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ADAPTING CONCEPTUAL MODELS FOR CROSS-CULTURAL APPLICATIONS

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ABSTRACT: As Campbell and Tirri (2004) pointed out, it is of major importance to use psychological tests and questionnaires that are carefully constructed so that their reliability and validity can be determined in different cultures or subcultures. However, before investing in such efforts, it is even more urgent to develop solid conceptual constructs. Otherwise, the researcher runs into the danger of collecting data in an empirical manner and loosing touch with reality. This approach also makes it difficult to apply findings to other lines of investigation in the psychological literature. In this article we first show why and how the Munich Dynamic Ability-Achievement Model (MDAAM) evolved from the Munich Model of Giftedness (MMG). We then integrate a number of diverse ideas and empirical findings from various international studies. In the second part we will illustrat how the MDAAM can stimulate and structure theoretical and empirical research. Attempting to bridge the gap between the process-oriented approaches of cognitive studies and expertise research on the one hand and the psychometric studies in the field on the other hand, the MDAAM can be used as an integrative model of giftedness, talent, expertise, and achievement.

Key - words: theoric model, empirical research, gifted studies

RESUMEN: Como señalan Campbell y Tirr (2004) es de gran importancia usar test y cuestionarios psicológicos construidos cuidadosamente para que su confianza y validez pueda ser determinada en diferentes culturas y subculturas. Sin embargo antes de invertir en tal esfuerzo es más urgente desarrollar constructos conceptuales sólidos de otra manera el investigador corre el riesgo de recolectar datos de manera empírica y y perder contacto con la realidad. Esta aproximación también dificulta aplicar los descubrimientos a otras líneas de investigación en la literatura psicológica. En este artículo enseñamos primero porque y cómo el Modelo dinámico de habilidad-rendimiento Munich (MDAAM) evoluciona del Modelo Munich de superdotación. Luego integramos un número de diversas ideas y descubrimientos empíricos desde varios estudios internacionales. En la segunda parte ilustramos como el MDAAM puede estimular y estructurar investigación teórica y empírica. Intentando cubrir la brecha entre las aproximaciones orientadas a procesos de los estudios cognitivos y la investigación práctica por un lado y por otra lado los estudios psicométricos en el campo. El MDAAM puede ser usado como un modelo integrativo de superdotación, experto, talento y rendimiento**.**

Palabras clave: modelo teórico, investigación empírica, estudios de superdotación

1. INTRODUCTION

During the last decade of the 20th century there was an intensive discussion between two antagonistic streams of psychological research dealing with exceptional achievement:

- Exceptional contributions to society are made by individuals with exceptional gifts (giftedness research).
- Exceptional contributions to society can be made by individuals with a wide range of ability (expertise research).

The main argument for the expertise research line of thinking is that (innate) giftedness or intelligence is totally unimportant for exceptional achievement. Instead the role of experience is stressed, “deliberate practice”, which involves task commitment, motivation, and self-control. These (motivational) competencies are posited as responsible for the development of the expertise that is needed for exceptional achievement. This way, the expertise research conducted by Ericsson (Ericsson & Charness, 1994, 1995) attacked the traditional giftedness assumption that it is necessary to have exceptional levels of ability to make significant contributions to society. Gardner (1995), a supporter of the “giftedness side”, defended the traditional conceptualization and counterattacked the Ericsson position (see also the discussion during the symposium of the CIBA foundation in Bock & Ackrill, 1993).

A closer analysis, however, shows that there is a considerable overlap between the giftedness and expertise conceptualizations. These two approaches result from different accents and not from unbridgeable opposite standpoints. Perleth (1997) – see also Klauer (1992) – points out that expertise, as well as giftedness, represents different aspects of the same reality from different points of view:

