Investigating Changes in Middle School Students' Motivation Level in Mathematics

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INTRODUCTION

Many teachers report that student motivation to learn mathematics seems to decrease during the middle school years. Some empirical studies confirm that intrinsic motivation for learning decreases during adolescence but the change is most apparent for student's motivation levels in their learning of mathematics (Gottfried, Fleming, & Gottfriend, 2001). Additionally, Pajaras and Graham (1999) indicated that students' motivational factor such as self-efficacy is a decisive variable to predict performance. Such findings call for special attention to understand factors that influence the undesirable adolescents' motivation. Although there is already a long tradition in research regarding motivation and its influence on performance, less is known about what specific variables which motivation depends on.

Lewin (1951) summarized that motivation always depends on two main factors. In his field theory, he adopted the general assumptions of Gestalt psychology for the interpretation of motivated behavior (for further introduction see Graham & Weiner, 1996). Thereby, Lewin suggested that any motivated behavior is determined by both the person (*P*) as well as the environment (*E*) and summarized this assumption with the following mathematical function:

Motivated behavior = $f(P,E)$

Accordingly, it is assumed that an individual and the environment are interdependent as a person always exists in relation to a social context. Consequently, an individual's motivation can refer to his/her own personal aspects (traits, interests, goals, and so on), but could also be influenced decisively by the environment the individual faces with. In an educational context, we are particularly interested in how students' motivation develops and - if it is low - how it can be fostered. However, as the person's aspects are usually stable (e.g. personality traits), it is particularly of interest, which impact the learning environment actually has on students' motivation. Indeed, studies showed that teachers' behavior plays a crucial role for the development of students' motivation (e.g. Sakiz, Pape, & Hoy, 2012). However, as students' personality and motivation is significantly associated (Meford & McGeown, 2012), it is still unclear whether or not the learning environment is still decisive factor for students' motivation besides controlling for students' personality. Thus, the present study focused on examining the relative impact of a students' personality and perceived learning environment on adolescents' motivation in mathematics.

THEORETICAL FRAMEWORK

Types of motivation

Motivation is the study of "why people think and behave as they do" (Graham & Weiner, 1996, p. 63). Motivation is not a "unitary phenomenon" because people have different levels of motivation and different types of motivation (Ryan & Deci, 2000a, p. 54). In Self-Determination Theory (SDT), motivation is distinguished between intrinsic and extrinsic. In the educational domain, intrinsic motivation to learn refers to those learning behaviors accomplished because they are considered to be interesting and enjoyable. Unfortunately, many aspects of education are not inherently interesting or enjoyable and will therefore need other extrinsic reasons (Niemiec & Ryan, 2009). Thus, students are extrinsically motivated to learn if they are driven by an expected outcome (external impetus)

following their learning, for example, receiving an announced reward or trying to avoid punishment (see Ryan & Deci, 2000a).

However, the mere distinction between intrinsic and extrinsic motivation is more complex than a simple separation. As SDT posits, there are various types of extrinsic motivation when thinking about students who are less interested in learning a subject: Some learn with resistance and disinterest while others do so with an inner attitude of willingness (see Ryan & Deci, 2000a). The latter case would reflect a somehow internalized way to motivate oneself to learn. Consequently, SDT presumes four distinct types of extrinsic motivation (see Figure 1) that vary with regard to the degree to which they are perceived to be autonomous (Niemiec & Ryan, 2009) or self-determined.

#Insert figure 1#

On the far left, the motivational state is called amotivation. A student is completely amotivated to learn whenever he/she lacks any intention to attempt to learn. To the right of amotivation the least autonomous type of extrinsic motivation refers to extrinsic regulation. In this state a student attempts to learn in order to satisfy an external demand or receive an externally imposed reward. It has been shown that such behaviors are hardly maintained once the external, controlling consequences have been removed (Vansteenkiste, Ryan & Deci, 2008). The next category of extrinsic motivation is labeled introjected regulation. The introjected state involves the feeling of pressure in order to avoid guilt or anxiety or to attain ego-enhancements or pride (Ryan & Deci, 2000a). Thus, the main reason to learn is to reduce internal pressure such as striving to feel proud or to avoid shame. Extrinsic and introjected regulation of motivation both are assumed to be less autonomous and thus can be considered to be types of *controlled motivation*.

