Towards a Systemic Theory of Gifted Education

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Running head: Towards a systemic theory of gifted education

Abstract

In this target article, we argue that current approaches to gifted education are based on the erroneous view that to understand the development of exceptionality we need to understand firstly the components of giftedness, including cognitive such as intelligence and non-cognitive factors such as motivation. In contrast, systemic approaches to understanding exceptionality focuses on the interactions of these components where it is important to firstly understand the system that leads to exceptionality before it is possible to understand its components. After analyzing the weaknesses of current approaches to gifted education we then present three central arguments for the need for a paradigm shift. This is followed by an introduction of constructs of a systemic approach of gifted education. Using the actiotope model of giftedness to understand the development of exceptionality, this article describes the basic principles of a gifted education that is based on this systemic approach.

Keywords:

actiotope model of giftedness; gifted education; systems theory; exceptionality

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1. Introduction

Talent and giftedness research has traditionally focused on an exclusive group of individuals with the potential for exceptional accomplishments in one or more area (Heller 1989). An alternative perspective views systems as the origin of excellence and of its potential to develop excellence (e.g,. Phillipson & Callingham, 2009; Phillipson & Sun, 2009; Ziegler, 2005, Ziegler & Stoeger, 2004a). Such a system comprises 1) the individual, including her or his subsystems, and 2) an individual's external environment.

This target article describes our effort in constructing a systemic theory of gifted education. This conceptualization offers a theoretical and practical alternative to an entrenched method of educational support—more or less unchanged for a century—based on acceleration, enrichment, ability grouping and on targeted financial support, usually provided in the form of scholarships (Petersen, 1916; Ziegler, 2008). Since the change we describe is monumental, it is appropriate to speak in terms of a paradigm shift.

The need for new paradigms is both legitimate and necessary whenever existing paradigms become entropic or stagnant and no longer address current demands (Kuhn, 1962; Lakatos & Musgrave, 1970). Thus we will use the first two sections of this article to justify and develop the systemic approach to gifted education by juxtaposing it with current methods.

2. Current Approaches to Gifted Education

An understanding of the theoretical premises upon which current approaches to gifted education are founded helps explain its problems. We commence by discussing the bases of current approaches to gifted education and will proceed to an analysis of its educational objectives. Lastly we will explain in what regard current research into giftedness is more advanced than the current practice of gifted education. Nevertheless, there are still serious deficiencies in this research that precludes any sustainable development in gifted education.

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2.1 The roots of current approaches to gifted education

Pioneers of giftedness research such as William Stern (1912) in Europe and Lewis Terman (1922) in the United States were firmly rooted within the tradition of the scientific revolution of the modern era. Their strengths as well as their weaknesses influenced their output and were formative for the nascent discipline of giftedness research.

The scientific revolution of the modern era reflects the contributions of two illustrious thinkers. Galileo Galilei directed scientific attention towards those phenomena which could be measured, quantified, and described through the maxims of natural laws (e.g., Sharratt, 1994; Weidhorn, 2005). Exploration of the human mind, as we find it today in phenomena such as IQ measurements, would be impossible without his contributions. René Descartes's fruitful development of these ideas a generation later was a logical next step. His analytical method was based on the premise that a complex phenomenon is best understood by identifying its component parts and explaining the overall phenomenon through understanding the combined effects of these (e.g., Gower, 1997; Gullberg, 1997).

At that time it was not a coincidence that the machine was the dominant metaphor for explaining the natural world: To understand the world it is sufficient to simply identify its component parts and how they are put together. A mechanistic view relies on discovering and applying the laws that govern the interactions of its parts.

The undisputable success of the mechanistic metaphor—especially in physics, which was long viewed as the preeminent scientific discipline—explains why this view of science remains popular. Indeed, almost all current models of giftedness function within this tradition. Giftedness is dissected into its measurable component parts. Viewed together, these component parts are meant to facilitate the prognostication of above-average or excellent achievements.

