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Review Article

Giftedness, Gender and Motivation – The Impact of Mathematics Self-Efficacy, Interest and Attitudes as Determinants to Identify Mathematical Giftedness

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Abstract: A widespread but internationally inconsistent phenomenon is the underrepresentation of girls in programs aimed at supporting mathematical giftedness from primary-school age. It contradicts the consensus that girls and boys have equal potentials independent of certain domains. According to current giftedness models that emphasize the significance of both cognitive and co-cognitive parameters, motivational constructs are one important factor to consider in the context of identification and support. For instance, existing studies indicate that girls and boys who were identified as being mathematically gifted, as well as boys who were not, often show more advantageous mathematical self-concepts and attributions than girls who were not identified as such. The obvious question is whether such empirical indicators can also be found in similar motivational constructs, since altogether they might provide deeper indications of the significance of motivational factors as determinants to identify mathematical giftedness from a gender perspective. This article investigates this question by focusing on mathematics self-efficacy, interest and attitudes in a quantitative cross-sectional questionnaire study with children at primary-school age. It did so by comparing frequent characteristics of four groups: boys and girls identified as being mathematically gifted, as well as boys and girls who were not. Against the background of available findings on other motivational factors as well as various research results on self-efficacy, interest, and attitudes, the hypotheses were obvious that girls and boys who were identified as being mathematically gifted, as well as boys who were not, often show more advantageous mathematics self-efficacy, interest, and attitudes than girls who were not identified as such. Summarized, the study's results confirm these hypotheses in principle. Thus, the findings can help to explain the phenomenon of the rare identification of girls' mathematical giftedness, because teachers, for example, might perceive boys' potentials primarily. As a consequence, the development of advantageous characteristics of mathematics self-efficacy, interests and attitudes independent of questions as to the identification of mathematical giftedness seems to be important especially with girls.

Keywords: Mathematical Giftedness, Gender, Self-Efficacy, Interest, Attitudes, Motivation

1. Introduction and Rationale

In Western and Northern Europe, in North America, Australia, Africa and in a few Asian countries, girls and women are usually underrepresented in both the educational and occupational areas of the "STEM"-sector. In contrast, in Eastern European and many Arab countries, similar statistics are mostly either more balanced or occasionally even dominated by females [1-3]. In Germany (and similarly in other countries of the first mentioned group; [4]), the phenomenon of girls' underrepresentation can already be observed with schoolchildren who take part from a very early age in programs aimed at supporting mathematical giftedness (in this article, referred to by the acronym "mg") [5]. It contradicts the interdisciplinary consensus that both sexes have equal potentials across all academic domains [6-7], and its investigation is highly relevant especially against the background of research on facets of diversity [8-9]. The older the children are, the stronger might be gender-specific stereotyping of mathematics as a possible explanation. But, when it comes to younger children, such aspects seem to be of rather little importance; this assumption seems to be confirmed by the fact that the findings of international comparative studies are inconsistent as to gender-specific differences in achievement, even if boys usually tend to higher achievements in mathematics in the "OECD"-countries [10-11].

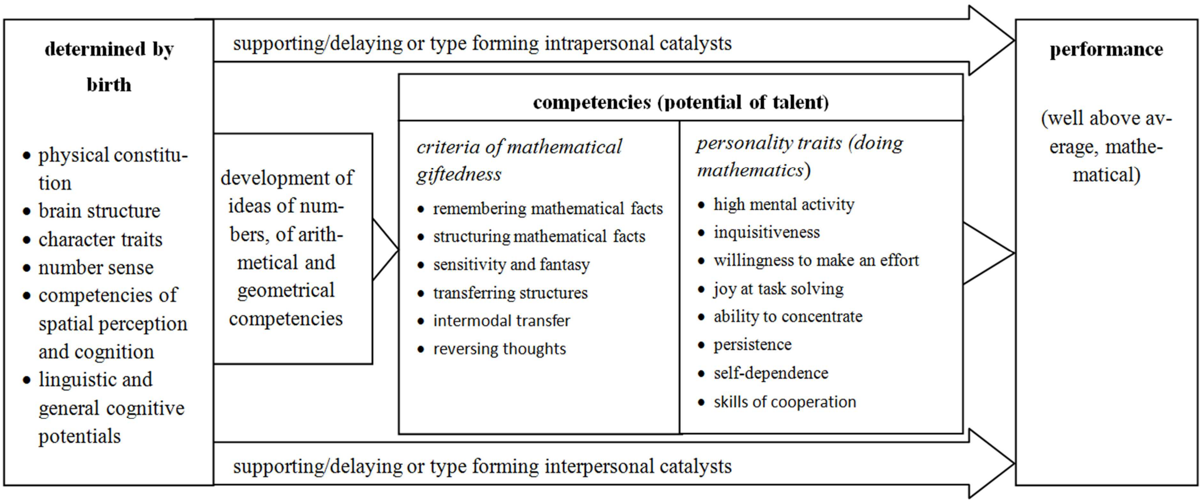

Figure 1. *The model of Fuchs and Käpnick [19], simplified and translated by the author [32].*

Moreover, studies have reported for many years a decline of gender-specific differences in math ematical competencies, while there cannot be found any differences with children at primary school [12-14].[1] This is why it is interesting to look for aspects (irrespective of their origin, e.g., effected by gender-stereotyped affirmations) that improve the identification and support of girls' mg from early primary-school age. There is an abundance of research findings regarding such aspects in Mathematics Education and different disciplines such as psychology, biology and theories of socialization. Because of this variety, it is necessary to avoid one-sided perspectives, but rather to take complex and interdisciplinary influences into account. Therefore, with a holistic approach, diagnostics should be organized as a process considering both cognitive and co-cognitive parameters as determinants to identify mathematically gifted children (see also Figure 1 which is elucidated in section 2.) [18-19], and motivational factors are reputed to be one of the most important perspectives to explain gender-specific phenomena in mathematics [20]. For instance, when it comes to the significance of motivational constructs as determinants to identify mg, existing quantitative cross-section studies indicate that girls and boys who were identified as being mathematically gifted, as well as boys who were not, often show more advantageous[2] mathematical self-concepts and attributions than girls who were not identified as such [15]. Additionally, there seem to be strong impacts of giftedness-identification on the emergence of advantageous motivational factors in particular with girls, which is indicated by a qualitative-exploratory study that focused on the significance of motivational factors in the development of mg [17]. In summary, the interdependence of the findings mentioned make it relevant to study the significance of motivational constructs more comprehensively. Beyond aspects associated with the development of giftedness, the obvious question is whether the empirical indicators of mathematical self-concepts and attributions can also be found in similar motivational constructs, since altogether they might provide deeper indications of the significance of motivational factors as determinants to identify mg from a gender perspective.

This article will investigate this question by focusing on mathematics self-efficacy ("mse"), interest ("mi"), and attitudes ("ma") in a quantitative cross-sectional questionnaire study with children at primary-school age. It therefore provides a follow-up study to the author's previous investigations [15, 17]. Its aim is to investigate the frequent characteristics of the factors focused on among boys and girls through a comparison of four groups: boys and girls identified as being mathematically gifted ("img"), and boys and girls who were not ("n-img"). First, a theoretical framework of mg and corresponding diagnostic procedures will be outlined, in particular to illustrate the selection of children named as "img". Second, the theoretical frameworks of the motivational factors observed will be built, and their significance regarding possible gender-specific impacts on the identification of mg will be specified. Based on surveys of existing empirical evidence, the hypotheses in question will be deduced. Third, the study's design will be outlined. Finally, against the background of the indicators outlined by

[1]The argumentation in this section mainly corresponds to previous work of the author [15–17]. The study presented in this article is a follow-up to these investigations, and the embedding will be outlined at the end of this section.

[2]Motivational constructs have to be seen as having strong interdependencies with internal influences such as expectations of success and affective aspects, and with interpersonal, environmental factors. It can be assumed that the holistic complex of all catalysts has an impact on an individual's behavior in the sense of an expectancy-value-conception [21]. In this article, motivational constructs are designated "advantageous", if it can be assumed that their characteristics cause positive effects on the complex previously mentioned. Otherwise, they are designated "disadvantageous".

previous work of the author [15, 17], the findings will be reported and discussed.

2. Outline of the Theoretical Framework Dealing with Mathematical Giftedness[3]

Since the phenomenon of exceptional mathematical abilities, potentials or achievements is to be seen as a relatively diffuse complex regarding its terms or models, it demands a fundamental positioning [23-24]. Lucito has already defined the categories of "ex post facto", "IQ", "social", "percentage", and "creativity", which are still valid in principle today [25-26]. Usually, models that try to describe the phenomenon by accentuating achievements are based on IQ definitions, while models emphasizing potentials are based on social definitions; the other definitions are rarely used. The current state of research is reflected by models that separate an individual's potential from his or her achievements, particularly since underachievement can be explained. Instead of focusing on individual performances (often referred to by the term "talent"), this article will follow Gagné and refer to the phenomenon of exceptional abilities with the term "giftedness", which focuses on the potentials of individuals [27]. Beyond terminology, current educational approaches are at least agreed when it comes to the following issues [28]. First, the phenomenon is complex, and it demands that attention be paid to both cognitive and co-cognitive intra- and interpersonal determinants. Second, it occurs domain-specifically – for example, the criteria of mg have been identified (exceptional abilities to remember mathematical facts, to structure mathematical patterns, to transfer structures, to change intermodal representations autonomously, or to reverse thoughts, as well as sensitivity, originality and fantasy regarding mathematical phenomena, relations or aesthetics [29-31]). Third, gifted children should be identified and fostered as early as possible to support the emergence of their potentials. As a consequence, the complex of all aspects represents a dynamic phenomenon that demands a holistic view of individual personalities, and therefore complex long-term process diagnostics as a synthesis of different procedures.