Table 1

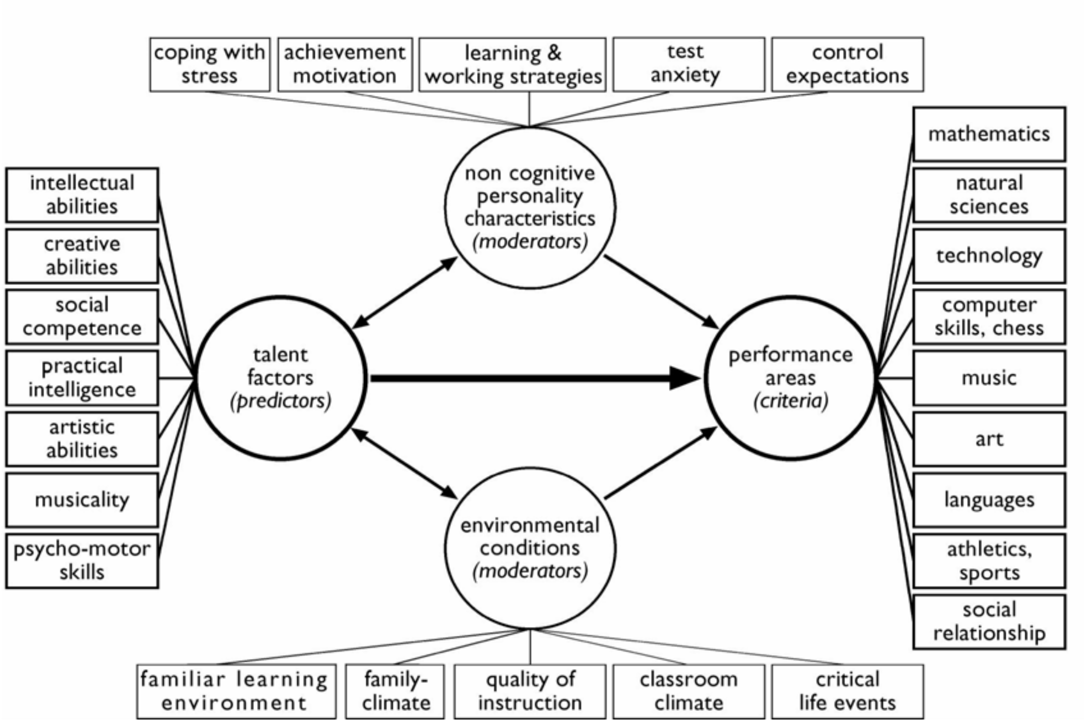
		Achievement (performance)		
		High	Middle	Low
Giftedness (competencies)	High			
	Middle			
	Low			

This table shows how both lines of research can be synthesized. Expertise researchers (Achievement columns) first investigate individuals who reach a high level of achievement (left column of matrix) independently of intelligence or giftedness. Giftedness researchers, on the other hand, concentrate on gifted individuals (upper row of matrix) independently, whether they later produce high achievement or not. The matrix clearly shows that both research streams can study individuals who at the same time have high competences and perform at extraordinary levels. All in all, more than half of the cells in this matrix contain subjects that are currently under investigation.

When comparing giftedness and expertise research, a second difference is obvious: giftedness researchers prefer prospective studies, trying to find out what happens to gifted individuals as they develop, while expertise researchers favour a retrospective approach. This means investigating the factors that are responsible for their achievement. However, the retrospective expertise research does not see individuals who fail to excel. Likewise, prospective giftedness research sometimes fails to find individuals who indeed develop extraordinary achievement (see Tannenbaum, 1992). Again, it is clear that research with individuals who have the potential for or, in fact, reach high levels of performance, should follow both research strategies. Also see Schneider (2002).

Which elements should be taken into account when constructing a model of giftedness that can integrate relevant findings from diverse fields of psychology?

***Figure 1:** The Munich Model of Giftedness (MMG) according to Heller (2001).*

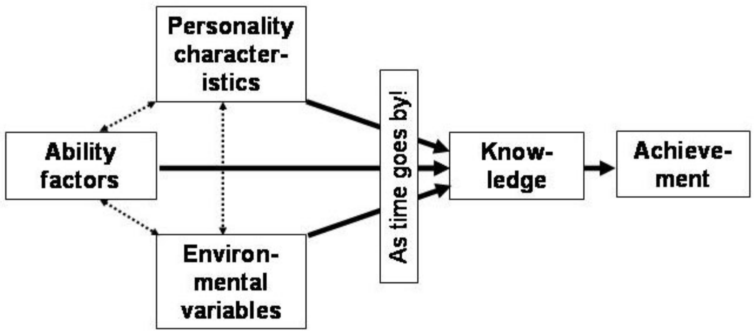


Expertise and giftedness researchers agree that analysis of giftedness and achievement has been done in a domain specific manner. Even Renzulli (1993) and Mönks (1992) distinguish implicitly different domains of intelligence. Models such as the Munich Model of Giftedness (MMG) or the Gagné model (DMGT) stress this point more explicitly. The MMG (see Figure 1) was constructed from analyses of diverse examples after examining the following considerations:

1. Taking into consideration the domain specifity of extraordinary performance: As can be seen from the figure, this model stresses the domain specifity of giftedness and achievement factors as well as the role of personality and environmental factors that moderate the relationship between ability and achievement. See Heller (2001) ode Heller, Perleth and Lim (2005) for more detailed description of the constructs in this model ("control expectations" is a construct similar to attributional styles, for the assessment of "familiar learning envioronment" mainly scales of educational styles were used, "quality of instruction" refers beyond other to classroom management of the teachers).

