INTEREST IN MATH BETWEEN SUBJECT AND SITUATION

Angelika Bikner-Ahsbahs

Universität Flensburg, Germany

Interest is an important factor in learning and achievement. In my research, I reconstruct phenomena of interest change in everyday mathematics classroom education, and I identify conditions influencing the development of interest in mathematical objects. This leads to an approach to an empirically-grounded theory on interest based learning in math classes.

1. Introduction

An interested pupil pays attention in class, works in a concentrated and an engaged way, learns more, is involved in the activities, enjoys his/her involvement, wants to go on with the activity (Hidi/Berndorf 1998), and sometimes does not notice how time goes by. In this state of affairs close to that of flow (Csikszentmihalyi 1987) capacity and challenge fit perfectly (Bikner-Ahsbahs 1999 p. 52 ff). Research has shown interest to be a strong predictor of quality of experience in mathematics classes, i. e. potency, intrinsic motivation, self-esteem, importance and the perception of skill (Csikszentmihalyi/Schiefele 1993, Schiefele/Csikszentmihalyi 1995). However, interest also is a predictor of mathematical achievement. Thus it is an important factor in learning and development (Bauer 1988, Krapp 1996, Deci 1992, 1998). But how does interest arise? Undoubtedly, interest is a phenomenon of social negotiations (Renninger 2000, Krapp 1996, Deci 1992, 1998). However, there is little research analysing social processes (Deci 1992, Krapp 1996, Schiefele 1998, Wild/Krapp 1996).

In 1988, Bauer was the first to introduce interest research in German math didactics. Taking up Bauer´s reflections, Bikner-Ahsbahs has worked out an empirically grounded concept of fostering mathematical interest in everyday lessons (1999). The study was based on questionnaires about a project encouraging interested pupils in extra curricular mathematics. Referring to the empirical research on interest, the results were applied to everyday lessons. However, the social processes of the development from interest in daily classroom situations haven´t yet been investigated. Because of this lack of investigation in social processes I´ve designed a study to develop theoretical components through the reconstruction of phenomena concerning interest development, in order to explain the emergence of interest in everyday lessons, its development, encouragement and hindrance.

2. Theoretical Framework

Krapp et al (Krapp 1992) have proposed interest to be a construct describing a person-object-relation which can be seen in activities with three characteristic aspects: expansion of competence (cognitive aspect), association with predominantly positive feelings (emotional aspect) and assigning advanced value to the interest matter (valuable aspect) (1992, 1996). An interested person identifies himself/herself with the matter of interest. The self-determination theory describes this process of identification (Deci 1992, 1998). Deci regards motivation as a continuum between extrinsic and intrinsic motivation whereas interest is taken as an object-specific type of intrinsic motivation. An extrinsicly motivated activity may be increasingly self-determined leading to individual interest by taking the steps of introjection, identification, and integration (Krapp 1992, Deci 1992). Using the basic needs for competence, autonomy and relatedness, Deci is able to explain the emergence of priorities (Deci 1992, Krapp 1996). Several studies show that competence- and autonomy-supportive teaching enhance intrinsic motivation and interest (Deci 1992), and that the experience of competence and autonomy is related to the development of interest (Wild/Krapp 1996, Prenzel/Drechsel 1996). Investigations focus on two different kinds of interest: individual interest on the intrinsic side and situational interest on the extrinsic but self-determined side of motivation (Hidi/Berndorff 1998, Mitchell 1993).

2.1. Individual interest

Individual interest develops slowly but in a relatively stable and situationally independent way. (Hidi/Andersen 1992). The observation of developing processes of individual interest can only be achieved in a long-term project. Renninger (1992, 2000) compares extended interest to non-interest and attraction. Her concept of interest is associated with increased levels of knowledge and value bringing together positive and negative emotions. The connection to Krapp´s concept of interest can easily be explained in the context of mathematics education: My experiences in fostering mathematically interested pupils have shown that pupils with high individual interest like to find mathematical proofs on their own, although these processes are associated with frustration. However, pupils with low individual interest are likely to avoid such frustrations. They derive more pleasure from finding proofs in a group with the support of a teacher. As individual interest in math increases, value gets more important than the experience of positive emotions.

