Prospective teachers' conceptions of what characterize a gifted student in mathematics

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This paper explores Swedish prospective teachers' conceptions of what characterise a gifted student in mathematics. This was studied through a qualitative questionnaire focusing on attributions. The results show that a majority of the students attribute intrinsic motivation to gifted students, more often than extrinsic motivation. Other themes were other affective factors (e.g. being industrious), cognitive factors (e.g. easy to learn), and social factors such as good behaviour and background.

Key words: Attributions, conceptions, giftedness, thematic analysis

Introduction

The discussion on special needs education in Sweden has primarily focused on student difficulties (Mattsson, 2010). However, recently a broader focus on what gifted students might need has started (Edfeldt & Wistedt, 2009). Since there is no clear definition of what giftedness is (Mattsson, 2010) there is a need to clarify what different conceptions about gifted students exists in order to discuss the concept. Such discussion would provide a better picture of what the concept might comprise for various groups. When studying head teachers' conceptions, Mattsson's (ibid.) results show that the characteristics of such students at upper secondary level are both cognitive attributes (e.g. creative and logical ability) and non-cognitive attributes (e.g. motivation). This is in line with previous international research (e.g Leiken & Stanger, 2011). Mattsson (2010) says that reliability of her study rests on comparisons with similar studies. This present study would allow such comparison although studying another group in the educational system. The purpose is to explore prospective teachers' conceptions about gifted students in mathematics with the fol-

lowing research question: Which characteristic traits including gender are by prospective teachers attributed to gifted students in mathematics?

Theoretical background

Concept giftedness

Research has used different definition of giftedness depending on focus. A common starting point is to use 'special mathematical abilities' following Krutetskiis (1976). Juter and Sriraman (2011) show that depending on different emphasis on creativity, achievement, and giftedness different personalities can be portrayed and be viewed differently. Here, we start with the perspective that:

> *Descriptions of giftedness are always based on the social values of the time and culture in which they are given. Throughout history, the meaning of giftedness has shifted according to the interests and preconceptions of people using the term and, like beauty, giftedness is often in the eye of the beholder (Freeman, 1979, p.7).*

This definition emphasizes that the concept is dynamic and generated by human thoughts through attributions. This is useful when studying humans' conceptions in order to find which properties are by different groups attributed to the concepts. It means that concept depends on social and cultural environment. This is similar to Mattsson's (2010) starting point. For a longer discussion about different definitions of giftedness and elements related to the concept, see e.g. Juter and Sriraman (2011) and Mattsson (2010).

Conceptions

This study aims to investigate prospective teachers' conceptions. Thompson (1992) describes conceptions as "conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preferences" (ibid, p. 132). We follow this description and conception is defined as an abstract or general idea that may have both affective and cognitive dimensions, inferred or derived from specific instances. Häggblom (2009) uses the term beliefs synonymously for opinion ('åsikt') and conception ('uppfattning'). Instead of moving in to a discussion of different affective and cognitive aspects of these concepts (see

e.g. Sumpter, 2009 or Hannula, 2006), we choose to use 'conceptions' as an generic term for all these different affective concepts. This choice means that we have no intention of making any conclusions how strongly or lightly these conceptions are held.

Attributions theory

Kelley (1973) describes attributions as part of theories used by individuals in order to get knowledge about the surrounding world. This means that attributions are part of human interpretations of phenomenon; the explanations people make for causes of events or outcomes (Weiner, 1992). Here it is interpreted as the properties that are related to the concept giftedness. These explanations include conceptions, as part of e.g. meanings, mental images and beliefs (c.f. Thompson, 1992). Through the categorisations of attributions we enable both analysis of and comparisons between categories, which provides further understanding about the chosen phenomenon. Attributions are changeable explanations in an individual's world meaning that the attributes are subjective, personal and can change over time (Weiner, 1972). Research about attributions theory can focus on contextual relationships between attributions of a phenomenon (c.f. Kelley, 1973). However, this study uses empirical data to highlight differences between categories (c.f. Weiner, 1972).