2. Taking into consideration that the development of extraordinary achievement needs long periods of application (exercise)*:* Giftedness and expertise researchers agree that an extraordinary achievement level can be reached only if one is ready to undertake a long, laboriously, goal oriented learning process. This long phase of application (exercise) explains why most individuals produce extraordinary achievement in only one domain. With the exception of Gagné's (2000) model that stresses learning processes in school, most models of giftedness do not reflect this demand. Even the MMG shows that giftedness ought to be transformed into achievement. Gagné's (1993, 1995) model, on the other hand, does not take into consideration the whole process of the development that is needed to produce extraordinary achievement.

Figure 2: Modification of the MMG by Ziegler and Perleth (1997).

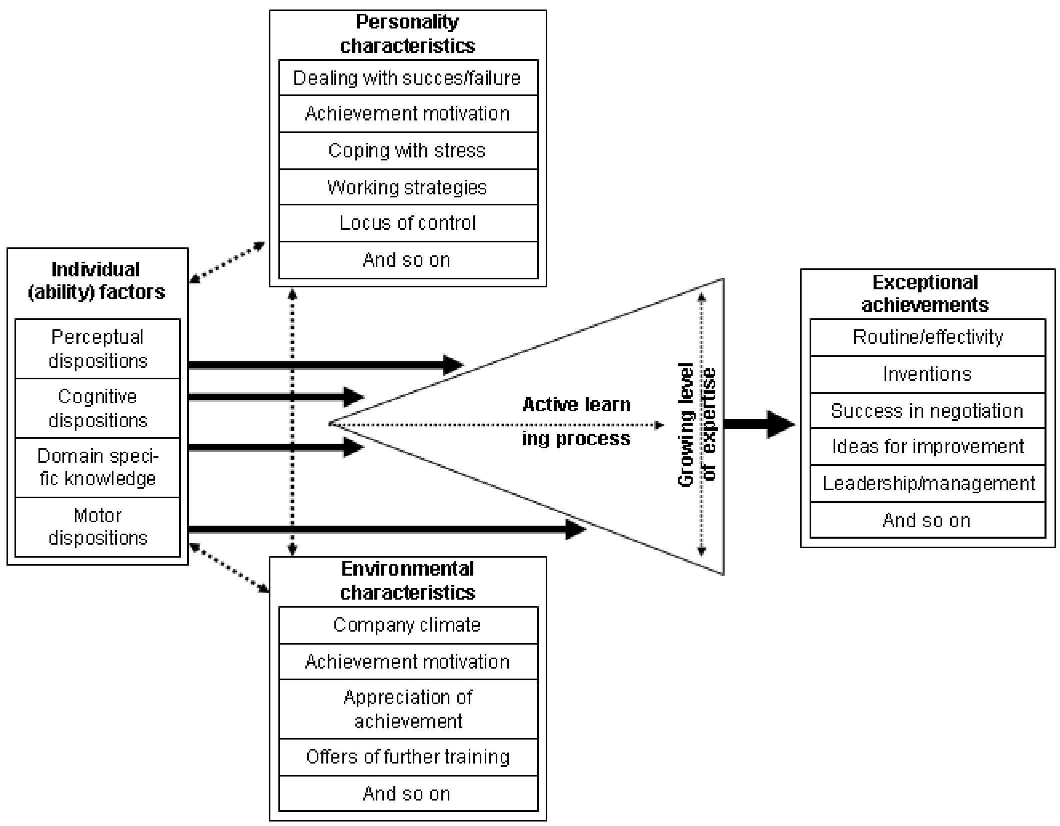


3. Separation of knowledge and general competencies: Expertise as well as intelligence research shows that a rich domain specific knowledge is a central prerequisite for exceptional achievement. Reflecting this demand, Perleth and Ziegler (1997) modified the MMG. As can be seen from Figure 2, the authors inserted a "knowledge box" between giftedness and achievement to signify the need to acquire specific knowledge. They also stressed the necessary long processes of application, even citing from the song in the Casablanca movie classic "As time goes by."

4. The quality of learning process: A decisive prerequisite for reaching a high level of expertise is the maintenance of an active and aim-related learning process ("deliberate practice" sensu Ericsson) over a long period of time. Exceptional achievement demands an active learner who is permanently ready to overcome barriers hindering the acquisition of the next expertise level. Such achievement requires the individual to push himself to his limits. Expertise and giftedness researchers agree

about the fundamental importance of personality characteristics for individuals who want to reach high levels of performance.

Figure 3: The Munich Process Model of Giftedness by Ziegler and Perleth (1997).