2.2. Situational interest

Situational interest is influenced by the environment and is therefore fickle (Hidi/Andersen 1992). Little is known about how situational interest develops and how situational interest might lead to individual interest (Hidi/Berndorf 1998).

Mitchell´s research (1993) indicates a multifaceted structure of situational interest in school mathematics with five subfacets. First of all, situational interest consists of a catch-facet and a hold-facet. Interest is caught by a situation of cognitive, sensory, or social stimulation. Mitchell shows that pupils at the age of 14 to 16 get interested in mathematical activities by using computers and puzzles and by participating in group work. For smaller children I would expect a sensory stimulating facet to catch interest, too, and my investigations indicate, that not all forms of group work are interest-catching. Even Mitchell asks the question under what conditions group work is perceived as interesting by students (Mitchell 1993, p. 433).

Environments which catch interest need not necessarily hold interest. Situational interest can be held if students perceive lessons as meaningful (*meaningfulness*) and if they feel involved in the activities (*involvement*). Thus, suitable environments and social contexts influence situational interest (Mitchell 1993). But what does suitable mean? In my study, I look for situational conditions of environmental and social interactions in natural settings which influence situational interest. The pursuit of conditions for long-term individual development then leads to conclusions about a possible development of individual interest.

2.3. Interest and learning in mathematics classroom education

Social processes of interest development cannot be observed directly. They are inferred from indicators by means of an "interaction analysis". Therefore I use the theoretical approach of the "interpretative Unterrichtsforschung" of the German math didactics (Krummheuer/Naujok 1999). Concerning this theoretical approach, the individual and social learning processes are based on the construction of meaning (Krummheuer/Voigt 1991). In everyday math classes, mathematical meanings are produced through negotiation. As they are results of interactions they are taken-as-shared. The participants of an interaction do not clarify symbols and meanings in an extensive way. They accept ambiguity as far as the interaction process can go on (Krummheuer 1992, Voigt 1995); progressive questions indicate the interest of a pupil. In the social-constructivist approach of his interactional learning theory Krummheuer conceives learning both as a creative, individual, innerpsychic process and at the same time as a socializing social process directed at convergence (Krummheuer 1992, p. 167). In this process the mathematical subject matter, the individual learning process, and the social interactions are mutually dependant. So it seems reasonable to assume that the development of interest is triggered by social interactions (cf. Deci 1998).

Learning in lessons is regarded here from a social-constructivist view as a process based on the individual constructions of meaning which are at the same time results from collective interactions. Therefore, students are active knowledge designers and also participants in a collective learning process. The teacher arranges the learning environment as an initiator of the learning process, which he/she accompanies and observes more or less. Otherwise he/she is a participant of the interactions. Mutual dependence of all the aspects suggest that the development of interest is influenced by the individuals, the learning environment, and the interactive situation.

During an interaction, individuals structure situations consciously or unconsciously according to the acquired cognitive relation schemes and regard the situation from a certain viewpoint. This *definition of the situation* changes in the course of the interaction processes. Standardized and routinized definitions of the situation are called *frames* (Krummheuer 1992, p. 24).

In everyday lessons, a common goal links the teacher and the students, namely studying of math. Therefore students are usually willing to get involved. It can occur that this willingness changes to lower activity when an activity will be refused or the attention focusses on something else. On the other hand it can happen that the activity becomes more intensive or despite disturbances the activity remains intensive. In both cases we observe an *interest-change phenomenon*. However, some of these phenomena cannot be observed in teaching situations because they take place inside a person. For that I use an instrument reflecting those inner processes.

Reconstructing these phenomena, I look for conditions fostering or hindering the unfolding of situational interest.

3. Methodological framework

According to the theoretical framework, I use a triangular design to structure my investigations. An individual and an interactional perspective are considered as additional methodological components. Concerning the object matter of interest, the process of analyses will include a subject-related view as a third perspective.

In order to gain empirically based theoretical components, the process of discovery proceeds “subsumtively” or “abductively” (Kelle 1997 p. 143 ff, Beck/Jungwirth 1999). In the case of “subsumtion” a phenomenon is assigned to a known category (e. g. meaningfulness and involvement). In the case of “Abduktion” (the German term) a phenomenon which is inexplicable by known theories, is picked up. Theoretical knowledge then serves as a basis for the construction of new explanation patterns describing the observed phenomenon.