The approach of Fuchs and Käpnick shown in Figure 1 provides a representative example of concurrent modeling considering the consensus mentioned [19, 33–36]. The model describes the development of mg at primary-school age; it includes at its center a system of criteria that operationalizes mg with children in the third and fourth grade [30]. Therefore, according to those criteria, mg is an individual potential that is well above average, and that is characterized by a dynamic development that depends on inter- and intrapersonal influences in interdependence with supporting personality traits [32]. In this article, children who are named "img" took part in an enrichment project at the University of Münster called "Mathe für kleine Asse" ("Math for small aces") [37]. The theoretical framework of both the project and the study presented in this article is constituted by the model shown in Figure 1. Therefore, diagnostics are organized as a long-term process consisting of different steps: As a first step, at the beginning of the third grade, teachers of schools select children according to criteria mentioned. In a second step, children visit the project to gain first impressions about its organization and atmosphere. In a third step, children who decide to take part have to take an introductory test that is organized as a competition and that consists of "indicator tasks" which operationalize the criteria of mg. At the same time, this is the first facet in long-term process diagnostics that continue for as long as the children participate in the project and consider both cognitive and co-cognitive parameters. Beyond (half-) standardized tools like the introductory test or amending "IQ"-tests, it was mostly non-standardized tools such as observations of children's task-solving using rating sheets, interpretations of the transcripts of video documentations, or guided interviews with children, as well as their parents and teachers, that were used. In this manner, an impression of a child's individual mg gradually emerges [32]. Children who are named "n-img" have not progressed through similar procedures.

3. Theoretical Backgrounds[4]

Research on the motivational factors investigated mostly focuses on gender-specific differences without considering aspects of giftedness. Additionally, existing studies in the context of exceptional abilities mostly refer to "giftedness" as a "general-factor-concept" focusing on the construct of intelligence, and implying performance-related standardized ("IQ"-) diagnostics.[5] Collectively, the findings indicate the significance of the constructs investigated as determinants for identifying girls' potentials in principle, but they cannot be transferred automatically to the complex of mg; however, they are able to provide a basis for the intended deduction of hypotheses.

3.1. Mathematics Self-Efficacy (MSE)

Self-efficacy refers to "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" [38, p. 3]. It emerges from experiences with tasks that were successfully completed

[3] For this overview of approaches to giftedness, see also the previous work of the author [15–17]. More detailed reasons for disagreeing with the psychodiagnostic concept of a cross-domain "giftedness" are also discussed, for example, by Käpnick and Benölken [22].

[4] For descriptions of theoretical frameworks developed for interest in and attitudes to mathematics, and for the corresponding literature reviews, see also the author's previous work [15–16, 18]; all argumentations were revised and more recent findings were considered.

[5] Unless otherwise stated, the description of probands as "gifted" in the literature reviews is based on such diagnostics procedures. Probands who are named "non-gifted" either did not achieve at a high level (about 130) in an "IQ"-Test, or they were not assessed by psycho-diagnostic procedures, i.e., these probands are children from ordinary classes.

before, from vicarious experiences (for example, by comparing the skills of a different person to his or her own capabilities in a certain situation), from feedback, or from an individual's physiological or affective conditions. The dimensions of self-efficacy are distinguished according to outcome expectations which focus on an individual belief that behavior will result in a certain outcome, and efficacy expectations which focus on an individual's belief that he or she can perform a certain behavior successfully or not [38]. The concept of mse used in the study refers to Bandura's classical concept, which is a customary practice in empirical studies [39].

Self-efficacy is seen as one of the most important components of motivation, and it can be distinguished clearly from different facets, in particular from self-concepts: self-efficacy is conceptualized much more specifically, and it is interpreted as being domain-related, subject-related or even task-related [39]. Studies indicate that self-efficacy influences school achievements; for example, advantageous characteristics are usually connected to high achievements, a higher level of goal orientation, advantageous learning strategies, and sustainable self-regulated learning [40–41]. Additionally, self-efficacy has to be seen as having reciprocal interdependencies with different motivational factors [42], especially in mathematics [43]. In summary, self-efficacy can be interpreted as an important catalyst for achievement-related choices [21], and it seems to be a strong predictor of girls' and women's achievement in particular [44]. Its characteristics are reputed to be an important explanation as to the choice of occupations in the STEM-area [45].

Beyond differences in self-efficacy related to the socio-cultural or socio-economic background [46], gender-specific differences in single aspects closely connected to self-efficacy have been found: older studies indicated that girls tend to feel less competent in mathematics than boys from early primary-school age, while boys tend to overestimate, and girls to underestimate, their mathematical abilities [47–48]. Studies have long shown that girls in general have less confidence in their mathematical abilities than boys [49–50]; the differences become more and more apparent with increasing age [51]. With regard to the specific construct of self-efficacy, boys have long tended to more advantageous characteristics than girls [52]. Even if this observation has not been consistent in recent years regarding the entire complex of STEM-disciplines [53], with girls often showing more advantageous characteristics than boys in writing [54], many studies indicate that girls still show more often than boys low characteristics of mse [55–58]. Gifted children usually show a higher level of confidence of success and a stronger conviction that they will achieve their goals through effort than non-gifted children [59]. At the same time, studies indicate that gifted girls tend to a lower level of both proactive self-regulation and success orientation than gifted boys, but gender-specific differences as to the specific construct of self-efficacy cannot be observed in general with gifted children [59–60], and gifted girls show just slightly lower characteristics than gifted boys [59, 61].

In summary, based on the analysis of existing empirical evidence, and in accordance with findings on different motivational components, the following hypothesis can be deduced: img girls and boys as well as n-img boys show a more advantageous mse than n-img girls (hypothesis 1).

3.2. Mathematics Interest (MI)

In contrast to approaches that describe interest as a stable personal disposition [62], this study uses the concept developed by Prenzel, Krapp and Schiefele [63]; thus, interest is seen as the result of an interaction between a person and an object. This approach distinguishes between a temporary interest emerging from environmental influences without long-term effects (called "situational interest"), and a permanent interest that is characterized by long-term preoccupations with a specific object (called "individual interest"); additional conditions such as taking part in challenging programs like "Mathe für kleine Asse" might support development from situational to individual interest. It is characterized by (1) value-related, (2) affective, and (3) cognitive components [64]. Among the described framework, the concept of mi used in this study considers current approaches to a multidimensional structure, i.e., a distinction between subject-, context- and topic-related interest [65]. The dimensions of subject- and context-related interest were conflated in the term "mi inside the classroom", since primary-school children cannot be expected to differ between activities and contexts applied in classrooms [66]. Topic-related interest is covered by the term "mi outside the classroom".

Approaches to Mathematics Education usually refer to the person-object-concept of interest [67], and emphasize the significance of an individual's support to the emergence of mi [68]. Regarding the identification of mg, and against the background of approaches describing giftedness as a holistic developmental complex, mi can be seen as a catalyst of great importance, since studies indicate its complex interdependencies with different motivational factors and its substantial influence on learning and achievements [66].

Both boys and girls prefer gender-stereotyped activities (as well as toys) from an early age, which induces gender-stereotyped behavior as to occupational decisions [69]. As many findings show, primary-school children often have a lot of interests like sports, TV, computer games, meeting friends, and reading [70]. Gender-specific differences can already be found from this early age [71–72]: for instance, horse-riding, animals and reading are said to be "typical" interests of girls; football, technology and computers, "typical" interests of boys [73–74]. From primary-school age, boys more often show stronger mi both inside and outside the classroom (which in principle is valid for the entire "STEM"-sector [57]), while girls are interested in language and literature [66, 70, 75-77]. The interests of gifted children are not more pronounced than those of non-gifted children, even if the former seem to be more interested in research questions and academic subjects like mathematics, languages and literature, and the same gender-specific differences can be observed [70, 78]. Additionally, gifted children tend to neglect gender stereotyping of certain domains [79], and gifted girls have both more interests that are supposed to be "typical" interests of boys, and a larger spectrum of interests than gifted boys [80, 15]. As to the distinction between dimensions of interest, the majority of primary-school children do not differ between mi inside and outside the classroom [66]. However, current studies do not focus on aspects specific to gender or giftedness considering the distinction between dimensions of interest. There are only a very few studies with a focus on different levels of abilities, achievements or respective developments with regard to mi; the results of these studies provide evidence that pupils at a comparatively low level of achievement express a greater interest in mathematics than pupils at a high level of achievement [81], but these studies do not focus on "giftedness". An often reported phenomenon is the decline of mi during adolescence and a decline of respective gender-specific differences [82].

In summary, the following hypotheses can be deduced: img girls and boys as well as n-img boys show a stronger mi inside the classroom than n-img girls (hypothesis 2a); img girls and boys as well as n-img boys show a stronger mi outside the classroom than n-img girls (hypothesis 2b).