Ziegler and Perleth (1997) tried to integrate the demands listed up to this point for a model of giftedness in the vocational domain (Figure 3; note that this model was not used in empirical research, so the constructs have not been operationalized by the authors). As can be seen from the figure, the learning process is stressed much more now (no longer just saying "As time goes by"). Furthermore, Ackerman (1987, 1988) found that in the first phase of developing expertise, cognitive factors and specific knowledge are of major importance. In the middle phase perceptual characteristics are needed, and in the last stage, motor variables are the main determinants for differences in achievement. This research suggests that giftedness researchers should look for the personality characteristics that operate at different phases of development. This also leads to the question, "What are the cognitive functioning characteristics of gifted individuals?"

5. Giftedness as a dynamic construct: Ericsson and Charness (1994) claim that intelligence tests measure only learned knowledge. Indeed, the measurement of intelligence requires a solid knowledge base because all items or problems must have some content (be it verbal or figural one). In other words, experiences are important for the development of intelligence and giftedness. From this perspective we have to differentiate between dynamically developing giftedness factors (in the sense of traits as prerequisites for achievement) and innate basic dispositions (perception, memory characteristics, activation level, motor factors, etc.).

Besides such perceptual and motor factors, extreme expertise researchers also accept the significant importance of motivational personality characteristics. They believe that a high level of expertise can be achieved only after a long and partly laborious activity in a special domain with a high degree of motivation and a positive attitude towards achievement (Ericsson, Krampe & Tesch-Römer, 1993; Ericsson, 1996, 1998; Ericsson, Roring & Nandagopal, 2007; Gruber, Weber & Ziegler, 1996). Excellence has to be regarded as a product of giftedness as well as personality characteristics and characteristics of the learning environment.

6. Taking into account innate characteristics: An integrative model of giftedness and achievement cannot ignore the recent findings of genetic psychology. Plomin (1994) provides convincing evidence about the interrelations between genetic gifts and the influences of the learning environment. Scarr and McCartney (1983) and Plomin (1994) describe three types of this interrelation:

- Passive correlation between gifts and environment are found because children and parents share genetic and environmental influences. If, for example, a child inherits some musical ability from his parents, it is also likely that musical parents will provide a family environment in which music plays a prominent role (e.g. the family of Mozart).

- Correlations because of reactive gifts-environment-relationships occur when the environment (namely, teachers in school or other adults) reacts to the gifts of the children and offer learning opportunities in which the talents can be developed (e.g. Gauss, the son of a poor cobbler, whose teacher detected his extraordinary mathematical ability and recommended the boy to the Duke of Braunschweig).

- Finally, active gift-environment-relationships are caused by the fact that gifted children actively shape their environment after their wishes and needs by seeking out friends with similar interests (musical children chose friends who prefer musical activities).

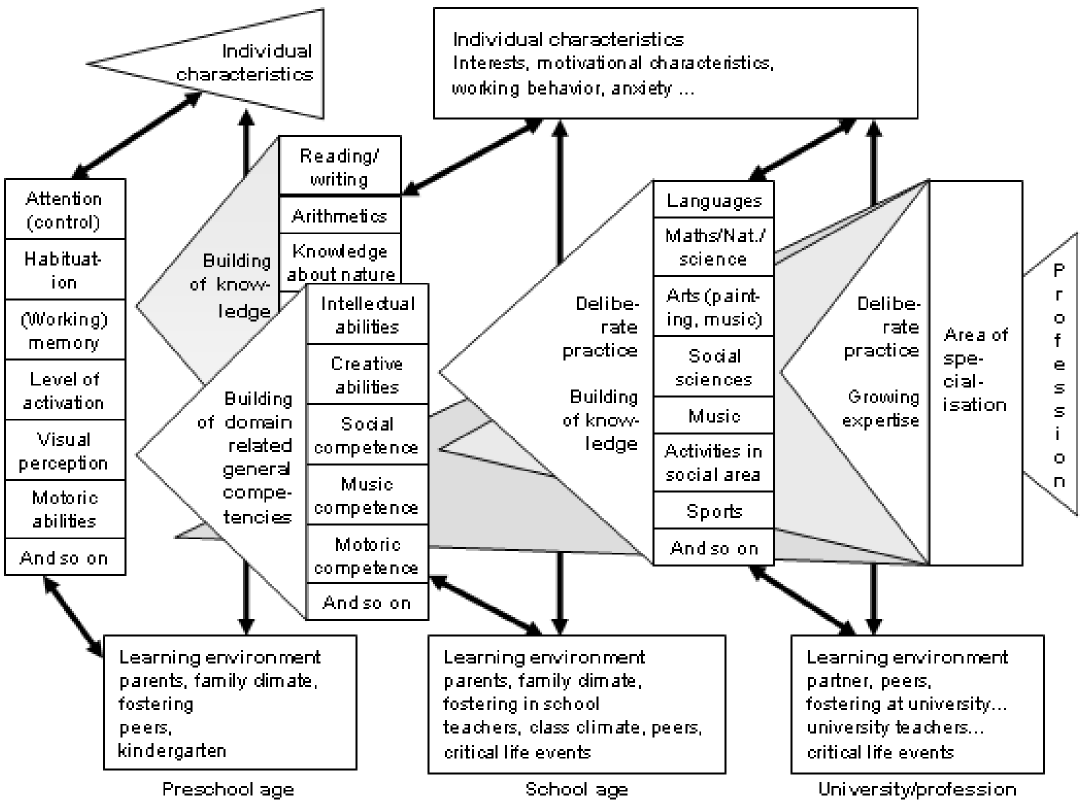
However, some expertise researchers (above all, Ericsson) have not considered taking into account the differentiated interrelations between innate factors (gifts) and environmental variables. Moreover, Ericsson´s argument that innate intelligence has no impact for achievement because empirical findings do not show differences in intelligence between individuals of different expertise levels, is no evidence against the significance of innate achievement predispositions for the development of achievement; see also Schneider (2002), Heller et al. (2005).