In accordance to the difference of individual and situational interest, the core data consist of individual and situational data: For nearly half a year, the fraction lessons of a group of students at the age of 11 to 13 were observed and videotaped. Relevant situational data are taken from the video recordings. Transcripts of selected episodes are taken as documents for an interaction analysis. The individual data stem from a one-to-one correspondence of students, who want to become math teachers, with the pupils of this study.

Having identified interest-change phenomena, I reconstruct these phenomena as case studies with the methods of an interaction analysis. This approach involves the interpretative paradigm, i. e. methodological limitation in the research process using the following steps (Krummheuer/Naujok 1999 p. 66 ff, Beck/Maier 1994): transcription and interpretation of the selected episodes, common sense description, extensive interpretation, developing and proving of the interpretation hypotheses, combining the hypotheses of situational and individual data and working out a theoretical structure based on the comparison of similar and different cases.

4. Some data and first results

Up to now, only some interest-change phenomena are reconstructed. Nevertheless, first hypotheses have emerged which indicate that:

- the stimulation of interest is lowered by opposing definitions of the situation and is intensified by corresponding matters of interest.

- the construction of meaningfulness does not come about automatically but must be stimulated.
- exercises with formats that activate algorithmic-mechanical frames (Krummheuer 1992) prevent students from getting deeply involved with constructions of mathematical meaning. The construction of meaningfulness remains superficial.
- particular competition situations generally prevent the students from holding situational interest.

The data I selected confirm the last statement.

4.1. Competition situation

Competition is a rather usual form of learning mathematics in classes. These situations are meant to be especially motivating. But do they foster interest in mathematical objects? (cf. Deci 1992).

Competition must be fair for all participants. Therefore, rules have to be fixed beforehand. Usually the candidates know about the types of competition tasks they have to expect. Often a referee makes sure that the rules are followed during the contest. The primary goal in a competition situation is to win and not to get involved or to increase the knowledge of the task matter except when involvement is part of the task itself.

Rules for a learning situation are rather flexible and they can change during a learning process. Normally the teacher determines the kind of learning tasks the students have to work on.

The following translated transcript shows a competition situation with short-question-routines demonstrating typical conflicts the teacher and the students have.

The students are divided into two teams standing on either side of the teacher´s desk. The teacher allocates the task to the first two candidates. The one who solves it first may sit down, the other one has to go to the end of the line. Tobi and Anti are the next candidates.

1	T	(*rubs his hands*) the ggT (*German term for largest common denominator*) (.) the ggT of 19 and 41 (...) (*looks at Anti, looks up, puts the forefinger at his mouth*) a bit more quiet
2	Tobi	one
3	T	(*looks at Tobi*) right why is it one´ Tobi.
4	Anti	oha (*turns round and goes out of the line*)
5	Tobi	um because 19 is only divisible through itself and one
6	T	exactly and 41 too. (*Tobi goes out of the line.*) what ‚what do we C A L L these numbers 19 and 41´ (*bends down to the left as if he wants to pick up something, comes up again and points at the candidates Kia and Eric with both forefingers at the same time.*)
7		(*Kia, at the left from the T, an some students from the other team are raising their hands, Kia und Eric are the candidates, Lea und Ina are standing behind Eric. Kia raises her hand but Eric does not. The T looks at Kia first, then at Eric and then at*

Kia again.)
8 Kia prime numbers
9 T right (*does a circling movement with his right hand above Kia´s head and looks at her, but Kia does not go out of the line.*)
10 Kia (*doubtfully*) oh should I sit down´
11 T yeah that was it.
12 /Eric sch (*turns*)
13 Lea oh well oh well he didn´t <u>know</u> that
14 /Ss he didn´t know that
15 /Eric I didn´t <u>know</u> that
16 Lea he didn´t <u>know</u> that
17 T (...) that was a <u>question</u> (..)scht
18 (*Eric turns round and goes to the end of the line.*)
19 /Ss that´s <u>mean</u>
20 /Lea that´s <u>mean</u> Mr K
21 (*The protest of the pupils gets louder.*)
22 T no ,a <u>question</u> (....)
(*The pupils all shout out at once.*)