3.3. Mathematics Attitudes (MA)

When it comes to explaining an individual's behavior, social-psychological approaches attach particular importance to the construct of "attitudes". This construct focuses on an evaluation of an object that an individual imagines or perceives in his or her environment. If an individual has developed attitudes towards an object, then these attitudes can be explicitly and consciously accessed, or they can emerge implicitly and spontaneously, and influence the individual's behavior [83]. Thus, attitudes provide a connection between an object and an individual's reaction: attitudes serve the purposes of cognitive activities such as processing information [84], instrumental activities such as striving for positive action outcomes, and social activities such as identifying with specific objects, as well as helping to preserve self-esteem [85]. In general, the attitudes of an individual are not necessarily coherent with his or her behavior [86], but usually such coherences can be assumed when a specific object is focused on [87]. The emergence of attitudes is mostly ascribed to experiences, and in particular to such experiences as learning from role models or conditioning processes [88]. The concept of ma used in the study refers to a classical operationalization consisting of the following components: (1) cognitive, (2) affective and value-related, and (3) behavior-related. This concept represents a broad consensus of social-psychological approaches [89].[6]

When it comes to identifying mg among girls, the construct of ma might play an important role, since it influences an individual's behavior based on experiences, which are assumed to be important determinants in achievement-related choices in general, embedded in interdependencies with other motivational factors and with social stereotyping [21]. In particular, studies indicate the existence of reciprocal relations between ma and achievements [90]. Thus, disadvantageous characteristics of ma might be an essential factor in the tendency of girls to be less frequently interested in mathematics than boys.

Overall, boys show advantageous ma more often than girls [56, 91], for example regarding the attractiveness of the subject [92]. As to the cognitive component, studies focus primarily on how individuals assess the usefulness and difficulty of mathematics. Occupational choices are influenced by the assessment of the usefulness of mathematics [93], but in particular girls tend to ascribe a lower level of usefulness to mathematics [92, 81]. As to the assessment of difficulty of mathematics, the impressions are not entirely clear, because some studies did not find any differences specific to gender or giftedness between img and n-img children [18], but other studies indicated that mathematically gifted boys and girls, as well as non-gifted boys, ascribe a lower level of difficulty to mathematics than non-gifted girls [94]. Some findings show gender stereotypes, since girls are more likely to associate mathematics with males the older they become [95-96]. Recent studies indicate that this might also apply to younger children, and there might be interdependencies with the development of motivational factors [97], but this complex topic still seems to require deeper explorations with primary-school children. As to the affective component, the intrinsic values given to mathematics by girls are lower than the values given by boys [11, 98]. In contrast, some studies indicated that mathematically gifted boys and girls, as well as non-gifted boys, give a higher intrinsic value to mathematics than non-gifted girls [94]. A further phenomenon in this context touches on the multilayered complex of anxiety with regard to mathematics: Such anxiety was observed above all from the middle-school age. More recently, studies have focused on the primary-school age, where anxiety regarding mathematics is seen as reciprocal with achievements and independent of age [99]. Usually, female pupils tend to show higher levels of anxiety when it comes to mathematics than male pupils [100]. But there is still overall a desideratum in terms of anxiety regarding mathematics at the primary-school age, and initial studies have not found gender-specific differences [101]. As far as the behavior-related component is concerned, boys obviously do mathematics outside school lessons more often than girls [102].

Against the background of the different components of ma, and as an analogy to both the results on other motivational factors and the hypotheses 1, 2a and 2b, the following summarizing hypothesis can be deduced: img girls and boys, as well as n-img boys, show more advantageous ma than n-img girls (hypothesis 3).

[6]While "beliefs" are regarded as a construct that is difficult to operationalize, a basis has been chosen here with reference to the classical attitude model that allows a clear component assignment [54].

4. The Study

The study was designed to answer the question of how mse, mi and ma can be characterized with regard to img girls and boys, as well as to n-img girls and boys. Comparing the groups will facilitate a discussion of how significant the motivational constructs are as determinants for identifying mg, and in particular with regard to girls.

4.1. Questions

In summary, the following hypotheses were deduced:

Hypothesis 1: img girls and boys as well as n-img boys show a more advantageous mse than n-img girls.

Hypothesis 2a: img girls and boys as well as n-img boys show a stronger mi inside the classroom than n-img girls.

Hypothesis 2b: img girls and boys as well as n-img boys show a stronger mi outside the classroom than n-img girls.

Hypothesis 3: img girls and boys as well as n-img boys show more advantageous ma than n-img girls.

4.2. Design

The study adds to previous research on the significance of motivational factors as determinants for identifying mg using questionnaires that are appropriate to primary-school children, and that can be completed within a short time [18, 15]. Operationalizations of all the motivational constructs were tested in pilot studies.[7] The benefit of using a quantitative design was obvious, since previous studies on the motivational factors had been exploratory [18]; the present study follows a preceding study of the author on mathematical self-concepts and attributions [15], and adopts a comparative approach to broaden and deepen impressions on the motivational characteristics of boys and girls. Despite the quantitative design, though, the study is still rather exploratory, since established tools to measure motivational characteristics were not used out of consideration for the children's lower ages (see 4.2.2.).

4.2.1. Sample and Procedure

The sample contains N=336 children in the third and fourth grade (167 girls, 189 boys). The subsample of img children is n=172 (66 girls, 106 boys). Children assessed as "img" had taken part in "Mathe für kleine Asse" for at least one school year, i.e., they are named as "img" as a result of long-term process diagnostics (see 2.). The sample contains n=164 primary-school children (80 girls, 84 boys) from schools in the cities of Münster and Bremen. These probands are described as "n-img", since no diagnostics of their mg similar to the group named "img" were conducted. Thus, the groups of img and n-img children are independent of each other. All n-img children were questioned at the end of the school year of 2014/2015, but the img children were questioned at the end of the school years of 2014/2015, 2015/2016 and 2016/2017; no child refused to fill in the questionnaire. An overview of the sample is given in Table 1.

***Table 1.** Overview of the sample.*

group	boys	girls	total
img	106	66	172
n-img	84	80	164
total	190	146	336

img = identified as being mathematically gifted; n-img = not identified as being mathematically gifted

At the beginning of each school year, the parents of the children taking part in "Mathe für kleine Asse" gave their written consent to their children's participation in the research project. At the schools, the study was approved by the principals in collaboration with the parents. Questioning within "Mathe für kleine Asse" was organized by the author in all cases, and questioning in the schools was organized mostly by the author, but in two classes it was organized by a person who had been briefed in all the details beforehand. All procedures governing the questioning were consistent: after being informed on how to complete the questionnaire, the children were asked to answer the questionnaire independently and honestly. In particular, a fictional example was developed with the children, which is structurally comparable to the scales of the questionnaire, and possible differences between mathematics interest inside and outside the classroom were explained.[8] The children completed the questionnaire without any time limit (no one took more than 15 minutes).

4.2.2. Method

Apart from showing gender[9], the questionnaire was anonymized. All inputs and items were framed in a closed form. The phrasing of all items follows both the respective theoretical framework (see 3.) and common styles used in existing studies (the original phrasing was formulated in German):

To measure mse, the established scale of Jerusalem and Satow regarding school-related self-efficacy was adapted [104], and its items were related to mathematics using a phrasing that seemed appropriate to primary-school children. The following inputs were presented: "Mark with a cross a

[7] The pilot studies were conducted during the school year of 2013/2014 [103]. The initial impressions of the very first questioning in the school year of 2014/2015 are discussed by a summarizing proceedings paper of the author [16].

[8] As to the distinction between the interest dimensions, the questionnaire instructions contained the following elucidation (translated from German): "I would like to know how you like mathematics inside and outside the classroom. 'Mathematics inside the classroom' focuses on everything you do in mathematics lessons at school. 'Mathematics outside the classroom' focuses on, for example, mathematical activities or themes in your life beyond mathematics lessons at school or even outside school."

[9] As to the distinction of "gender" and "sex", the English language is more precise than the German. "Gender" describes a socializing construction, but "sex" a biological determination [69]. In the German language, the term "Geschlecht" can comprise both dimensions. Although this article assumes a sociolizatory view in the sense of "gender" in principle, no explanations beyond a biologistic bipolarity were found in the questionnaires' statements. Therefore, the term "sex" will be used to describe the factors within the methodology- and result-related sections, since it is able to underline the subsamples' independence.

statement that you think best fits you: (1) I can always manage to solve difficult mathematical tasks if I try hard enough. (2) It is easy for me to understand new matters in mathematics lessons. (3) If I am asked to solve a difficult mathematical task on the blackboard, I am convinced that I can usually find a solution. (4) Even if I am ill for some time, I can cope well with mathematics. (5) If new mathematical matters are explained very fast, I am not able to understand everything. (6) Even if my mathematics teacher does not believe in my mathematical skills, I am convinced that I can cope well with mathematics. (7) Even if I had a bad mark in mathematics, I am sure that I will achieve a better mark soon."

To measure mi inside the classroom from a value-related, an affective and a cognitive aspect, established items were adapted [66, 105]. The following instruction was given: "This is about mathematics inside the classroom. Mark with a cross the statement that you think best fits you: (1) Mathematics inside the classroom is really important to me. (2) I always look forward to mathematics inside the classroom. (3) I am interested in mathematics inside the classroom." An analog input was presented on mi outside the classroom: "This is about mathematics outside the classroom. Mark with a cross a statement that you think best fits you: (1) Mathematics outside the classroom is really important to me. (2) I always look forward to doing mathematics outside the classroom. (3) I am interested in mathematics outside the classroom."