2. THE MUNICH DYNAMIC ABILITY-ACHIEVEMENT MODEL AS AN INTEGRATING FRAMEWORK FOR GIFTEDNESS AND EXPERTISE RESEARCH

Perleth (1997, 2000, 2001) attempted to bridge the gap between traditional giftedness research and the more process-oriented fields of cognitive and expertise research in the development of the Munich Dynamic Ability-Achievement Model (MDAAM). This integrative model of giftedness has to:

- Consider the domain-specific character of abilities and achievements;
- Take into account findings of cognitive information processing research as well as genetic psychology;
- Show how cognitive and other abilities are converted into achievements (e.g. by learning processes, amount of time spent learning, and the quality of experiences);
- Consider the acquisition of knowledge and the role of knowledge as prerequisites of achievement;
- Include personality characteristics (e.g., interests, task commitment, stress resistance);
- Pay attention to environmental variables such as family and school climate as well as the role of peers and the community of excellence;
- Has to be formulated at an appropriate level of complexity so that it is convincing to teachers as well as parents of gifted children and youth – fulfilling one of Sternberg’s (1990) criteria for a *good definition of giftedness*.

Figure 4: The Munich Dynamic Ability-Achievement Model (MDAAM) according to Perleth (2001, p. 367).



The model presented in Figure 4 attempts to integrate important perspectives of expertise and giftedness research and to put them into a common and consistent framework in the sense of the above formulated demands. Even if Figure 4 might produce an opposite impression, Occam's razor was used for the conception of the model – *Entia non sunt multiplicanda sine necessitate*. The seeming complexity is due to the examples that were chosen to illustrate the different groups of variables. No examples for the expertise domain were given because no selection seems adequate with respect to the nearly unlimited possibilities.

Individual characteristics or traits such as aspects of attention and attention control, habituation, memory efficiency (speed of information processing), aspects of working memory, level of activation, perception, or motor skills can all be seen as innate dispositions or prerequisites (left side of the model). Perleth, Schatz and Mönks (2000) regard these characteristics as representing the basic cognitive equipment of an individual.

The model distinguishes between three or four stages of achievement or expertise development that are related to the main phases of school and vocational training: preschool, school, and university or vocational training.

These stages can be roughly characterized by the classification Plomin (1994) uses to distinguish passive (preschool age), reactive (primary school age), and active (adolescence and older) genotype-environment relations. The fourth phase of professional activities is only indicated in the model and has to be completed by conception (see Ackerman, 1988). Surely it has to be expected that deviations from this sketched "normal" development will occur, especially with gifted individuals.

Certain learning processes belong to each of these stages. They serve the building up of knowledge and competencies and are symbolized by the grey triangles. These triangles open to the right indicating growth in abilities, knowledge, or competencies. The left corner of the triangles indicates when the respective learning process begins (the different tones of grey are used to make the figure clearer):

- During preschool years the forming of general domain-related competencies is assumed. These are abilities or talents that are depicted in the MMG as giftedness factors. Examples are intellectual or creative abilities, social competencies, musical or motor abilities.
- The development of these competencies is contrasted even in this early age by the accumulation of knowledge (nature, reading, writing, calculation).
- During school years the formation of knowledge in different areas is predominating (languages, natural and social sciences, arts, music, social behavior, etc.), and this knowledge has to be acquired in active, goal-specific learning processes ("deliberate practice").
- The stage of university or vocational training is the phase of increasing specialization and the development of expertise in a respective domain. Depending on the respective domain, this specialization can also start considerably earlier. Professional musicians or high-performance athletes, for example, often begin to occupy themselves with their domains as early as preschool or primary school years (symbolized by the respective long triangles in Figure 4).