Transcription key

S(s), T	student(s), teacher
<u>exact</u>	emphasized
EXECT	with a loud voice
e x a c t	prolonged
exact.	dropping the voice
exact´	raising the voice
,exact	with a new onset
(.),(..)...	1, 2 ... sec pause
(....)	more than 3sec pause
(*gets up*)	nonverbal activity
/S	interrupts the previous speaker

The teacher defines the situation as a learning situation using the opportunity to repeat the knowledge about prime numbers (3-6). Tobi is the first to give the right answer, so the next question for him cannot simply be another competition task (3-5). From the view of the students, too, the learning process is defining the situation (3-6). As usual in the contest, the teacher looks at the next candidates alternately and points at them. But by raising their hands the students do not regard the next question as a competitive one (6; 7). There are three reasons for that: The task still belongs to the previous learning context, the teacher´s movement (6) gives the task a casual status and the question does not ask for a number as it usually does in this competition, but for a term.

As Kia is allowed to sit down, the students of the other team probably feel at a disadvantage (13-24) and protest vehemently: Obviously the pupils are more concerned with winning the contest than with learning. The teacher however seems to know about the problem with the situation (17, 22), but he gets the upper hand.

From the students´ viewpoint, learning and competition situations are incompatible. Changing the situation must be clearly pointed out to avoid confusion. The teacher regards the whole situation as a learning one; competition just serves as motivation. So the teacher thinks he can change rules during a game but that is not compatible with the role of a referee.

Further transcripts show: If these conflict situations appear frequently, the possibly motivating effect of a competition can decrease, as it is already the case here with students not in the queue any more. Thus the possibly motivating effect of competition:

- can only be kept, if the teacher separates explicitly and clearly the learning from the competition situation.
- concerns only the participants of the contest and
- is primarily concerned with winning the competition.

Competition games must be fair. That means that rules must be precisely fixed. Thereby, it is impossible for students to become immersed in the task, to think deeply about it, to analyse mathematical peculiarities, ... , unless that is part of the task itself.

- Competitions with short question-answers-routines foster at best the interest in competitions or the routine in dealing with mathematical exercises but do not hold the situational interest in mathematical objects, for competition games do not allow the development of meaningfulness and involvement.

Learning situations at school require that there are individual differences among the students. It is even desirable that teachers encourage their students according to their individual differences in various ways. Further transcripts show that special encouragement in a competition situation immediately gives the impression of a lack of fairness, for students demand sticking to the rules. Competitions expecting short-term answers do not permit any personal freedom for students. Therefore, interest in mathematical objects usually cannot be developed in these situations.

4.2. Conclusions

The central criterion to win in the competition situations I´ve investigated so far is the promptness to solve mathematical exercises. It is still uncertain if every kind of competition in math lessons hinders the development of mathematical interest. If, above all, the quality of resolution is the criterion to win a contest, these competition situations may initiate deep, intensive, and meaningful explorations of mathematical issues, so that students might be more likely to develop interest in mathematical objects. The contest character may not always be in the centre of a competition situation in math classes. More research has to show conditions, under which competition situations are likely to foster mathematical interest.

References

Bauer, L. A. Mathematik und Subjekt. Deutscher Universitätsverlag, 1988.

Beck, Ch./Maier, H. Zu Methoden der Textinterpretation in der empirischen mathematikdidaktischen Forschung: Maier, H./Voigt, J. Verstehen und Verständigung. IDM 19, Untersuchungen zum Mathematikunterricht. Aulis Verlag Deubner, Köln, 1994, p. 43–76.

Beck, Ch./Jungwirth, H. Deutungshypothesen in der interpretativen Forschung. Journal für Mathematik-Didaktik, Jg. 20, Heft 4, 2000, p. 28–49.

Bikner-Ahsbahs, A. Mathematikinteresse – eine Studie mit mathematisch interessierten Schülerinnen und Schülern. Verlag Franzbecker, Hildesheim, Berlin, 1999.

Csikszentmihalyi, M. Das Flow-Erlebnis. Klett-Cotta, 1987.

Csikszentmihalyi, M./Schiefele, U. Die Qualität des Erlebens und der Prozeß des Lernens. Zeitschrift f. Pädagogik, 1993, 39, Jg., Nr. 2, p. 207–221.