Categories

There are different ways to create categories of attributions. Leiken and Stanger (2011) divide attributions made by three teachers into categories such as intellectual characteristics, creativity and affect/motivation/personality, where the data generated focus on the image of a gifted student and highlight personal traits. Their results do not include any attributions concerning social context e.g. background. The results depend on the definitions of gifted (i.e. what properties lies in the concept) and the methodological approach (e.g. inductive or deductive methods). The starting point in this study is that there is no initial categories in order to enable: (1) categories that have not been pre-decided; and, (2) a comparison between results of data generated categories and previous research. Data showed that there was a need to further specify the categories from the initial division of cognitive and non-cognitive factors. Non-cognitive factors are affective factors (e.g. motivation and emotion),

social factors (e.g. background) and personal factors (e.g. behaviour). Here, gender is emphasised. Cognitive factors could be creativity, problem solving ability, and ability to grasp and understand.

Affective factors are a collective name involving an individual's psychological, physical and social existence incorporating both negative and positive affects (Hannula, 2006). Affective factors depend on how the social environment is organised with related conceptions about mathematics and mathematics education (Evans & Zan, 2006). For instance, affective factors such as self-esteem in mathematics works towards good results and therefore helps to re-generates more positive affects such as liking of the subject (Zan, Brown, Evans & Hannula, 2006). One affective factor that needs further specification is motivation. We see motivation as actions derived from either intrinsic (e.g. I feel good) or extrinsic (e.g. I need to pass this exam) factors (Ryan and Deci, 2000). Emotions are defined as emotional direction: positive, neutral, or negative. According to Häggblom (2009) prospective teachers perceive that motivation (supported by positive feelings) and activeness is important, although this study does not focus on gifted students.

Social factors such as background can influence a child's education. Parents' goal for their children, including expectations, tends to increase the child's achievement (Peters, Grager-Loidl & Supplee, 2000). Another social factor is the ability to behave. Teachers at primary level do not only judge their students as gifted simply because of 'good behaviour' such as sitting down quietly and do what you are told, but it is considered a positive factor when assessing students (Hodge & Kemp, 2006). Previous research looking at teachers' attributions shows that there are differences between what is attributed to a gifted girl and a gifted boy in mathematics (Fennema, Peterson, Carpenter & Lubinski, 1990). Even though attributions such as 'independence' and 'interest for the subject' are ascribed to both genders, boys are more often considered high-achievers and attributed properties associated with advanced studies in mathematics. Boys are reported to be high achieving because of their abilities and having intrinsic motivation such as answering questions during lessons voluntarily. Boys are also considered being competitive. Girls, on the other hand, were gifted because of hard work (ibid, 1990). Sumpter (2009) studied Swedish upper secondary school teachers' conceptions about differences in boys and girls' mathematical reasoning. Most teachers said that crea-

tive mathematical founded reasoning was a neutral behaviour. It would be probable to think that such conception are related to attributions of being creative and gifted in mathematics. Therefore the concept might be more likely to be considered neutral. Here, the view is that differences between boys and girls in the prospective teachers' conceptions are not due to any biological differences, but a result of the concept 'gifted in mathematics' being gendered.

Cognitive factors include early development such as having spatial-and graphic abilities i.e. being able to do advance puzzles or to interpret difficult pictures. These factors are in relation to the age of the child (e.g. Diezmann & Watters, 2000). Logic is categorised as a cognitive factor (Mattsson, 2010). Creativity as a cognitive factor exists in contrast to a norm based standard and emerges in a social and cultural context (Csikszentmihalyi & Wolf, 2000). One way of defining creativity in mathematics at school level is provided by Sriraman (Liljedahl and Sriraman, 2006): (1) the process that results in unusual (novel) and/or insightful solution(s) to a given problem or analogous problems; and/or, (2) the formulation of new questions and/or possibilities that allow and old problem to be regarded from a new angle. This definition allows us to categories attributions based on that creativity is personal. Other cognitive attributions are those related to problem solving. Schoenfeld (1985) has described such competencies as resources, beliefs, heuristics, and control. These factors encompass the ability to master, identify and choose appropriate strategies.

Method

Method for data collection

The chosen population was students enrolled in one of the first courses of the first semester in teacher education programme in a major university in central Sweden. The students are in a mixed group including all prospective teachers from nursery to upper secondary school level. The reason for asking students in their first semester is to avoid that the attributions simply mirror a specific teacher course. The teachers of the course estimate the maximum participants to around 100 although 65 were at the random selected lessons, making this the maximum amount of respondents. Of these 65 students, 53 volunteered to

answer the questionnaire. With one falling off, the final number of responses was 52 giving a response rate of 80%. The response rate is in parity with Mattsson (2010). The students answered a questionnaire at the end of a lesson. The data that constitute the base for the analysis is the written responses to the following questions: (1) How do you perceive a gifted student [in mathematics]? Describe such a student.; (2) In your description above, did you think about: (i) a boy; (ii) a girl; or, (iii) neutral?; and, (3) Which properties characterise a gifted student [in mathematics]? The purpose of first question is to give a general description of a gifted student in mathematics whereas the third question aims to further clarify by focusing on properties. By using mainly open-end questions opens up for responses not directed by the questionnaire.