A more self-determined form of extrinsic motivation is regulation through identification. Here, a student has identified with the personal importance of a learning activity (Ryan & Deci, 2000a) because the learning behavior is considered to be valuable or relevant for a life goal such as graduating from a university. The most autonomous category of extrinsic motivation is labeled integrated regulation. Actions characterized by integrated regulation are evaluated and brought into congruence with one's other values and needs and thus are assimilated onto one's self (Ryan & Deci, 2000b). Integrated regulations share many qualities with intrinsic motivation but are still extrinsic because the action is done for its supposed instrumental value and not for the behavior itself (Ryan & Deci, 2000a). Thus, identified as well as integrated regulation of motivation can be considered to be types of *autonomous motivation*.

Many empirical studies in the educational context revealed that more autonomous extrinsic motivation, namely identified and integrated regulation, was associated with higher engagement (Connell & Wellborn, 1991), higher performance (Miserandino, 1996), higher perceived competence and interest (e.g., Black & Deci, 2000; Krapp, 2005) as well as lower dropout (Vallerand & Bissonnette, 1992).

Finally, at the far right of the continuum is the classic state of intrinsic motivation as the prototype of self-determination. Here, as previously discussed, a student intrinsically regulates himself/herself by enjoying the specific task. A student would engage in learning because he/she is highly interested in the learning material. No other (external) reasons would have to be provided. For sure, it would be highly desirable to only have intrinsically motivated students. However, there are always less interesting contents that have to be learned, thus, students will not incessantly be intrinsically motivated for all of their subjects. Various empirical studies revealed, that particularly the motivation for mathematics lacks during adolescence (Kesici, Erdogan, Konya, 2010). Therefore, it is of great interest to investigate in detail, which specific personal and/or contextual factors determine students' motivation in

mathematics in order to derive implications for how to support students' motivation in every day school life.

The impact of personality on students' motivation

For the educational context, the study of Komarraju, Karau, and Schmeck (2009) revealed the decisive role of the Big Five personality traits in predicting college students' academic motivation and achievement. Also, the results of Clark and Schroth (2010) indicated that those who were intrinsically motivated to attend college tended to be extroverted, agreeable, conscientious, and open to new experiences.

The impact of the learning environment on students' motivation

The aforementioned field theory posits that motivation is always a function of internal (person) and external variables (context). Accordingly, in SDT three basic needs (internal) are assumed which have to be satisfied by the social and environmental context (external) before intrinsic motivation can emerge: The need for competence, the need for autonomy, and the need for relatedness (Ryan & Niemiec, 2009). The extent of those needs might vary depending on the person's personality.

The *need for competence* refers to social contextual events that allow the learner to feel competent because he/she can effectively master a scholastic task (Niemiec & Ryan, 2009). If students are able to understand and acquire the relevant skills to succeed at the tasks given in the classroom setting they will feel competent. Therefore, teachers can facilitate their students' perceived competence (self-efficacy) by optimal challenges, effectiveness promoting feedback, and freedom from demeaning evaluations (Ryan & Deci, 2000a).

However, the mere feeling of being competent will not enhance intrinsic motivation unless it is accompanied by a sense of autonomy (Ryan & Deci, 2000b). Thus, learners must also experience their learning behavior as volitional and reflectively self-endorsed (Niemiec & Ryan, 2009) in order to maintain or enhance intrinsic motivation. They have to feel independent from undesired internal or external pressure (Krapp, 2005). Indeed, research

showed that autonomy-supportive teaching practices are associated with positive outcomes in the classroom (e.g. Chirkov & Ryan, 2001). Accordingly, instructors can support the *feeling of autonomy* by giving the learner choices and the opportunity for self-direction. On the contrary, any kind of perceived control (e.g. threats, deadlines, competition pressure) leads to a diminishing effect on intrinsic motivation. Thus, with regard to the quality of their motivation to learn students could benefit from a more autonomy-supportive instruction at school.

Besides the perceived autonomy and competence, a third factor, namely the *need for relatedness*, is crucial for intrinsic motivation. Intrinsic motivation is more likely to flourish in contexts characterized by a sense of security and relatedness (Ryan & Deci, 2000b). Thus, students' willingness to accept the proffered classroom values depends immensely on their perception of being respected and cared for by their teachers (e.g. Ryan, Stiller & Lynch, 1994). Hence, students' learning motivation might also be enhanced by an esteeming learning context characterized by instructors who treat their students with respect and provide group projects with congenial fellow students.