Deci, E. The Relation of Interest to the Motivation of Behavior. In: Renninger, K. A./Hidi, S./Krapp, A. The Role of Interest in Learning and Development, 1992. p. 44–70.

Deci, E. The Relation of Interest to Motivation and Human Needs –The Self-Determination Theory Viewpoint. In: Hoffmann, L./Krapp, A./Baumert, J. Interest and Learning. Proceedings of the Seeon Conference on Interest and Gender. IPN 164. 1998, p. 146–162.

Hidi, S./ Andersen, V. Situational Interest and Its Impact on Reading and Excpository Writing. In: Renninger, K. A./Hidi, S./Krapp, A. The Role of Interest in Learning and Development. Lawrence Erlbaum Ass. Inc. 1992, p. 43–70.

Hidi, S./Berndorff, D. Stuational Interest and Learning. In: Hoffmann, L./Krapp, A./Baumert, J. Interest and Learning. Proceedings of the Seeon Conference on Interest and Gender. IPN 164. 1998, p. 74–90.

Kelle, U. Empirisch begründete Theoriebildung. Deutscher Studienverlag, Weinheim, 1997.

Krapp, A. Das Interessenkonstrukt. In: A. Krapp/M. Prenzel. Interesse, Lernen, Leistung, Aschendorff Verlag, Münster, 1992, p. 297–329.

Krapp, A. Interesse und intrinsische Lernmotivation: Ein Überblick über neuere Forschungsansätze in der Pädagigischen Psychologie. Kongressbericht der Deutschen Gesellschaft für Psychologie, 1996, p. 270–276.

Krummheuer, G. Lernen mit Format. Deutscher Studienverlag, Weinheim, 1992.

Krummheuer, G./Naujok, N. Grundlagen und Beispiele Interpretativer Unterrichtsfochung. Leske+Budrich, Opladen, 1999.

Krummheuer, G./Voigt, J. Interaktionsanalysen von Mathematikunterricht: Maier, H./Voigt, J. Interpretative Unterrichtsforschung. IDM 17, Aulis Verlag, Köln, 1991, p. 7–32.

Mitchell, M. Situational Interest. Its Multifaceted Structure in the Secondary School Mathematics Classroom. J. of Educ. Psych. Vol. 85, No. 3, 1993, p. 424–436.

Prenzel. M./Drechsel, B. Ein Jahr kaufmännische Erstausbildung: Veränderungen in Lernmotivation und Interesse. Unterrichtswissenschaft. Zeitschrift für Lernforschung. 24 Jg., H. 3, 1996, p. 217–234.

Renninger, K. A. How Might the Development of Individual Interest Contribute to the Conceptualization of Intrinsic Motivation? In: C. Lausone/ J.M. Harackiewicz. Intrinsic and Extrinsic Motivation: the Search for Optimal Motivation and Performance. San Diego CA: Academic Press, 2000.

Renninger, K. A. Individual Interest and Development: Implications for Theory and Practice. In: Renninger, K. A./ Hidi, S. / Krapp, A. Role of Interest in Learning and Development. Lawrence Erlbaum Ass. Inc. 1992, p. 361–395.

Schiefele, U. Individual Interest and Learning – What we Know and What We Don't Know. In: Hoffmann, L./Krapp, A./Baumert, J. Interest and Learning. Proceedings of the Seeon Conference on Interest and Gender. IPN 164. 1998, p. 91–104.

Schiefele, U./Csikszentmihalyi, M. Motivation and Ability as Factors in Mathematics Experience and Achievement. Journal for Research of Mathematics Education 1995, Vol. 26, Nr. 2, p. 163–181.

Voigt, J. Thematic Patterns of Interaktion and Sociomathematical Norms. In: Cobb, P./ Bauersfeld, H. The Emergence of Mathematical Meanings: Interaction in Classroom. Lawrence Erlbaum Ass. Publishers. Hillsdale, New Jersey, 1995, p. 163–201

Wild, K.-P./Krapp, A. Die Qualität subjektiven Erlebens in schulischen und betrieblichen Umwelten: Untersuchungen mit der Erlebensstichprobenmethode. Unterrichtswissenschaft. Zeitschrift f. Lernforschung. 24 Jg., H. 3, 1996, p. 195–216