Method for analysis

In order to identify, analyse, and report patterns (themes) within the data we used thematic analysis. A theme represents a patterned responses or meaning within the data set (Braun & Clarke, 2006) and can be identified in one or two primary ways in thematic analysis, inductive or deductive. We used an inductive approach, but discussing our results using the same main categories as Mattsson (2010): cognitive and non-cognitive factors. This means that we besides the two initial categories had a data driven analysis instead of a theory driven analysis. From these two initial categories we followed the six steps of analysis given by Braun and Clarke (2006). This includes to within the initial categories looking for similar codes and to sort these codes into different themes. When sorting we needed to look for overarching themes and relationships between themes. This included separation, e.g. looking at the differences between the attribute 'being industrious' and acting industrious such as the response 'doing your homework'. The first one is a personal property and the second one is behaviour, here set in a specific social context. In the end, the themes had to be internally coherent, consistent, and distinctive.

Another issue to take into account is the level at which themes are to be identified: semantic or explicit level, latent or interpretative level (Braun & Clarke, 2006). We conducted an analysis on an explicit level although as a second step there is an aim to go beyond description in order to reach an interpretation. The purpose of the interpretation is to theorize the significance of the patterns and their broader meanings and implication, here in relation to

previous literature. This is a qualitative study trying to highlight different themes. If similar results as Mattsson (2010) this would add to a general perception of the concept 'gifted student in mathematics', since the two studies uses different methods and respondents.

Results

The responses to the first and the third questions was gathered and analysed. The attributions made by the prospective teachers generated three themes of non-cognitive traits (motivation, other affective factors, and social factors) and one theme called cognitive traits. In the presentation below, each theme will be exemplified and compared and/or discussed with previous research.

Non-cognitive traits

Let us start by looking at the non-cognitive traits. The main sub-categories within each of each of these three themes are listed below in Table 1.

	Number	
Character trait	*frequency*	*percentage*
Motivation	44	85
Intrinsic	27	52
Extrinsic	17	33
Other affective factors	41	79
Industrious	12	23
Social emotional traits	7	13
Active	7	13
Focused	6	12
Positive	5	10
Social factors	24	46
Behaviour	17	33
Background	7	13

Table 1. Non-cognitive attributes. Characteristics of gifted student in mathematics as stated by the prospective teachers. The number of respondents is 52; each prospective teacher may have provided more than one character trait.

Just as in Mattsson (2010) the most frequently found trait were attributes concerning motivation. Here, 85 % of the respondents gave a response that included motivation. The responses have been further categorised into intrinsic and extrinsic motivation. Several replies indicate conceptions describing gifted students as driven by intrinsic motivation, e.g. interested in mathemat-

ics, having ambition and are engaged in mathematics education. Most of these attributions have a positive emotional direction. Examples of attributes that encompass extrinsic motivation were (external) goals set at a high level, high demands, (very) good tests results, (very) good grades, spending a lot of time on school work (initiated by the school context) and high pressure (originated from external causes).

The second category is other affective factors. The most common attribution was industrious (and here with no indication of internal or external motivation) and personal traits including social behaviour combined with emotions such as empathic, adaptability, autistic, lonely, demanding, and shy. In this theme we also find responses such as active, having patience, self-esteem, and being positive. Here we excluded all responses that are related to social behaviour, environment and background such as doing homework or academic parents. The relative large number of responses that falls into these themes mirrors research that shows that affective factors do play a role for high-achieving students if to consider high-achieving as a part of the concept 'gifted in mathematics' (Evans & Zan, 2006; Hannula, 2006; Häggblom, 2009).

Other non-cognitive traits were social factors. This is a category of attributions that differs from Mattsson (2010) and Leiken and Stanger (2011). Almost half of the prospective teachers (44%) gave a response with an attribution that falls into this theme. We divide the attributions into background (social context and general knowledge and skills), and behaviour set in a social context such as things you do (lessons and homework). The first sub-category encompasses attributions describing how students behave in the social context i.e. manners. Here we find characteristics such as working hard during class, being prepared for class, paying attention during class, raising your hand, being quiet, helpful, doing your best, doing your homework or do what you are supposed to do. This view would reinforce the view that 'good behaviour' is considered a positive factor (Hodge & Kemp, 2006). The second sub-category deals with the social context such as parents with an academic background, having had good encouragement and attributes dealing with literacy and general knowledge. These are conceptions that follow previous research saying that parents' goals for their children, including expectations, tend to increase the child's achievement (Peters, Grager-Loidl & Supplee, 2000).