In summary, only people who experience themselves as competent, self-determined, and related to others in a proffered learning context will have the chance to develop intrinsic motivation to learn. Thus, at school, the development of students' intrinsic motivation requires the support of their needs for competence, autonomy, and relatedness, which can be provided by their social agents of the learning context, namely their teachers.

RESEARCH QUESTIONS

The purpose of the study was to provide some empirical evidence for extending the literature emphasizing a humanistic understanding of teaching and learning mathematics at the middle school level within the well-established framework of Self-Determination Theory.

Based on the discussed theoretical background the following three research questions are addressed by the present empirical study:

(1) Which impacts do the students' personality have on their motivation to learn in mathematics?

(2) Which impacts do the perceived learning environment have on students' motivation to learn in mathematics?

(3) Does the perceived learning environment account for students' motivation after controlling for their personality?

METHODOLOGY

Participants and Setting. Prior to the data collection, researchers obtained permission from the principals, class teachers, as well as students' parents. Data were collected in German school settings with a cross-sectional research design. Data were collected by trained university students during regular school lessons and took approximately 90 minutes (two German school lessons).

Instruments. The primary variables measured by researchers included: Motivation and Basic Needs Satisfaction at School and Intelligence Test. Researchers also collected demographic data (e.g. gender, age, migration background, and student current performance in mathematics).

(1) *Student Questionnaire on Motivation and Basic Needs Satisfaction at School*:

Two scales of students' motivation in mathematics: (Autonomous Motivation has 6 items with α=0.85; and Controlled Motivation has 5 items with α=0.63). These scales were adapted from a previously used instrument (Katz, Assor, & Kanat-Maymon, 2008).

Three scales of basic needs satisfaction: This survey was used to assess students' basic psychological need satisfaction (Perceived Autonomy Support has 5 items with α=0.67; Perceived Competence Support has 5 items with α=0.68; and Perceived Relatedness has 5

items with α=0.74). These were adapted from a formerly used instrument by Katz, Kaplan, and Guetta (2010).

(2) Students' Personality test:

With this self-report instrument the participants had to answer four scales regarding students' personality: Extraversion has 12 items with α=0.76; Need for Loneliness has 12 items with α=0.76; Academic Ambition and Valuation of Education has 12 items with α=0.82; and Tendency to Obedience and Dependence towards Adults which has 12 items with α=0.74). These scales were taken from the German personality test for children aged 9-14 by Seitz and Rausche (2004). The selected scales were administered in their original versions to the participants.

DATA SOURCES AND ANALYSIS

The current analysis is based on 239 German middle schools students of which 47.3 % are boys. Data from 57 fifth-graders, 101 seventh-graders, and 80 ninth-graders; these data were collected between May and July 2014. Student participants' average age was about 13.01 years (*SD*= 1.77). About 47.9 % reported that they came from migration background, that is, students and/or parents were from a country other than Germany. Students' estimated performance levels in mathematics were documented as an average grade of about a C (*M*=2.93 in the German school system; *SD* = 0.84). Fifteen percent of the participants stated that they had already repeated a school year.

RESULTS

The first and second research question was answered by regression analyses which considered students' personality and perceived learning environment, respectively, as independent variables predicting students' motivation.

With regard to the first research question, the regression analyses revealed that the personality of the students itself accounts already for 41% of the variance in students' autonomous motivation in math, but only 3% of the variance in students' controlled motivation in mathematics (for detailed results see also model 1 in Table 1 and 2, respectively).

Moreover, the regression analyses concerning the impact of the learning environment on students' motivation (second research question) showed indeed that the perceived learning context significantly accounts for students' autonomous motivation in mathematics, explaining 12% of the variance in the dependent variable. Particularly, the perceived autonomy support seems to be decisive for the development of autonomous motivation in mathematics (Beta=.253; t=2.916; p=.004), whereas the perceived autonomy support (Beta=.085; t=0.910; p=.364) as well as the perceived relatedness (Beta=.043; t=0.518; p=.605) seem to play a minor role. Additionally, the impact of those scales assessing the perceived learning environment on students' controlled motivation in mathematics, was also found to be significant. However, these scales only accounted for 5% of the variance in the dependent variable. In this case, the perceived relatedness seems to be the most important and only significant predictor of the learning context (Beta=-.197; t=-2.281; p=.023), indicating that the lower the perceived relatedness to the mathematics teacher is, the higher is students' controlled motivation to learn for this subject. On the contrary, perceived autonomy support (Beta=.014; t=.140; p=.889) as well as perceived competence support (Beta=-039; t=-.427; p=.669) can be disregarded when explaining the development of students' controlled motivation in mathematics.