To measure ma according to cognitive, affective and behavior-related aspects, established items were adapted as well [105-106]. The following instruction was given: "Mark with a cross the statement that you think best fits you: (1) Mathematical tasks are sometimes too difficult. (2) I enjoy doing mathematics. (3) I engage in mathematics beyond mathematics lessons at school."

To evaluate the items, a four-step Likert-scale was offered in each case ("that's not correct", "that's almost not correct", "that's almost correct", "that's correct"; or the children could choose "I don't know").

4.2.3. Evaluation[10]

Statements about all items except the fifth mse item and the first ma item were translated into numbers from 1 ("that's not correct") to 4 ("that's correct"). Regarding the two remaining items, the assignment was turned around: for instance, "that's not correct" was translated into 4, and "that's correct" into 1, since such assessments reflect advantageous characteristics in those cases. As to the mse-scale, the correlation coefficient as defined by Pearson between the items moves in a range from. 308 to. 551 (with $p<.01$ in each case), and the internal consistency is good (Cronbachs α=.840). Regarding the items of the mi-inside-the-classroom scale, the Pearson coefficient is between. 403 and. 523 (with $p<.01$ in each case), and the internal consistency is acceptable (Cronbachs α=.705). As to the mi-outside-the-classroom scale, the Pearson coefficient between the items is in a range from. 470 to. 569 (with $p<.01$ in each case), and the internal consistency is acceptable (Cronbachs α=.764). Finally, the Pearson coefficient between the ma items ranges from. 422 to. 637 (with $p<.01$ in each case), and the internal consistency is acceptable (Cronbachs α=.738). Because the internal consistencies are at least acceptable, the items have been combined to one scale as mean values from the individual items in each case. Data have been evaluated by analyzing variance with the factors "giftedness" and "sex" to find significant deviations between the mean values of the four groups. Additionally, η^2-values have been calculated to assess the explanatory force of both the factors and their interaction by their effect sizes.[11] The prerequisites for the variance analysis are the independence of the sample groups and the normal distribution of the characteristic observed in the groups under the homogeneity of the variances [108]. The independence of the subsamples is guaranteed by the distinction between both the identification of giftedness and sex (see 4.2.1.). A graphical analysis of the distribution histograms as well as the corresponding quantile-quantile plots led to the judgment that the data are sufficiently similar to a normal distribution (on this procedure, see, for example, the remarks of Hatzinger and Nagel [109]). The requirement of variance homogeneity is statistically firm as a result of Levene testings [108]. Thus, the requirements are sufficiently fulfilled.

5. Results

5.1. Mathematics Self-Efficacy (MSE)

Table 2 presents the averages and standard deviations calculated on the basis of the scale composed for mse.

Table 2. *Averages (standard deviations) of mse statements.*

group	boys	girls	total
img	3.59 (39) n=106	3.51 (42) n=66	172
n-img	3.43 (48) n=84	2.79 (45) n=80	164
total	190	146	336

img = identified as being mathematically gifted; n-img = not identified as being mathematically gifted

The averages of img boys, img girls and n-img boys are similar, while the value of n-img girls is clearly lower (Table 2). Statistical evaluation shows both a significant main effect on giftedness (F (1,332) =82.194, $p<.001$, η^2=.198) and a significant main effect on sex (F (1,332) =56.259, $p<.001$, η^2=145), as well as a significant effect of interaction between giftedness and sex (F (1,332) =34.387, $p<.001$, η^2=.094).[12] As to the explanatory force, the η^2-values indicate that both

[10]The statistical evaluation was conducted by IMB SPSS Statistics 24 (2016).

[11]A value of $\eta^2<0.06$ means a small effect, of $\eta^2<0.14$ a medium effect, and of $\eta^2\geq0.14$ a strong effect [107].

[12]As to the interaction effects, an analysis of the corresponding profile charts indicates an ordinal interaction, since the mean value line profiles do not cross and show the same tendency. Thus, the main effects on both giftedness and sex can be interpreted.

the strong effect of giftedness of 19.8% and of sex of 14.5% play a similar role in explaining variance, even though the giftedness effect is stronger. The interaction of the factors shows a medium effect of 9.4%. Thus, the mse of img children is on average more advantageous than that of n-img children, but n-img boys are more similar to img girls and boys than to n-img girls, who show more disadvantageous characteristics of mse than all other groups. Therefore, the statistical evaluation confirms hypothesis 1.

5.2. Mathematics Interest (MI)

5.2.1. Inside the Classroom

Table 3 shows the averages and standard deviations of mi inside the classroom.

Table 3. *Averages (standard deviations) of mi inside the classroom statements.*

group	boys	girls	total
img	3.22 (65) n=106	3.01 (70) n=66	172
n-img	3.37 (59) n=84	2.78 (55) n=80	164
total	190	146	336

img = identified as being mathematically gifted; n-img = not identified as being mathematically gifted

The mean values of the boys' groups are relatively similar, and the value of img girls is slightly lower. The value of n-img girls is clearly lower than all other groups (Table 3). There is a significant main effect on sex (F (1,332) =33.028, p<.001, η^2=.090), but there is no significant main effect on giftedness (F (1,332) =.277, p=.599, η^2=.001). Additionally, the statistical evaluation shows a significant effect of interaction between giftedness and sex (F (1,332) = 7.587, p=.006, η^2=.022). Considering the η^2-values calculated, sex with a medium effect of 9% plays a more important role in explaining variance than the interaction between giftedness and sex with a small effect of 2.2%. Thus, independent of the identification of giftedness, boys tend to show a larger mi inside the classroom than the girls' groups on average. The img girls seem to take an intermediate position, but, as indicated by the significant effect of interaction, the characteristics of img girls seem to be more similar to the boys' groups than to the n-img girls, who show a lower mi inside the classroom than all other groups. Hence, the statistical evaluation confirms hypothesis 2a in principle.

5.2.2. Outside the Classroom

The averages and standard deviations of mi outside the classroom are presented in Table 4

Table 4. *Averages (standard deviations) of mi outside the classroom statements.*

group	boys	girls	total
img	3.56 (.58) n=106	3.53 (45) n=66	172
n-img	3.37 (.63) n=84	2.69 (66) n=80	164
total	190	146	336

img = identified as being mathematically gifted; n-img = not identified as being mathematically gifted

The averages of img boys and img girls are nearly identical, and the average of n-img boys is slightly lower than that of these groups, but quite similar. The value of n-img girls is clearly lower than that of all other groups (Table 4). There are significant main effects on both giftedness (F (1,332) =60.790, p<.001, η^2=.155), which should be interpreted to a limited extend because of the almost identical mean values, and sex (F (1,332) =29.668, p<.001, η^2=.082), and there is a significant effect of interaction between these factors (F (1,332) =23.749, p<.001, η^2=.067).[13] The η^2-values indicate that giftedness with a strong effect of 15.5% plays a larger role in explaining variance than both sex with a medium effect of 8.2% and the interaction between the factors with a medium effect of 6.7%. Hence, the mi outside the classroom of img children is more advantageous than that of n-img children on average, but n-img boys are more similar to img children than to n-img girls, who show lower characteristics than all other groups. Therefore, the statistical evaluation confirms hypothesis 2b in principle.

5.2.3. Excursus: A Comparison of MI Inside and Outside the Classroom

As noted above, img children and n-img boys both show a larger mi inside and outside the classroom than n-img girls on average. In addition, comparing the mean values of all groups regarding both dimensions reveals that, while the averages of n-img boys are the same regarding both dimensions (3.37 in each case), and those of n-img girls are nearly identical (2.78 and 2.69), the mi of both img boys and girls is slightly stronger outside the classroom (3.56 and 3.53) than inside the classroom (3.22 and 3.01).

5.3. Mathematics Attitudes (MA)

Table 5 presents the averages and standard deviations of ma.

Table 5. *Averages (standard deviations) of ma statements.*

group	boys	girls	total
img	3.45 (57) n=106	3.34 (60) n=65	171
n-img	3.19 (70) n=84	2.36 (67) n=80	164
total	190	145	335

img = identified as being mathematically gifted; n-img = not identified as being mathematically gifted

The mean values of img boys and img girls are relatively similar, and the average of n-img boys is slightly lower than, but comparable to, these groups. In contrast, the value of n-img girls is clearly lower than the values of the other groups (Table 5). Statistical evaluation shows both a significant main effect on giftedness (F (1,331) = 78.007, p<.001, η^2=.191) and a significant main effect on sex (F (1,331) =44.890, p<.001, η^2=.119), as well as a significant effect of interaction between the factors (F (1,331) =25.311, p<.001, η^2=.071).[14] As to the explanatory force, the η^2-values indicate that the strong effect of giftedness of 19.1% plays a more important role in explaining

[13] It is an ordinal interaction again (see note 12).

[14] It is an ordinal interaction as well (see note 12).

variance than both the medium effect of sex of 11.9% and the medium effect of interaction between the factors of 7.1%. Thus, the ma of img children are on average more advantageous than the ma of n-img children, but n-img boys are more similar to img children than to n-img girls, whose characteristics are clearly lower than all other groups. Therefore, the statistical evaluation confirms hypothesis 3.