Cognitive traits

Now we focus on the attributions of cognitive traits. The main sub-categories within this theme are listed below in Table 2.

	Number	
Character trait	*frequency*	*percentage*
Easy to learn/grasp	16	31
Logical ability	10	19
Understanding	8	15
Able to apply different methods	8	15
Independence	6	12
Creativity	5	10
Problem solving	5	10

Table 2. Cognitive attributes. Characteristics of gifted student in mathematics as stated by the prospective teachers. The number of respondents is 52; each prospective teacher may have provided more than one character trait.

First, we can see that the sub-categories in cognitive traits are not as frequent compared to the non-cognitive sub-categories (c.f. motivation 85%). The most common reply here was easy to learn/grasp (31%). This follow previous research studying gifted students (Diezmann & Watters, 2000; Hodge & Kemp, 2006). 'Easy to learn/grasp' implies flexibility and an ability to assimilate a mathematical content with ease and little effort. Our results differ from Mattsson (2010) who lists creative ability as the most frequently found attribution (32%). Creativity was attributed by 10% of the prospective teachers. Other cognitive characteristics were logical thinking, independence, being able to apply different methods, understanding, and problem solving. In relation to the other themes, cognitive attributions were few. The concept 'gifted student in mathematics' is here more related to affective factors than to creativity or logical ability.

Gender

Looking at gender, none of the prospective teachers in this study gave a response to the open-end questions that included such an attribution. As a first result we conclude that gender is not a stressed category by this group of prospective teachers. In order to answer whether gifted students in mathematics is a gendered concept, the responses to the second question were gathered with the following results, see Table 3.

	Number	
Gender	*frequency*	*percentage*
Neutral	38	73
Girl	9	17
Boy	5	10

Table 3. Gender of gifted student in mathematics as stated by prospective teachers. The number of respondents is 52.

These results indicate that the concept was by most students stated as neutral.

Discussion

Since there are limitations of this study, e.g. the number and selection of participants, we can talk about *indications of stereotyping* within the attributions made by the prospective teachers to the concept 'giftedness in mathematics'. The results from the analysis point out that the concept was considered a matter about non-cognitive traits more than cognitive ability. Above all positive intrinsic motivation was attributed. Compared to Mattsson (2010) similar themes were the results of the analysis where motivation was the most common reply in both studies. Here, we can add intrinsic motivation as a subcategory. Giftedness is then more about internal factors instead of reacting to external stimuli. Another contribution, in contrast to Leiken & Stanger (2011) and Mattsson (2011), is that social factors are attributed as a part of the concept 'giftedness'. This is different than an attribute focusing on individual social skills and/or behaviour. When comparing with research not focusing specifically on mathematics we can see that social factors exist, not necessarily as a factor for giftedness but sometimes used as a part of description of interpersonal relationships (Carman, 2011). To illustrate this, one individual participating in Carman's (ibid.) study stated that a gifted person is particularly good in mathematics but not so popular socially.

Moving on to cognitive factors, the most common attribution was 'easy to learn/grasp'. This attribution was more frequent than students stressing the element of creativity, a trait commonly attached to giftedness (e.g. Mattsson, 2010; Juter and Sriraman, 2011). Creativity does not appear to be as important in prospective teachers' conceptions about giftedness in mathematics as in Juter and Sriraman's (2011) theoretical discussion of the concept.

Looking at gender, here seen as part of a social construct, the concept 'giftedness' was considered neutral. The differences between boys and girls reported by e.g. Fennema, Peterson, Carpenter and Lubinski (1990) were not repeated. However, this could be due to different countries, methods and/or targeted groups. But, it could be interesting to note that the result from this present study is in line with Sumpter's (2009) results. This could be an indication of a potential confirmation that a highly cognitive behaviour is thought of, by two different groups in the educational system, as gender-neutral phenomenon.

As summary, we see this study as (i) a contribution to research on prospective teachers conceptions; and, (ii) both confirming and adding to Mattsson's (2010) results on concept giftedness, but more research about this complex and dynamical concept is needed.

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