantly more often than students of group 2 *before* they reported on their task-specific interest.

RESULTS AND DISCUSSION

In Table 1 the interest mean scores (Ms) and standard deviations (SDs) regarding the three types of problems and the two groups are presented. A one-factorial repeated-measures ANOVA with the type of the problem as the within-subject factor was used to compare the task-specific interest of the two groups. The crucial assumption while using repeated measures ANOVA is the sphericity. Mauchly's test of sphericity indicated that the assumption of sphericity by the factor type had been violated ($\chi^2(2) = 22.13$, $p < .001$). Thus we used the Geisser/ Greenhouse correction to adjust the degree of freedom.

	M_1 (SD_1)	M_2 (SD_2)	Cohen's d	T(df=190)
modelling	2,74 (1,05)	2,97 (0,88)	0.14	1.638
dressed up	2,89 (1,06)	3,11 (0,82)	0.06	1.622
intra-mathematial	2,83 (1,02)	3,19 (0,86)	0.19*	2.568
*p<0.05, M_1 (SD_1): group 1, M_2(SD_2): group 2				

Table 1: Students' task-specific interest

Students' task-specific interest, types of problems and task processing

The ANOVA shows that the factor "types of problems" has a significant influence on students' task-specific interest (*F(1.8)=7.681, p<0.001,* eta^2*=.04*). Thus it can be concluded that students' interest differs according to the three types of problems. To avoid the alpha error accumulation we have used the Bonferroni correction in the post-hoc test. The post-hoc test reveals that the students' interest regarding modelling problems is lower than their interest regarding word and intra-mathematical problems (c.f. Table 2). No differences between students' interest regarding "dressed up" word problems and intra-mathematical problems were found.

(I) type	(J) type	Mean Difference (I-J)	Std. Error (SE)	*p*
Modelling problems	"Dressed up" word problems	-.15	.04	<.0 1
Modelling problems	Intra-mathematical problems	-.15	.05	<.0 1
"Dressed up" word problems	Intra-mathematical problems	-.01	.04	1,0 0

Table 2: Values for post-hoc analysis of differences in task-specific interest

The ANOVA with task processing as a between factor indicates that this factor has a statistically significant effect on task-specific interest (*F(1)=4.358, p=.038,* eta^2*=.02*). Hence it follows that students' task-specific interest decreases after task processing from 3.1 (SE=.09) to 2.82 (SE=.09).

To answer the third question we analyzed the interaction effect of types of problems and task processing on task-specific interest. No interaction effect could be observed in the data (*F(2)=1.316, p=.27*). This result implicates that the task processing has no influence on lower interest regarding modelling problems compared to task-specific interest regarding other types of problems. Modelling problems are less interesting than "dressed up" word problems and intra-mathematical problems before as well as after task processing. The task-specific interest in "dressed up" problems and intra-mathematical problems does not differ before and after task processing significantly. However, interest regarding intra-mathematical problems decreases slightly more strongly than interest regarding other types of problems.

DISCUSSION

As we found no differences between task-specific interest regarding “dressed up” word and intra-mathematical problems, the results of the study by Schukajlow et al. (2012) can be confirmed. However, unlike previous results students have lower interest to modelling problems than to the other types of problems. One possible reason for this inconsistency is the usage of different topics for the measurement of task-specific interest (Pythagoras’ theorem and linear functions vs. Pythagoras’ theorem only). Another explanation for lower interest regarding modelling problems is that students don’t solve these problems in regular mathematics classes and may be unsure of their ability to solve this type of problem (for similar results in physics see (Hoffmann, Häussler, & Lehrke, 1998)).

Other important results are (1) no interaction effect between task processing and types of problems and (2) the decrease of task-specific interest after task processing. This decrease of interest can be explained by the novelty of the problems for one of the two groups. Task processing can negatively influence the novelty of the tasks and thus also the situational interest. However, the same problems were presented in the performance test as well as in the questionnaires. It is possible that task-specific interest would not change or even increase after task processing if other problems were to be used for the measurement of interest.

The main limitations of this study are that only one mathematical content area was incorporated and only one statement summarized across four problems was used for the measurement of task-specific interest.

References

Blum, W., & Niss, M. (1991). Applied mathematical problem solving, modelling, applications, and links to other subjects. State, trends, and issues in mathematics instruction. *Educational Studies in Mathematics, 22*, 37–68.

Deci, E. L. (1992). Interest and the intrinsic motivation of behavior. In K. A. Renninger, S. Hidi, & A. Krapp (Eds.), *The Role of interest in learning and development.* Hillsdale, N.J: L. Erlbaum Associates.

Hoffmann, L., Häussler, P., & Lehrke, M. (1998). *Die IPN-Interessenstudie Physik*. Kiel: IPN.

Krapp, A. (2000). Interest and human development during adolescence: An educational-psychological approach. In J. Heckhausen (Ed.), *Advances in psychology: Vol. 131. Motivational psychology of human development* (1st ed., pp. 109–128). Amsterdam: Elsevier.

Mitchell, M. (1993). Situational interest: Its multifaceted structure in the secondary school mathematics classroom. *Journal of Educational Psychology*, (85(3)), 424–436.

Niss, M., Blum, W., & Galbraith, P. L. (2007). Introduction. In W. Blum, P. L. Galbraith, H.-W. Henn, & M. Niss (Eds.), *Modelling and Applications in Mathematics Education: the 14th ICMI Study* (pp.1–32). New York: Springer.

Pekrun, R., Vom Hofe, R., Blum, W., Frenzel, A. C., Goetz, T., & Wartha, S. (2007). Development of Mathematical Competencies in Adolescence: The PALMA Longitudinal Study. In M. Prenzel (Ed.), *Studies on the educational quality of schools. The final report on the DFG Priority Programme (pp. 17-37).* Münster, Germany: Waxmann.

Schraw, G., & Lehman, S. (2001). Situational Interest: A Review of the Literature and Directions for Future Research: Educational Psychology Review, *13*(1), 23-52. doi:10.1023/A:1009004801455

Schukajlow, S., Leiss, D., Pekrun, R., Blum, W., Müller, M., & Messner, R. (2012). Teaching methods for modelling problems and students' task-specific enjoyment, value, interest and self-efficacy expectations. *Educational Studies in Mathematics*, *79*(2), 215–237.

Zan, R., Brown, L., Evans, J., & Hannula, M. S. (2006). Affect in Mathematics Education: An Introduction. *Educational Studies in Mathematics*, *63*(2), 113–122.