For the third research question data were analyzed by blockwise regression analyses, using the four scales of students' personality in the first block to control for it (model 1) and the three scales of perceived learning environment in the second block (model 2). The

dependent variable was students' motivation, namely autonomous and controlled motivation, respectively.

The results of these blockwise regression analyses are presented in table 1 and 2. The first table depicts the findings regarding the prediction of students' autonomous motivation.

#Insert table 1#

Model 1 highlights that students' personality itself accounts for 41% of the variance in students' autonomous motivation. This goes basically back to students' academic ambition and their tendency to obedience. The more ambitious a student is and the more the child tends to obey an adult the higher is students' autonomous motivation. Even though the overall analysis of variance for testing model 2 (perceived learning environment after controlling for students' personality) was significant, none of the considered three predictors was statistically significant. However, the perceived autonomy support as well as the perceived competence support showed a tendency to facilitate the development of autonomous motivation in students.

Insert table 2#

In contrast, personality seems to have a much lower impact on students' controlled motivation (table 2). It only accounts for 3% of the variance in this dependent variable, mainly explained by students need for loneliness. The remaining three personality predictors were not significant. However, the overall analysis of variance for testing model 2 (perceived learning environment after controlling for students' personality) was significant and added 5% of explained variance in students' controlled motivation. Particularly, if students feel less related to their teachers they tend to develop a higher controlled motivation.

DISCUSSION AND IMPLICATIONS

The present empirical study aimed at investigating which particular personal as well as contextual factors are decisive for students' motivation in mathematics. Basing on SDT, two types of motivation were distinguished: autonomous motivation and controlled motivation, respectively. Both of these dependent variables could be explained by students' personality as well as students' perceived learning context. For autonomous motivation, students' personality seems to be much more important than the perceived learning context. In line with the findings of (Medford & McGeown, 2012). However, in contrast to Clark and Schroth (2010) students' extraversion was not significantly associated with the autonomous motivation to learn.

IMPLICATIONS AND FUTURE RESEARCH

For controlled motivation, students' personality does not account much for the variance; only 3% of the variance can be explained by students' extraversion, academic ambition, need for loneliness, and tendency to obedience. The results from the study revealed some evident on other factors that influence motivation. Although, the present study have not explore influences of parents on educational style, aspirations, other research indicated that parents play a role (Gonzalez-Dehass, Willems, Holbein, 2005). For instance, Gonzalez-Dehass, Willems, and Holbein (2005) revealed that parents could influence students motivation in terms of their engagement, their perceived of competence, perceived of control, self-regulation, mastery goal orientation Thus, in future studies the perceived learning context at home should also be assessed in the student questionnaire. Furthermore, asking parents about their educational methods and aspirations for their children might bring an additional insight into the explanation of students' motivation, different agents of the social context, not only teachers, but also parents, peers, and so on.

This study finding corroborated with the assumptions of SDT: autonomous motivation is mainly predicted by autonomy support and competence support; controlled motivation goes back to relatedness. This study is not only a self-reported data for motivation and learning environment; it is rather the perception of the students than the actual instruction of the teacher that was assessed. Future research may consider adding other observational instruments or teacher questionnaires. A bigger sample size is necessary in order to make some generalization of the results. Also, future research studies should look into international comparative studies (e.g. intercultural research) needed before generalizing the findings, as this might be only particularly true for German students.

At first glance, the relative low impact of the perceived learning context might look disillusioned. However, it is not possible to change anything on students' personality traits as they are assumed to be stable and instruction might have to be assimilated to students' personality; Personality has to be taken into account when preparing lessons. Thus, even though the perceived learning context seems to play a minor role for autonomous motivation, this is the option which teachers have an influence on.

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