Given this context, it is not surprising that multifactorial models of giftedness (e.g., Gagné 2004; Heller 2005; Mönks 1992; Tannenbaum 1983) are currently the most influential theories of giftedness by a wide margin. These models identify an ensemble of factors which represent giftedness. Typically they distinguish between three types of factors, including those factors that:

- Pertain to giftedness in the narrower sense (e.g. verbal, nonverbal, and quantitative abilities);
- Include non-cognitive internal factors (e.g. motivation, control beliefs, anxiety); and
- Include external factors (e.g. friends, classroom climate, home environment).

The assumption is that knowledge of the nature and effects of these factors will allow for the prediction of exceptional accomplishments. The fingerprint of an approach to science rooted in the tradition of Galileo and Descartes is clearly recognizable here.

The mechanistic approach is most easily recognized in the processes for identifying giftedness (Ziegler & Stoeger, 2008a). For example, Heller's and Perleth's (2007a, 2007b) Munich Giftedness Test Battery (MHBT) follows this method. The authors reduce a given case of giftedness into numerous components (e.g., thought and learning potential, knowledge, originality, social, verbal, quantitative mathematical, and nonverbal capabilities, as well as originality, cognitive flexibility, social cognition, expectations of success, fear of failure, attentiveness, quality of instructional support). Reflecting on the inadequacies of the mechanistic approach, commonly referred to as Laplace's "demon", we believe it is flawed to suggest that measuring each of these factors can provide the basis for predicting exceptional performance.

2.2 The Practice of Gifted Education

Traditional approaches to gifted education are based on the implicit assumption that protecting gifted individuals from inhospitable surroundings should suffice for ensuring that the most can be made of their potential.1 Such a strategy represents an autocatalytic approach to gifted education and it is precisely in this respect that we can see how the current approaches to gifted education have fallen behind the mutifactorial models of giftedness that specify both the internal and external requirements which need to be fulfilled before potential can be realized. Yet it remains the case that more than 90 percent of the funds allocated for gifted education are channeled into a number of well established strategies (Ziegler & Stoeger, 2004b). These strategies and their justifications include:

- scholarships which are supposed to protect talented individuals from disadvantageous financial circumstances and the threat such conditions pose to their financial independence during their studies;
- ability grouping (e.g., schools or classes for gifted individuals) which ensure that gifted individuals are not held back by the slower pace of learning among individuals of average abilities;
- accelerating programs which are also intended to prevent gifted individuals from being held back by the lower learning speeds of their peers;
- enrichment programs aimed at adding breadth and depth to the learning experience and to forestall any peer influence which could slow the pace of learning;
- pull-out programs which combine the benefits of acceleration, enrichment, and ability grouping through the temporary removal of gifted students from regular instruction for special instruction.

Typical of these support efforts is that they are hardly tailored to individual needs and instead applied to groups. We argue that not one of these strategies truly focus on improving the learning competencies or motivation of individuals. In reality, these approaches are mainly defensive because they are aimed at <u>protecting</u> gifted individuals from deficiencies in

1 We use the term “gifted individual” to refer to those with a statistical probability for outstanding performance, rather than an individual with a particularly personality or intellectual trait.

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the learning-environment. In particular, an education system that focuses on the learning of individuals with average abilities is seen as detrimental to those students with the potential for exceptional achievement.

Using the parlance of inclusive education, this approach focuses on the “deficits” of the education system. Hence, any support measures for gifted students are designed to overcome these deficits and based on the premise that giftedness is a personal trait that compels individuals in an autocatalytic manner towards exceptional performance.

This premise also makes it necessary to identify gifted students before implementing support measures. In Hong Kong, for example, the gifted education policy is heavily reliant on trait models of giftedness, referring concurrently to the Marland definition of giftedness, psychometric intelligence and multiple intelligences (Phillipson, Phillipson & Eyre, in press). At exceptional levels of giftedness, corresponding to Tier-3, it is increasingly more problematic to identify the target students.

