Elena KLIMOVA, Dresden

Basic psychological needs and the development of interest in mathematics during a learning activity

This paper serves the purpose of examining a learning activity aimed at developing mathematical abilities – a mathematical discussion – with regard to its beneficial impact on the students' interest in mathematics.

Theoretical basic and statement of the research question

As Kießwetter emphasized, a learning environment perceived as friendly and motivating plays an important role in developing mathematical skills and in forming area-specific action and behavior patterns (cf. also Fritzlar, 2010, p. 119; Käpnick, 2014, p. 540). Furthermore, long-term studies confirm the increasing role of intrinsic motivation and interest in the learning material for successfully learning mathematics in secondary-level education (Murayama 2013). The necessity of enhancing this area is underpinned by the problematic decrease of interest in mathematics during the course of secondary-level education.

Therefore, the main objectives of research are the development and evaluation of interest-enhancing learning activities to improve mathematical skills in secondary-level education. During the research for this paper, a learning activity was examined with regard to its beneficial impact on the students' interest in mathematics. The learning activity consisted of a mathematical discussion between teams in the form of a competition named Matboj, following a fixed set of rules and assessed by a jury (see Klimova, 2012).

This research is mainly based on two theoretical frameworks: the person-object interaction theory of interest – POI theory – and the self-determination theory of motivation – SDT (Krapp, 2005; Ferdinand, 2014, p. 100).

Research questions: Does a mathematical discussion as a learning activity evoke situational interest in children who are identified as mathematically gifted? To what extent is there a correlation between the satisfaction of basic needs and the degree of the experienced situational interest? Which other factors have an impact on the situational interest and to what extent?

Research design and methodology

The study was conducted in an experimental manner and implemented within the framework of a cross-sectional study at the four-day mathematics weekend hosted by the secondary school for gifted students in Schwäbisch

Siller, H.-S., Weigel, W. & Wörler, J. F. (Hrsg.). *Beiträge zum Mathematikunterricht 2020.* Münster: WTM-Verlag, 2020.
doi: 10.37626/GA9783959871402.0

Gmünd. The mathematics weekend is designed to promote mathematical talent in students from grades 7 to 10 and consists of mathematical seminars and multiple learning activities. The experimental group comprised 55 students from Germany and Switzerland with an average grade of 1.8 in mathematics (equivalent to A-), who spend 1.9 hours of their free time per week dealing with mathematical issues and who volunteered for the mathematics weekend.

The research design was based on the works of Bortz and Döring (Bortz & Döring, 2006) as well as Raab-Steiner and Benesch (2008). The main emphasis was placed on quantitative results. Within the framework of this study, all learning activities were evaluated using an EvaSys questionnaire (Gericke, 2014). The questionnaire was tested for the first time and therefore does not claim to be complete. The items were ranked with a five-point ordinal scale, allowing the respondents to indicate their degree of agreement with the respective statement through a rating from 1 (fully agree) to 5 (fully disagree). The research analysis was performed with SPSS. The data evaluation was performed by assessing the respective characteristics with regard to their extent and by carrying out a factor analysis. For the characteristic factors, descriptive-statistical values were calculated. In addition, two other analytical procedures were employed: bivariate correlation and t-test for independent samples.

Key results

The manifestations of the basic needs indicate an overall positive trend. Most respondents considered themselves competent in the competition (A = 2.06 with SD = 0.72), autonomous (A = 2.11 with SD = 0.83) and particularly socially integrated (A = 1.84 with low SD = 0.66).

	items	*A*	*SD*	SG	FM	IM	EM	SM	CE	AE	SR
SG		1.85	0.988								
FM		1.96	1.036	.276*							
IM	9	2.12	0.92	.061	.764**						
EM	5	3.81	0.96	-.325*	-.048	-.012					
SM	3	1.85	0.79	.353*	.607**	.463**	-.047				
CE	8	2.06	.72	-.090	.218	.579**	.138	.373*			
AE	3	2.11	.83	-.064	.127	.366*	.241	.213	.829**		
SR	5	1.84	.66	-.104	.022	.148	.288	.210	.516**	.570**	
SI	5	2.21	.99	-.097	.322*	.567**	.345*	.217	.762**	.684**	.521**

Table: Overview of the descriptive statistics of the variables included in the analysis

Explanatory notes on the table: A = average; SD = standard deviation; SG = school grade in mathematics; FM = favorite subject mathematics; IM = intrinsic motivation; EM = extrinsic motivation; SM = self-concept mathematics; CE = competency experience; AE = autonomy experience; SR = social relatedness; SI = situational interest; ** $p < 0.01$; * $p < 0.05$.