6. Discussion

6.1. Synopsis

This article investigated the significance of mathematics self-efficacy (mse), interest (mi) and attitudes (ma) as determinants for identifying mathematical giftedness (mg) at primary-school age. It did so by comparing frequent characteristics among boys and girls identified as being mathematically gifted (img), as well as among boys and girls who were not (n-img). Children identified as img participated in the long-term enrichment project "Mathe für kleine Asse".

From a review of existing empirical evidence, hypotheses were deduced regarding the characteristics in question. The findings of psycho-diagnostic studies on "typical" gender- or giftedness-specific phenomena of mse, mi and ma suggest that advantageous characteristics are usually to be expected among img children and n-img boys, but n-img girls tend to more disadvantageous characteristics than the other groups. Psycho-diagnostic findings regarding a "general-factor-concept" of exceptional abilities cannot be transferred automatically to a complex conception of mg, which requires domain-specific criteria, holistic perspectives, and long-term process diagnostics (as conducted in "Mathe für kleine Asse").

The hypotheses were investigated through a questionnaire study; mse, mi and ma were operationalized in a closed form following common styles of existing tools, with these tools being adapted with regard to the study's focus to make them appropriate to young children. In short, the statistical findings confirm the hypotheses. First, img girls and boys show on average more advantageous characteristics of mse than n-img children, but n-img boys are more similar to img children (relatively similar to the studies of Schütz [59]). In contrast, n-img girls show more disadvantageous characteristics than all other groups, which corresponds to typical reports on low levels of mse especially among girls [55]. Second, the boys' groups show a stronger mi inside the classroom than the girls' groups (similar to the results of Blossfeld and colleagues [57]), but img girls are more similar to the boys' groups than to n-img girls, who show a lower mi inside the classroom than all other groups. As to mi outside the classroom, img children show higher levels compared to n-img children, but n-img boys are more similar to img children than to n-img girls, who show lower characteristics than all other groups. Furthermore, only img children seem to differ between mi inside and outside the classroom, and show a stronger mi outside the classroom, while n-img children took similar stances in both cases (a possible explanation for the findings of Hellmich [66]). Third, the ma of img children are more advantageous than the ma of n-img children, but n-img boys differ to only a limited degree; the ma of n-img girls are clearly more disadvantageous than the ma of all other groups (similar to the older findings of Wieczerkowski and Jansen [94]).

6.2. Deeper Interpretation of the Results

As to the significance of mse, mi and ma as determinants for identifying mg, although gender-specific differences in mathematical competencies tend not to be found with primary-school children (see 1.), the findings indicate that girls show more disadvantageous characteristics than boys within the group of n-img children. In contrast, it is rare to observe disadvantageous characteristics among both img boys and girls; hence, the characteristics of n-img boys are more similar to those of img children.

Like insights from the project "Mathe für kleine Asse", relations that describe the occurrence of "giftedness" in the terminology of the psychological diagnosis of intelligence speak in favor of the fact that the groups of children "identified as being mathematically gifted" and those "not identified as being mathematically gifted" have a very small overlap. For example, research on intelligence assumes a proportion of about 2.5% of gifted people in the population as a whole [110]. Similarly, the partner schools of the project "Mathe für kleine Asse" propose from experience at most one or two children per class to participate. Overall, it can therefore be assumed that very few children in a class have a mathematical potential far above the average [15].

The findings of this study suggest that the advantageous characteristics of the motivational factors investigated can be found independent of an identification of mg more often among boys. As also noted by a previous work of Benölken, such motivational phenomena might constitute an important reason why the mg of boys can be identified more efficiently: because of the advantageous characteristics of their motivational factors, boys might tend towards a very strong liking for or preoccupation with mathematics, and teachers might perceive their potentials most. Conversely, disadvantageous characteristics might lead to children not developing a stronger liking for or preoccupation with mathematics. This might apply especially to those children in a class with a well-above-average potential in mathematics, which might be more difficult to identify as a consequence of disadvantageous motivational characteristics [15].

The study's findings are of course not suited to predicting how mse, mi and ma can be characterized among girls who have a high, but unidentified, mathematical potential (in particular, because of the long-term process diagnostics used). However, taking into account on the one hand the findings of a preceding study of the author, which show the strong influence of identifying giftedness on the emergence of advantageous motivational factors among girls in particular, and on the other the fact that disadvantageous characteristics can be found more often among girls within the group of n-img children [17], makes the following thesis obvious: the disadvantageous characteristics of mse, mi and ma are important factors effecting the less frequent identification of high mathematical potentials among girls (in accordance with the author's findings on mathematics self-concepts and attributions [15]). As a consequence, it might be more difficult for teachers to perceive the high mathematical potentials of girls, or girls might not perceive themselves as having a high potential and turn to different interests where they think that they have higher capabilities instead. Thus, the findings of this study might help explain the phenomenon whereby mathematically gifted girls are seldom identified (see 1.).

Besides improving the identification of and support for mathematically gifted girls, the findings suggest that the characteristics of motivational factors are in general more often disadvantageous among girls than among boys. Against the background of a consideration of different facets of diversity [8], this observation is highly relevant to organizing mathematics lessons in a way that is sensitive to gender.

6.3. Limitations of the Study

While attention was paid to ensuring a balance in the number of n-img girls and boys, it is important to discuss the underrepresentation of girls in the group of img children: because of the process diagnostics used (see 2.), and the relatively small number of girls participating in "Mathe für kleine Asse", it takes a long time to assemble an appropriate subsample for this group. Conversely, there are more boys than girls in the group of img children, since participants in "Mathe für kleine Asse" are more often male. Comparable to the author's preceding study [15], this imbalance has to be accepted, since it takes a very long time to achieve equal distributions against the background of the long-term diagnostics used. The diagnostic procedures used in the study to identify mg have been established for many years within both "Mathe für kleine Asse" and comparable programs [37, 5]. The children were questioned at the end of a school year, i.e., when a complex assessment of children's potentials was possible. Hence, children are most probably correctly assessed as being "mathematically gifted" in the long-term approach. Additionally, because children participate in "Mathe für kleine Asse" as a specific support program at a university, there might occur extraordinary motivational effects that cannot be similarly observed among children who have a high potential, but who do not take part in such a program [15, 111]. Finally, the n-img subsample is nothing more than an insufficient image of the population. Altogether, the representativeness of the sample is limited.

The questionnaire used was in principle adequate to the aims of the study. Particular attention was paid to designing a tool appropriate to primary-school children (similar to the author's preceding study [15]). Compromises in the quality of the findings were accepted consciously: the questionnaire is suited to pragmatic use in classrooms, since its phrasing and style are appropriate to young children, and it can be completed in a short time. However, to make the questionnaires more suitable to primary-school children, it was necessary to reduce at least mi and ma in their conceptions, while their evaluation depends on very simple measurements. In contrast, the operationalization of mse follows completely the styles of an established instrument [104]. In summary, the external validity of the findings cannot be judged because tools that evidentially study criteria of quality were not applied completely, the img sample is composed very specifically, and the subsamples are neither balanced nor representative. Hence, the study has obvious limitations, and, despite both its quantitative design and its significant findings, it is rather exploratory in character. Thus, subsequent studies should focus on achieving more balanced samples and using established tools to measure mi and ma [112-114].

6.4. Practical Consequences and Directions for Future Research

The development of positive motivational characteristics for learning mathematics seems very important especially among girls, so that they can identify with mathematics and approach it as an area in which they have the feeling that they can "hold their own" or even succeed in showing high achievements. Of course, the motivational constructs investigated in this study have to be seen as being strongly interdependent with other motivational factors, as well as with influences of socialization and gender-specific preferences in solving tasks. Thus, teachers should consider offering sensible and continuous support for girls' motivation with regard to mathematics [15, 17-18], and especially so against the background of the misapprehension often reported that gifted children do not need any special support [115]. This is confirmed by the observation that only img children seem to distinguish between mi inside and outside the classroom, which indicates the significance of a challenging education, for example in the use of enrichment tasks in ordinary classes [19]. As to the question of how specific support for girls might be put into classroom practice, there are a number of possibilities. First, positive and authentic feedback can be useful [116]. Second, specific interventions can be fruitful: for example, Gaspard and colleagues suggest a 90-minute relevance intervention focusing on value beliefs [117], while Benölken suggests an extracurricular monoeducative course that considers possible "typical" preferences [118-119]. Another approach comprises task-fields that are composed in such a way as to promote learning among girls in particular [120]. Third and most importantly, both interactions favoring boys and gender stereotyping of mathematics should be avoided [121], and it is fundamental to scrutinize how specific preferences appear; international comparisons might contribute to a deeper insight here [122].

The study presented focused on the single components of motivation regarding their significance as determinants in identifying mg. As already indicated, further studies that use established tools should be conducted to investigate the external validity of the findings. In this context, an important desideratum is to triangulate the study's results with similar findings on different motivational factors like those of the author's preceding studies [15, 17]. This would enable the researcher to acquire perspectives on the significance of motivational constructs as determinants in the identification of mg that are more holistic. Additionally, their significance as determinants for the development of mg should be investigated more comprehensively, since existing findings are nothing more than exploratory. A perspective goal is the construction of a model for the development of mathematical giftedness, which includes gender-specific aspects and here in particular motivational factors.

7. Conclusion

In short, the results of the questionnaire study indicate that girls who were identified as being mathematically gifted in the frame of participating in a support program tend to show more advantageous characteristics of mathematics self-efficacy, interests and attitudes than girls who were not identified as such. In contrast, it is rare to observe disadvantageous characteristics of mathematics self-efficacy, interests and attitudes with boys in general, independent of the identification of mathematical giftedness in the frame of a support program.