The model not only identifies ability factors and knowledge domains as well as the respective learning processes, but it also highlights personality (motivational) characteristics that are important for the development of achievement and expertise. As shown in the model, these traits develop during preschool and the first years of primary school (see also Helmke, 1997), and they are conceptualized as being relatively stable during secondary school, university, or vocational training.

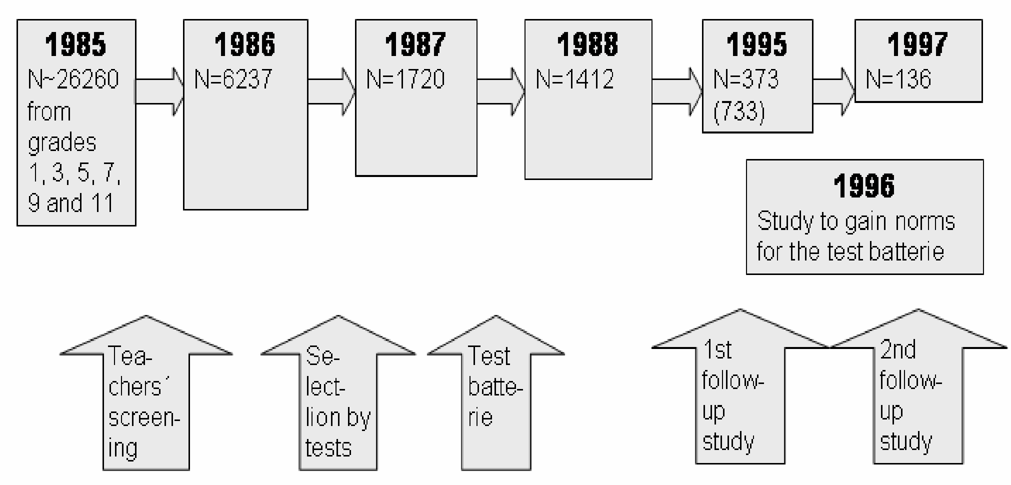
Finally, aspects of the learning environment are emphasized in the model. Different factors for the three main stages of development are specified for the development of achievement and expertise (see Figure 4 for more details). All in all, the influence of the family dominates in the first years, and then the characteristics of the school's learning environment (extra courses for the fostering of the gifted, school and class climate, extra-curricular activities, etc.) gain more and more influence. At the same time, the importance of friends and like-minded fellows increases. A more detailed description of the model is provided by Perleth (1997, 2001); see also Heller, Perleth and Lim (2005).

3. RESULTS

3.1 Found by applying the Munich Dynamic Ability-Achievement Model (mdaam) to data from giftedness research

The MDAAM was developed in context of the Munich longitudinal study of Giftedness (see Heller, 2001), and we will use data from this study to illustrate components of the model. The complete design of the study can be seen from Figure 5. The study began in 1985 with 26,260 students from six cohorts. In a first step (1985) the students have been selected on the basis of a teachers´ screening/ratings for each of the 5 giftedness factors under investigation. The second selection step was based on a test battery (1986); again the top scorers in each of the giftedness domains were selected for the next times of measurement of the study. After these two selection steps, data were collected from 1,720 and (due to drop outs) 1,412 students respectively in 1987 and 1988. The tests and questionnaire battery that were used contained scales for assessing the constructs of the original MMG described in Figure 1, i.e. not only giftedness factors but also personality and environmental variables.

Figure 5: Overview on the design of the Munich Giftedness Study; see Heller (2001).



The results of this study are reported at greater detail elsewhere (Perleth & Heller, 1994). In this chapter we will report evidence from two follow-up studies (Perleth, 1997, 2001). In 1995, Perleth sent a questionnaire to those 733 participants of the Munich Giftedness Study who had voluntarily given their addresses to the research team in 1988. This 1995 questionnaire collected data about the students' school, university and vocational activities. The focus of this study was on the prognostic validity of the test battery. We wanted to determine the students' school and academic achievements as well as their choice of a university major or their selection of a vocation. Unfortunately only 373 student sent back the questionnaire.