The exploratory analysis of the construct-related items led to further results.

- The average value of 1.7 for the item "Making an effort while solving problems" confirms both the participants' high level of motivation and a particularity of the learning activity – the high level of confrontation with mathematics.
- The participants rated the fairness of the tasks positively with 2.3. However, the standard deviation for this item is 1.3, which indicates a high variance of ratings.
- All items referring to social relatedness show a high level of acceptance by the respondents. The results of item (23.3) are particularly remarkable: Over the course of the learning activity (i.e. during the preparations for the discussion and during breaks in the presentation phase), the participants discussed mathematic problems among their group members with A = 1.7 (SD = 0.9), out of which 54% discussed at the highest intensity level 1. This result additionally demonstrates the potential of the learning activity for the acquisition of process-related mathematical skills. To this day, no proven study has been published on this aspect yet.
- There were three outliers in item (24.20) – the question whether the respondent would like to participate in a Matboj again. Otherwise, this question was rated with at least 3 by 88% of the participants, while 56% gave the highest rating 1.

There is a strong and very significant correlation between the existing intrinsic motivation and the situational interest during the mathematical discussion. Both having mathematics as one of the favorite subjects and extrinsic motivation have a significant impact on the student's interest. There is no correlation between the students' mathematical self-concept and the experienced situational interest in this experimental group. The t-test for independent samples did not indicate any significant gender-specific differences in experiencing basic needs or in the arousal of situational interest.

Conclusions

The satisfaction of basic psychological needs, which are prerequisites for the development of professional interests, the experienced situational interest and other characteristics were investigated with regard to their extent and

correlation. The basic needs identified as essential were sufficiently satisfied by the mathematical discussion as a learning activity. Above all, the participants primarily experienced social relatedness. There is a high positive correlation between emotional valence and experienced situational interest. The strongest correlation was found between the experienced competence and the evoked interest. In summary, the results show that mathematical discussions as implemented during the mathematics weekend encourage the arousal of situational interest and offer participants an opportunity to explore this interest. Given the fact that this research merely represents a cross-sectional study, no long-term development trends are demonstrated. The questionnaire is to be optimized and the emotion-neutral valence is to be investigated.

References

Bortz, J. & Döring, N. (2006). *Forschungsmethoden und Evaluation für Human- und Sozialwissenschaftler*. Heidelberg: Springer.

Gericke, B. (2014). *Können mathematische Wettbewerbe das Interesse von Schüler_innen steigern?* Research paper. University of Education Schwäbisch Gmünd, Germany.

Ferdinand, H. (2014). Entwicklung von Fachinteresse. In D. H. Rost (Hrsg.), *Pädagogische Psychologie und Entwicklungspsychologie*. Münster, New York: Waxmann.

Fritzlar, T. (2010). Begabung und Expertise: Eine mathematikdidaktische Perspektive. *mathematica didactica*, 33, 113–140.

Käpnick, F. (2014). Mathematische Talente erkennen und fördern. In M. Stamm (Hrsg.), *Handbuch Talententwicklung. Theorien, Methoden und Praxis in Psychologie und Pädagogik* (S. 537–547). Bern: Verlag Hans Huber.

Klimova, E. (2012). MatBoj-Wettbewerb als ein neuer fachspezifischer Wettbewerb in Mathematik zur Förderung begabter Schüler. In M. Ludwig & M. Kleine (Hrsg.), *Beiträge zum Mathematikunterricht 2012* (S. 449–552). Münster: WTM.

Krapp, A. (2005). Basic needs and the development of interest and intrinsic motivational orientations. *Learning and Instruction*, 15, 381–395.

Murayama, K., Pekrun, R., Lichtenfeld, S. & vom Hofe, R. (2013). Predicting Long-Term Growth in Students' Mathematics Achievement: The Unique Contributions of Motivation and Cognitive Strategies. *Child Development*, Vol. 84, Issue 4 July/August, 1475–1490.

Raab-Steiner, E. & Benesch, M. (2012). *Der Fragebogen. Von der Forschungsidee zur SPSS-Auswertung*. Vienna: Facultas.