The first main conclusion is that the study's findings might help to explain the phenomenon whereby high mathematical potentials of girls are seldom identified, since it might be more difficult for teachers to perceive such potentials, or girls might believe not to have a high mathematical potential and turn to different interests. Thus, from a gender perspective, considering characteristics of mathematics self-efficacy, interest and attitudes provides important determinants to identify high mathematical potentials. Independent of the giftedness context, the second main conclusion is that the development of advantageous characteristics of mathematics self-efficacy, interests and attitudes seems to be important especially among girls. Possible approaches are, among other things, specific interventions that focus primarily on increasing girls' value beliefs towards mathematics.

Because the findings are exploratory, and because they are limited to primary-school age, it is recommended that further studies should be conducted using established tools, and triangulating the results of the present study with similar findings on different motivational factors. Especially, a perspective goal might be the construction of a model for the development of mathematical giftedness, which considers gender-specific phenomena like the motivational factors investigated in this article.

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References

[1] Quaiser-Pohl, C. (2012). Mädchen und Frauen in MINT: Ein Überblick. In H. Stöger, A. Ziegler, & M. Heilemann (eds.), Mädchen und Frauen in MINT. Bedingungen von Geschlechtsunterschieden und Interventionsmöglichkeiten (pp. 13-39). Berlin: Lit.

[2] Abele, A. E., & Lenzner, A. (2004). Frauen heute im Mathematikstudium international. In A. E. Abele, H. Neunzert, & R. Tobies (eds.), Traumjob Mathematik. Berufswege von Frauen und Männern in der Mathematik (pp. 147-157). Basel: Birkhäuser.

[3] UNESCO [United Nations Educational, Scientific and Cultural Organization] (ed.). (2015). Women in science. Quarterly thematic publication, 1. http://unesdoc.unesco.org/images/0023/002351/235155E.pdf. Accessed 17 April 2016.

[4] Mattson, L. (2013). Tracking mathematical giftedness in an egalitarian context. Gothenburg: Chalmers University of Technology and University of Gothenburg.

[5] Bauersfeld, H., & Kießwetter, K. (eds.). (2006). Wie fördert man mathematisch besonders befähigte Kinder? Ein Buch aus der Praxis für die Praxis. Offenburg: Mildenberger.

[6] BMBF [Bundesministerium für Bildung und Forschung; German Federal Ministry of Education and Research] (ed.). (2015). Begabte Kinder finden und fördern. Ein Ratgeber für Eltern, Erzieherinnen und Erzieher, Lehrerinnen und Lehrer. Berlin: BMBF, Referat Übergreifende Fragen der Nachwuchsförderung, Begabtenförderung. https://www.bmbf.de/pub/Begabte_Kinder_finden_und_foerd ern. pdf. Accessed 08 September 2018.

[7] Endepohls-Ulpe, M. (2012). Begabte Mädchen und Frauen. In H. Stöger, A. Ziegler, & M. Heilemann (eds.), Mädchen und Frauen in MINT. Bedingungen von Geschlechtsunterschieden und Interventionsmöglichkeiten (pp. 103-132). Berlin: Lit.

[8] Veber, M. (2015). Potenzialorientierung - Weg und Ziel inklusiver Bildung. Schulpädagogik heute, 12, 1-22.

[9] Sliwka, A. (2012). Diversität als Chance und als Ressource in der Gestaltung wirksamer Lernprozesse. In K. Fereidooni (ed.), Das interkulturelle Lehrerzimmer. Perspektiven neuer deutscher Lehrkräfte auf den Bildungs- und Integrationsdiskurs (pp. 169-176). Wiesbaden: Springer VS.

[10] Reiss, K., Sälzer, C., Schiepe-Tiska, A., Klieme, E., & Köller, O. (eds.). (2016). PISA 2015. Eine Studie zwischen Kontinuität und Innovation. Münster: Waxmann.

[11] Bos, W., Wendt, H., Köller, O., & Selter, C. (eds.). (2012). TIMSS 2011. Mathematische und naturwissenschaftliche Kompetenzen von Grundschulkindern in Deutschland im internationalen Vergleich. Münster: Waxmann.

[12] Hyde, J. S. (2014). Gender similarities and differences. Annual Review of Psychology, 65, 373-98.

[13] Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and mathematics performance: a meta-analysis. Psychological Bulletin, 136 (6), 1123-1135.

[14] Ma, X. (2010). Gender differences in mathematics achievement. Evidence from regional and international student assessments. In H. J. Forgasz, J. Rossi Becker, K. -H. Lee, & O. B. Steinthorsdottir (eds.), International perspectives on gender and mathematics education (pp. 225-248). Charlotte, NC: Information Age Publishing.

[15] Benölken, R. (2014). Begabung, Geschlecht und Motivation. Erkenntnisse zur Bedeutung von Selbstkonzept, Attribution und Interessen als Bedingungsfaktoren für die Identifikation mathematischer Begabungen. Journal für Mathematik-Didaktik, 35 (1), 129-158.

[16] Benölken, R. (2015). The impact of mathematics interest and attitudes as determinants in order to identify girls' mathematical talent. Proceedings of the Ninth Conference of the European Society for Research in Mathematics Education (pp. 970-976). Prague, Czech Republic: Charles University and ERME.

[17] Benölken, R. (2017). Begabung, Geschlecht und Motivation. Erkenntnisse zur Bedeutung motivationaler Komponenten als Bedingungsfaktoren für die Entwicklung mathematischer Begabungen. mathematica didactica, 40, 55-72.

[18] Benölken, R. (2011). Mathematisch begabte Mädchen. Untersuchungen zu geschlechts- und begabungsspezifischen Besonderheiten im Grundschulalter. Münster: WTM.

[19] Fuchs, M., & Käpnick, F. (2009). Mathe für kleine Asse. Empfehlungen zur Förderung mathematisch interessierter und begabter Kinder im 3. und 4. Schuljahr (vol. 2). Berlin: Cornelsen.

[20] Brunner, M., Krauss, S., & Martignon, L. (2011). Eine alternative Modellierung von Geschlechtsunterschieden in Mathematik. Journal für Mathematik-Didaktik, 32 (2), 179-204.

[21] Eccles, J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J., & Midgley, C. (1983). Expectancies, values and academic behaviors. In J. T. Spence (ed.), Achievement and achievement motives (pp. 26-43). San Francisco, CA: Freeman.

[22] Käpnick, F., & Benölken, R. (2015). Ein konzeptioneller Ansatz zur Kennzeichnung mathematisch begabter Kinder und Möglichkeiten ihrer Diagnostik und Förderung aus fachdidaktischer Perspektive. Journal für Begabtenförderung, 2, 23-38.

[23] Leikin, R., & Sriraman, B. (eds.). (2017). Creativity and giftedness-Interdisciplinary perspectives from mathematics and beyond. Switzerland: Springer.

[24] Bauersfeld, H. (2013). Die prinzipielle Unschärfe unserer Begriffe. In T. Fritzlar & F. Käpnick (eds.), Mathematische Begabungen. Denkansätze zu einem komplexen Themenfeld aus verschiedenen Perspektiven (pp. 105-129). Münster: WTM.

[25] Lucito, L. J. (1964). Gifted children. In L. M. Dunn (ed.), Exceptional children in the schools (pp. 179-238). New York, NY: Holt, Rinehart and Winston.

[26] Feldhusen, J. F., & Jarwan, F. A. (1993). Identification of gifted and talented youth for educational programs. In K. A. Heller, F. J. Mönks, & A. H. Passow (eds.), International handbook of research and development of giftedness and talent (pp. 512-527). Oxford: Pergamon.

[27] Gagné, F. (2000). Understanding the complex choreography of talent development through DMGT-based analysis. In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subotnik (eds.), International handbook of giftedness and talent (2nd ed.; pp. 67-79). Amsterdam: Elsevier.

[28] iPEGE [International Panel of Experts for Gifted Education] (ed.). (2009). Professionelle Begabtenförderung. Salzburg: özbf.

[29] Kießwetter, K. (1985). Die Förderung von mathematisch besonders begabten und interessierten Schülern - ein bislang vernachlässigtes sonderpädagogisches Problem. Mathematisch-naturwissenschaftlicher Unterricht, 39 (5), 300-306.

[30] Käpnick, F. (1998). Mathematisch begabte Kinder. Frankfurt a. M.: Peter Lang.

[31] Sheffield, L. (2003). Extending the challenge in mathematics. Thousand Oaks, CA: Corwin Press.

[32] Benölken, R. (2015). "Mathe für kleine Asse" - An enrichment project at the University of Münster. Proceedings of the 9th Mathematical Creativity and Giftedness International Conference (pp. 140-145). Sinaia, Romania: MCG.

[33] Aßmus, D. (2017). Mathematische Begabung im frühen Grundschulalter unter besonderer Berücksichtigung kognitiver Merkmale. Münster: WTM.

[34] Schindler, M., & Rott, B. (2017). Networking theories on giftedness - What we can learn from synthesizing Renzulli's domain general and Krutetskii's mathematics-specific theory. Education Sciences. https://doi.org/10.3390/educsci7010006

[35] Fritzlar, T. (2013). Robert - Zur Entwicklung mathematischer Expertise bei Kindern und Jugendlichen. In T. Fritzlar & F. Käpnick (eds.), Mathematische Begabungen. Denkansätze zu einem komplexen Themenfeld aus verschiedenen Perspektiven (pp. 41-59). Münster: WTM.