In 1997 we administered another questionnaire to about 50 % of the 1995 sample. For this follow-up we concentrated on participants who showed above average achievements (e.g., good results in a regional competition in mathematics or sciences) or who had specialized (e.g., demonstrated growing "expertise" in their university studies) in one of the following domains: mathematics and sciences, music, and social activities. We then assembled a control group from participants with quantitative intelligence similar to the math/science group but without signs of above average achievement or the acquisition of expertise in this domain. A second control group consisted of hobby musicians. Lastly, a control group of (moderate) experts in diverse domains was established. This 1997 study examined the factors that, according to the model, favor above average achievement and the acquisition of expertise. While the 1995 follow-up study followed a prospective approach, the 1997 follow-up was retrospective in character, i.e. we also asked for learning activities and factors of the learning environment reaching back to the students' childhood (see below for additional information).

In 1996 an additional study was carried out to create norms for the instruments used in the study mentioned above. This was done as a quality control measure as many new constructed (not yet standardized) tests had been used in the longitudinal study. The results showed that the gifted participants in the Munich Giftedness Study were more than one standard deviation above the mean with respect to general intelligence (all forms of giftedness, not only intellectually gifted!). So the conclusions drawn from the data proved to be reliable.

3.2 Results from the prospective first follow-up study (1995): Where do the gifted go?

Although the sample was considerably reduced between 1988 and 1995, the results from the first follow-up study fit very well with the results found in the first years of the Munich longitudinal study of giftedness (see Perleth & Heller, 1994) and with other longitudinal studies (Weinert & Helmke, 1997). The results can be summarized in the theses that follow.
During school time the academic achievements, especially the overall score of the "Abitur" (German high school diploma that had been achieved by a part of the sample after 13 years of schooling), can be prognosticated in a satisfying manner, above all by the "academic" giftedness factors (total score of verbal, quantitative, figural intelligence: $r = .36$ to $r = .48$; see Perleth, 1997, 2001). This finding shows the importance of the giftedness factors that are associated with the acquisition of achievement and expertise. In the MDAAM, innate giftedness dispositions, such as the speed of information processing or visuo-motor coordination, show no substantial relation to later academic achievements ($< r = .20$).

When trying to predict domain-specific achievements during a student's university studies, however, the giftedness variables play a considerably minor part. This also holds true with respect to intellectual abilities. Here the knowledge acquired in school (measured by school grades received in the last two years of school) plays a much more prominent role ($r = .36$). Taken together, the findings underscore that giftedness variables are important for getting a solid knowledge base, whereas the knowledge itself is of crucial significance for acquiring expertise.

In addition to the findings reported so far, it can be said that domain-specific prediction of achievements results in higher correlation coefficients. However, these findings are restricted to relationships between intellectual ability and creativity and respective domains of achievement. Furthermore, there were also findings that show negative relations between the social activities and achievements of engineers during their time at the university.

The data from the 1995 follow-up study provide evidence about the prognostic role of personality variables. However, the results did not show that motivational, emotional, or learning environment variables play a significant role in the development of overall school achievements. This somehow disappointing result might be due to the fact that on the one hand the scales used were not sensitive enough to uncover correlations between emotional or motivational variables and achievements, while on the other hand, because of the small sample, relatively simple statistical tools had to be used. After all, for participants who choose different domains for their university studies, some differences concerning interests and leisure time activities could be found. All in all, it could be shown that the choice of the university major subject follows an individual's interests and activities in school.

3.3 Results from the second follow-up study (1997): Where do the experts come from?

For this exploratory study we asked participants to indicate their degree of specialization or expertise acquisition in the domains of mathematics or engineering, science, music, and social activities. Following Gruber and Mandl (1996) we cannot call them experts (on an international level) but semi-experts.
The individuals in the control groups were chosen from students with the following credentials:

1. They scored high in quantitative intelligence in the first phase of the study;
2. They had shown hobby activities in music without reaching an above average level (e.g. prize in a regional competition);
3. They had selected other domains of specialization (than those above).

The questionnaire asked the participants to examine the first steps of their domain of expertise; the role of their parents, teachers, and peers; characteristics of their learning environment (family, school); competitions and performances; university experience; and vocational training as well as current activities in the domain of expertise. In addition, we were able to use data from the original battery of tests and questionnaires to supplement our findings. Table 1 gives an overview of the sample for this second follow-up study (1997).

Table 2: Sample of the second follow-up study (where does the expert comes from?); see Perleth (2001).

	male	female	Total
Math/Science control	9	20	29
Math/Science experts	23	11	34
Simple hobby musicians (control group)	6	21	27
Excellent hobby	3	6	9
Engaged in social activities	8	11	19
"Self chosen domains"	12	14	31
Total	61	88	149

Due to the small size of the sample, the results will be presented using descriptive tools in line with the ideas proposed by Hoaglin, Mosteller and Tukey (1985). In addition, following the usual conventions, simple analysis of variance was used to evaluate the differences between the groups under investigation.