[36] Nolte, M. (2012). Challenging math problems for mathematically gifted children. In Proceedings of the 7th Mathematical Creativity and Giftedness International Conference (pp. 27-45). Busan, Republic of Korea: MCG.

[37] Käpnick, F. (2008). "Mathe für kleine Asse". Das Münsteraner Konzept zur Förderung mathematisch begabter Kinder. In M. Fuchs & F. Käpnick (eds.), Mathematisch begabte Kinder. Eine Herausforderung für Schule und Wissenschaft (pp. 138-148). Berlin: Lit.

[38] Bandura, A. (1997). Self-efficacy. The exercise of control. New York, NY: Freeman.

[39] Köller, O., & Möller, J. (2010). Selbstwirksamkeit. In D. H. Rost (ed.), Handwörterbuch Pädagogische Psychologie (4th ed.; pp. 767-774). Weinheim: Beltz.

[40] Hsieh, P.-H. P., & Schallert, D. L. (2008). Implications from self-efficacy and attribution theories for an understanding of undergraduates' motivation in a foreign language course. Contemporary Educational Psychology, 33 (4), 513-532.

[41] Liem, A. D., Lau, S., & Nie, Y. (2008). The role of self-efficacy, task value, and achievement goals in predicting learning strategies, task disengagement, peer relationship, and achievement outcome. Contemporary Educational Psychology, 33 (4), 486-512.

[42] Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? Educational Psychology Review, 15 (1), 1-40.

[43] Zimmerman, B. (2000). Self-efficacy: An essential motive to learn. Contemporary Educational Psychology, 25, 82-91.

[44] Ercikan, K., McCreith, T., & Lapointe, V. (2005). Factors associated with mathematics achievement and participation in advanced mathematics courses: an examination of gender differences from an international perspective. School Science and Mathematics, 105 (1), 5-17.

[45] Betz, N. E., & Hackett, G. (1986). Applications of self-efficacy theory to understanding career choice behavior. Journal of Social and Clinical Psychology, 4 (3), 279-289.

[46] McConney, A., & Perry, L. (2010). Socioeconomic status, self-efficacy, and mathematics achievement in Australia: a secondary analysis. Educational Research for Policy and Practice, 9 (2), 77-91.

[47] Hannover, B. (1991). Zur Unterrepräsentanz von Mädchen in Naturwissenschaften und Technik: Psychologische Prädikatoren der Fach-und Berufswahl. Zeitschrift für Pädagogische Psychologie, 5 (3), 169-186.

[48] Stipek, D. J., & Gralinski, J. H. (1991). Gender differences in children's achievement-related beliefs and emotional responses to success and failure in mathematics. Journal of Educational Psychology, 83 (3), 361-371.

[49] Geist, E. A., & King, M. (2008). Different, not better: Gender differences in mathematics learning and achievement. Journal of Instructional Psychology, 35 (1), 43-53.

[50] Fennema, E., & Sherman, J. (1977). Sex-related differences in mathematics achievement, spatial visualization and affective factors. American Educational Research Journal, 14 (1), 51-71.

[51] Pajares, F., & Graham, L. (1999). Self-Efficacy, motivation constructs and mathematics performance of entering middle school students. Contemporary Educational Psychology, 24 (2), 124-139.

[52] Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving. Journal of Educational Psychology, 86 (2), 193-203.

[53] OECD [Organisation for Economic Co-operation and Development] (ed.). (2007). PISA 2006 Schulleistungen im internationalen Vergleich. Naturwissenschaftliche Kompetenzen für die Welt von morgen. München: Bertelsmann. http://www.oecd.org/pisa/39728657.pdf. Accessed 14 April 2016.

[54] Pajares, F. (2003). Self-efficacy beliefs, motivation, and achievement in writing: a review of the literature. Reading & Writing Quarterly, 19 (2), 139-158.

[55] Huang, C. (2012). Gender differences in academic self-efficacy: a meta-analysis. European Journal of Psychology of Education, 28 (1), 1-35.

[56] Else-Quest, N. M., Hyde J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: a meta-analysis. Psychological Bulletin, 136, 103-27.

[57] Blossfeld, H. -P., Bos, W., Hannover, B., Lenzen, D., Müller-Böling, D., Prenzel, M., & Wößmann, L. (2009). Geschlechterdifferenzen im Bildungssystem. Jahresgutachten 2009. Wiesbaden: VS.

[58] Prenzel, M., Baumert, J., Blum, W., Lehmann, R., Leutner, D. Neubrand, M., Pekrun, R., Rolff, H. -G., Rost, J., & Schiefele, U. (2004). PISA 2003. Der Bildungsstand der Jugendlichen in Deutschland-Ergebnisse des zweiten internationalen Vergleichs. Münster: Waxmann.

[59] Schütz, C. (2000). Leistungsbezogene Kognitionen. In D. H. Rost (ed.), Hochbegabte und hochleistende Jugendliche. Neue Ergebnisse aus dem Marburger Hochbegabtenprojekt (pp. 303-337). Münster: Waxmann.

[60] Rost, D. H., & Wetzel, C. (2000). Proaktive Selbststeuerung, Kompetenzwahrnehmung, Erfolgsorientierung. In D. H. Rost (ed.), Hochbegabte und hochleistende Jugendliche. Neue Ergebnisse aus dem Marburger Hochbegabtenprojekt (pp. 279-302). Münster: Waxmann.

[61] Junge, M. E., & Dretzke, B. J. (1995). Mathematical self-efficacy, gender differences in gifted/talented adolescents. Gifted Child Quarterly, 39 (1), 22-28.

[62] Todt, E. (1986). Interesse. In W. Sarges & R. Fricke (eds.), Psychologie für Erwachsenenbildung/Weiterbildung. Ein Handbuch in Grundbegriffen (pp. 272-277). Göttingen: Hogrefe.

[63] Prenzel, M., Krapp, A., & Schiefele, H. (1986). Grundzüge einer pädagogischen Interessentheorie. Zeitschrift für Pädagogik, 32 (2), 163-173.

[64] Krapp, A. (2005). Die Bedeutung von Interesse für den Grundschulunterricht. Grundschulunterricht, 52 (10), 4-8.

[65] Krapp, A. (2010). Interesse. In D. H. Rost (ed.), Handwörterbuch Pädagogische Psychologie (4th ed.; pp. 311-323). Weinheim: Beltz.

[66] Hellmich, F. (2006). Interessen, Selbstkonzepte und Kompetenzen. Untersuchungen zum Lernen von Mathematik bei Grundschulkindern. Oldenburg: University of Oldenburg.

[67] Bikner-Ahsbahs, A. (2005). Mathematikinteresse zwischen Subjekt und Situation. Theorie interessendichter Situationen. Baustein für eine mathematikdidaktische Interessentheorie. Hildesheim: Franzbecker.

[68] Eichler, K. -P. (2010). Fördern mathematisch begabter Kinder und Entwicklung mathematischer Interessen bei allen Kindern. In T. Fritzlar & F. Heinrich (eds.), Kompetenzen mathematisch begabter Kinder erkunden und fördern (pp. 127-142). Offenburg: Mildenberger.

[69] Hannover, B. (2008). Vom biologischen zum psychologischen Geschlecht: Die Entwicklung von Geschlechtsunterschieden. In A. Renkl (ed.), Lehrbuch Pädagogische Psychologie (pp. 339-388). Bern: Huber.

[70] Pruisken, C. (2005). Interessen und Hobbys hochbegabter Grundschulkinder. Formeln statt Fußball? Münster: Waxmann.

[71] Hoberg, K., & Rost, D. H. (2000). Interessen. In D. H. Rost (ed.), Hochbegabte und hochleistende Jugendliche. Neue Ergebnisse aus dem Marburger Hochbegabtenprojekt (pp. 339-365). Münster: Waxmann.

[72] Perleth, C., & Sierwald, W. (1992). Entwicklungs- und Leistungsanalysen zur Hochbegabung. In K. A. Heller (ed.), Hochbegabung im Kindes- und Jugendalter (pp. 166-350). Göttingen: Hogrefe.

[73] Fromme, J., Meder, N., & Vollmer, N. (2000). Computerspiele in der Kinderkultur. Opladen: Leske+Budrich.

[74] Fölling-Albers, M. (1995). Interessen von Grundschulkindern. Ein Überblick über Schwerpunkte und Auslöser. Grundschule, 27 (6), 24-26.

[75] Watt, H. M. G. (2004). Development of adolescents' self-perceptions, values, and task perceptions according to gender and domain in 7th through 11th grade Australian students. Child Development, 75 (5), 1556-1574.

[76] Keller, C. (1998). Geschlechterdifferenzen in der Mathematik: Prüfung von Erklärungsansätzen. Eine mehrebenenanalytische Untersuchung im Rahmen der "Third International Mathematics and Science Study". Zürich: Zentralstelle der Studentenschaft.

[77] OECD [Organisation for Economic Co-operation and Development] (ed.) (2016). PISA 2015 Ergebnisse (Band I): Exzellenz und Chancengerechtigkeit in der Bildung. PISA, Bertelsmann. http://dx.doi.org/10.1787/9789264267879-de. Accessed 21 September 2017.

[78] Lubinski, D., Benbow, C. P., & Sanders, C. E. (1993). Reconceptualizing gender differences in achievement among the gifted. In K. A. Heller, F. J. Mönks, & A. H. Passow (eds.), International handbook of research and development of giftedness and talent (pp. 693-707). Oxford: Pergamon.

[79] Kasten, H. (2010). Geschlechtsunterschiede. In D. H. Rost (ed.), Handwörterbuch Pädagogische Psychologie (4th ed.; pp. 234-241). Weinheim: Beltz.

[80] Kerr, B. (2000). Guiding Gifted Girls and Young Women. In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subotnik (eds.), International handbook of giftedness and talent (2nd ed.; pp. 649-657). Amsterdam: Elsevier.

[81] Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: influences of gender, family, and school context. Journal of Research in Adolescence, 20 (2), 507-537.

[82] Fredriks, J. A., & Eccles, J. (2002). Children's competence and value beliefs from childhood to adolescence: Growth trajectories in two male-sex-typed domains. Developmental Psychology, 38 (4), 519-533.

[83] Bohner, G. (2003). Einstellungen. In W. Stroebe, K. Jonas, & M. Hewstone (eds.), Sozialpsychologie. Eine Einführung (4th ed.; pp. 265-315). Berlin: Springer.

[84] Herkner, W. (1993). Lehrbuch Sozialpsychologie (5th ed.). Bern: Huber.

[85] Shavitt, S. (1989). Operationalizing functional theories of attitude. In A. R. Pratkanis, S. Breckler, & A. G. Greenwald (eds.), Attitude structure and function (pp. 311-337). Hillsdale, NJ: Lawrence Erlbaum.

[86] Wicker, A. W. (1969). Attitudes versus actions: the relationship of verbal and overt behavioral responses to attitude object. Journal of Social Issues, 25 (4), 41-78.

[87] Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention, and behavior: an introduction to theory and research. Reading, MA: Addison-Wesley.

[88] Fischer, L., & Wiswede, G. (2002). Grundlagen der Sozialpsychologie (2nd ed.). München: R. Oldenbourg.

[89] Aronson, E., Wilson, T. D., & Akert, R. M. (2004). Sozialpsychologie (4th ed.). München: Pearson.

[90] Ma, X., & Xu, J. (2004). Determining the causal ordering between attitude towards mathematics and achievement in mathematics. American Journal of Education, 110 (3), 256-280.

[91] Hyde, J. S., Fennema, E., Ryan, M., Frost, L. A., & Hopp, C. (1990). Gender comparisons of mathematics attitudes and affect: a meta-analysis. Psychology of Women Quarterly, 14 (3), 299-324.

[92] Gaspard, H., Dicke, A. -L., Flunger, B., Schreier, B., Häfner, I., Trautwein, U., & Nagengast, B. (2015). More value through greater differentiation: Gender differences in value beliefs about math. Journal of Educational Psychology, 107 (3), 663-677.

[93] Wang, M. -T., & Degol, J. (2013). Motivational pathways to STEM career choices: using expectancy-value perspective to understand individual and gender differences in STEM fields. Developmental Review, 33 (4), 304-340.

[94] Wieczerkowski, W., & Jansen, J. (1990). Mädchen und Mathematik: Geschlechtsunterschiede in Leistung und Wahlverhalten. In W. Wieczerkowski & T. Prado (eds.), Hochbegabte Mädchen (pp. 134-151). Bad Honnef: Bock.

[95] Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. Journal of Research in Science Teaching, 45 (9), 971-1002.

[96] Newton, L. D., & Newton, D. P. (1998). Primary children's conceptions of science and the scientists: Is the impact of a National Curriculum breaking down the stereotype? International Journal of Science Education, 20 (9), 1137-1149.

[97] Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children. Child Development, 82 (3), 766-779.

[98] Nagy, G., Trautwein, U., Baumert, J., Köller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. Educational Research and Evaluation, 12 (4), 323-345.

[99] Raminirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2012). Math anxiety, working memory, and math achievement in early elementary school. Journal of Cognition and Development, 14 (2), 187-202.

[100] Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21, 33-46.

[101] Harari, R. R., Vukovic, R. K., & Bailey, S. P. (2013). Mathematics anxiety in young children: an exploratory study. The Journal of Experimental Education, 81 (4), 538-555.

[102] Schiepe-Tiska, A., & Schmidtner, S. (2013). Mathematikbezogene emotionale und motivationale Orientierungen. Einstellungen und Verhaltensweisen von Jugendlichen in PISA 2012. In M. Prenzel, C. Sälzer, E. Klieme, & O. Köller (eds.), PISA 2012. Fortschritte und Herausforderungen in Deutschland (pp. 99-122). Münster: Waxmann.

[103] Benölken, R. (2014). The significance of attitudes towards mathematics as determinants for the identification of girls' mathematical talent - a pilot-study. Proceedings of the 2nd Human and Social Sciences at the Common Conference (pp. 174-178). Zilina, Slovak Republic: EDIS-Publishing Institution of the University of Zilina.

[104] Jerusalem, M., & Satow, L. (1999). Schulbezogene Selbstwirksamkeitserwartung. In R. Schwarzer & M. Jerusalem, (eds.), Skalen zur Erfassung von Lehrer- und Schülermerkmalen. Dokumentation der psychometrischen Verfahren im Rahmen der wissenschaftlichen Begleitung des Modellversuchs Selbstwirksame Schulen (pp. 15-16). Berlin: Freie Universität Berlin. http://www.psyc.de/skalendoku.pdf. Accessed 12 April 2016.

[105] OECD [Organisation for Economic Co-operation and Development] (ed.). (2012). Internationaler Schülerfragebogen PISA 2012. https://www.bifie.at/system/files/dl/pisa12_internationaler_nationaler_schuelerfragebogen.pdf. Accessed 14 April 2016.

[106] IAEEA [International Association for the Evaluation of Educational Achievement] (ed.). (2011). PIRLS & TIMSS 2011 Schülerfragebogen. https://www.bifie.at/system/files/dl/Sch%C3%BClerfragebogen.pdf. Accessed 14 April 2016.

[107] Cohen, J. (1988). Statistical Power for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

[108] Nachtigall, C., & Wirtz, M. (2006). Wahrscheinlichkeitsrechnung und Inferenzstatistik. Statistische Methoden für Psychologen Teil 2 (4th ed.). Weinheim: Juventa.

[109] Hatzinger, R., & Nagel, H. (2009). PASW Statistics. Statistische Methoden und Fallbeispiele. München: Pearson Studium.

[110] Eysenck, H. J. (2004). Die IQ-Bibel. Intelligenz verstehen und messen. Stuttgart: Klett-Cotta.

[111] Stapf, A. (2006). Hochbegabte Kinder. Persönlichkeit, Entwicklung, Förderung (3rd ed.). München: Beck.

[112] Waldis, M. (2012). Interesse an Mathematik. Münster: Waxmann.

[113] Petermann, F., & Winkel, S. (2007). FLM 4-6. Fragebogen zur Leistungsmotivation für Schüler der 4. Bis 6. Klasse. Frankfurt a. M.: Harcourt Test Services.

[114] Ufer, S., Rach, S., & Kosiol, T. (2017). Interest in mathematics = Interest in mathematics? What general measures of interest reflect when the object of interest changes. ZDM, 49 (3), 397-409.

[115] Käpnick, F. (2011). Fünf häufige Irrtümer. Zum Umgang mit mathematisch begabten Kindern. Mathematik Differenziert, 3, 7-9.

[116] O'Mara, A. J., Marsh, H. W., Craven, R. G., & Debus, R. (2006). Do self-concept interventions make a difference? A synergetic blend of construct validation and meta-analysis. Educational Psychologist, 41 (3), 181-206.

[117] Gaspard, H., Dicke, A. -L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. Developmental Psychology, 51 (9), 1226-1240.

[118] Benölken, R. (2012). "Mathe für kleine Asse" (für Mädchen!). Über eine Gruppe des Münsteraner Förderprojekts für mathematisch begabte Kinder an einer Grundschule. In C. Fischer, C. Fischer-Ontrup, F. Käpnick, F. -J. Mönks, H. Scheerer & C. Solzbacher (eds.), Individuelle Förderung multipler Begabungen. Fachbezogene Forder- und Förderkonzepte (pp. 87-94). Berlin: Lit.

[119] Jahnke-Klein, S. (2001). Sinnstiftender Mathematikunterricht für Mädchen und Jungen. Baltmannsweiler: Schneider.

[120] Benölken, R. (2013). Begabte Mädchen finden und fördern. Erfahrungen aus dem Projekt "Mathe für kleine Asse". Grundschule, 11, 20-22.

[121] Jungwirth, H. (1991). Die Dimension "Geschlecht" in den Interaktionen des Mathematikunterrichts. Journal für Mathematik-Didaktik, 12 (2/3), 133-170.

[122] Benölken, R. & Mellroth, E. (2017). The significance of motivational factors from a potential- and gender-related view. Proceedings of the 8th Nordic Conference on Mathematics Education. Stockholm, Sweden: Nordic Society for Research in Mathematics Education. https://pp-prod-admin.it.su.se/polopoly_fs/1.329970.1493116650%21/menu/standard/file/Beno%CC%88lken%20and%20Mellroth_The%20significance%20of%20motivational%20factors%20from%20a%20potential-%20and%20gender-related%20view.pdf. Accessed 07 September 2018.