1. ***Are experts distinguished from the members of the control groups with respect to giftedness variables during early stages of the development of expertise?***

Even if the differences hardly reach significance, a trend can be seen that the experts score a little higher in giftedness variables than the members of the control groups. While it is obvious that the experts in math and science outperform their controls in quantitative intelligence ($d \approx 0,3$), it can be taken as a little surprising that this superiority also holds true for verbal intelligence ($d \approx 0,35$). With respect to social competencies, on the other hand, the math/science experts describe themselves as less competent ($d \approx 0,6$).

The excellent hobby musicians show a slight superiority over their controls with respect to cognitive abilities (d≈0,4), and they are also rated as more gifted and higher achieving by their teachers (d≈0,7). This unexpected finding can perhaps be explained by the possibility that more intelligent students can do their homework more rapidly and thus have more time to invest in music. But the school grades of our music experts were no better than those in the control group. No further differences in giftedness variables were found. Interestingly, this also holds true for motor skills variables. In the (German) handbook of music psychology (Bruhn, Oerter & Rösing, 1993) no such findings are reported, and relevant tests of musical ability do not correlate with the content subtest for motor skills (Butsch & Fischer, 1966).

All in all, only weak relations between giftedness variables and the groups under investigation were found. The resulting patterns of correlations indicate, however, that the different groups of experts and controls correspond to different patterns of abilities.

2. ***Do experts distinguish themselves from the members of the control groups with respect to personality characteristics (motivational and emotional) and interests during early stages of the development of expertise?***

The expert and control groups under investigation do not differ substantially with respect to personality (motivational, emotional, etc.) variables. However, the MDAAM postulates a significant difference of personality characteristics such as motivation, working behavior, or anxiety in the development of achievement. A reason for this finding might be due to the fact that the scales used in the Munich longitudinal study of giftedness are formulated in a general manner with respect to school learning, and since most of the participants of the Munich giftedness study, especially those of the expert and control groups, were well motivated and high achieving students. The scales might not have been able to separate these groups of strong students.

This interpretation is supported by the fact that differences could be found only in the scale that includes more specific items in the domain of math and science. A trend in favor of the math and science experts could be found here (d≈0,6 with respect to the math controls).

A different situation was found with respect to interests and domain-specific activities. The math and science experts did have higher levels of interests (d≈0,#) and more activities in their later domain of specialization (d≈0,#). The excellent hobby musicians showed high interests and numerous activities in the music domain, but they did not differ from their controls. Therefore the findings give no hints as to why some of them succeeded in the competitions or in reaching other excellent achievements in the field of music.

3. **Do experts distinguish themselves from the members of the control groups with respect to achievement variables (teacher ratings and school grades) during early stages of the development of expertise?**

Similar to the results concerning interests and activities, the math and science experts had the best school grades in mathematics and related subjects (d≈0,#), while the music groups surpassed the other groups but did not differ from one another. The latter holds true even for a special rating given by the music teachers (d≈0,#). However, no differences for the excellent and normal hobby musicians were found in variables such as perfect pitch, feeling for rhythm, and other criteria for musical ability (Seashore, Lewis and Saetveit, 1960). In school subjects such as German or English, no differences could be found at all between the different expert and control groups. All in all, each of the groups in the study showed above average school achievement.

4. **Do experts distinguish themselves from the members of the control groups with respect to the active goal related learning processes (deliberate practice) including support from persons of the learning environment?**

With respect to teachers' ratings, the math and science experts, as well as the excellent hobby musicians, turned out to have slightly higher task commitment, more problem solving abilities, and higher learning abilities (d≈0,#). This hint to differences in variables of the learning process is confirmed by the statements or ratings the members of the different groups made in the 1997 questionnaire. The experts (and excellent hobby musicians) reported to have begun activities in their domain of specialization early with a higher investment of time in the first months and years.

Further on, the experts in our study report more opportunities for activities in their special domain in their home and enthusiastically refer to the support they received from their parents. With respect to the offers of schools (special study groups, and additional instruction), the math and science experts made a more extensive use of offers related to their domain.

In the domain of music, the fostering of private and family domains are much more crucial than the offers of school. These young people are willingly playing in the school orchestra, but they do not make use of special offers of music instruction in school because the level of this instruction is too low for them. The support of a group of peers with similar interests and a comparable level of competence was most important for the excellent hobby musicians. The members of the peer group were also very important in this respect, even more important than teachers and parents.

Finally, the results of the 1997 questionnaires show that domain-specific competitions, e.g. Math and Science Olympiads (see Campbell, Tirri, Ruohotie & Walberg, 2004; Heller & Lengfelder, 2006) and music competitions, play an important role as incentives to increase competence. It can be concluded that the learning environment plays a crucial role in the development of expertise and achievement.

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