2.3 The Focus on Variables in Traditional Research

In the current paradigm, educational research has focused on identifying a list of variables that can support the development of excellence. Such variables include interests, creativity, and attributions (see the overviews provided by Colangelo & Davis, 2003; Davis & Rimm, 2004; Heller, Mönks, Sternberg, & Subotnik, 2002, Shavinina, 2009). Indeed, the problem with these measures is that they usually focus on just one variable. In this sense they remain stuck in the tradition of analytic approaches going back to Descartes. The implicit hope accompanying such efforts was that a focus on precisely one or another variable should have a generally positive effect on learning ability. The problem, however, is that this hope has remained unfulfilled. A general improvement in performance based on the encouragement of any one particular variable has yet to be documented. Probably the single most unambiguous result is that, to the contrary, pedagogic support focusing on one particular

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variable or a small number of variables demonstrates little to no efficacy. In the few cases (e.g., Lipsey &Wilson 1993) in which such measures have shown a salutary effect, the benefits have remained temporary and limited to the particular target variable.

3. Reasons for a Paradigm Shift to Systemic Gifted Education

Largely rooted in the mechanistic research paradigm, current approaches to gifted education have been in place for about a century, thereby accruing a considerable body of practical experience. Clearly, any shift from this approach should not be made lightly. In this section, we will establish that current approaches to gifted education are largely ineffective and provide what we believe are compelling reasons why a systemic approach to gifted education offers a better understanding of the causes of this lack of efficacy. We also provide evidence that a systemic perspective will lead to a better understanding of the development of excellence.

3.1 Ineffectiveness of Traditional Gifted Education

The 1990s witnessed a severe crisis of confidence within gifted education. Lipsey and Wilson's (1993) meta-analysis on the best research available at that time concluded that gifted education was not even remotely capable of supporting talented students in reaching their potential. Based on evaluation studies which fulfilled certain standards of quality, Lipsey and Wilson calculated average effect sizes and showed that the effect sizes ranged from minimal to, at best, moderate.

Moreover, Lipsey and Wilson (1993) conjectured that there was a systematic overevaluation of the actual effects since the research failed to account either publication bias or placebo effect.2 Once these two factors had been accounted for, traditional gifted education

[2] Publication bias describes the phenomenon in which researchers as well as the editors and publishers of scientific journals prefer significant positive results to those which are negative or
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proved to be almost completely lacking in efficacy. Simply put, the empirical basis of traditional gifted education had been discredited.

How could this situation have developed? How was it possible that giftedness researchers could seemingly fool themselves for so long? Joan Freeman (1998), a former president of the European Council for High Ability (ECHA), concluded that most research on gifted education consisted of anecdotal reports, single case studies, or advisory processes and, significantly, lacked control groups. It is not surprising that researchers in related fields are generally critical of the quality of the research in gifted education (Craven, Marsh, & Print, 2000).

Several countries have since commissioned reevaluations and field surveys of existing gifted education programs. For example, Comford Boyes, Reid, Brain, and Wilson's (2004) report to the British government found only tenuous evidence for the efficacy of accelerated learning which, in Lipsey's and Wilson's (1993) meta-analysis, had performed best among gifted education strategies. There was, in addition, clear evidence of a placebo effect and of "enthusiastic marketing" of the support strategy. A new meta-analysis of accelerated learning (Steenbergen-Hu & Moon, 2011) also found small to moderate effect sizes for the individual support strategies which would, however, almost disappear when publication bias and placebo effects were taken into account. The net gain of a century-long investment in gifted education is very discouraging.

3.2 Reasons for Not Achieving Support Goals

Whether or not the commonly accepted strategies for supporting the learning of gifted students are effective is a question of fundamental importance. If the answer is no, this

inconclusive. This leads to the latter sorts of results being underrepresented in research literature. Reports about measures or programs in gifted education which turned out to be ineffective were thus less likely to be published. Consequently, such negative results could not be considered in the meta-analyses (Dickersin, 1990; Sackett, 1979).

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suggests that a paradigm shift in these strategies is necessary.

The success of any shift in current strategies depends on being able to recognise the reasons for the low level of efficacy achieved thus far. Disturbingly, it appears that few researchers have realized that its educational strategies are largely ineffective. A review of standard literature reveals this state of denial (e.g., Colangelo & Davis 2003; Shavinina, 2009). And if this lack of efficacy is admitted, it is only for single programs not the current gifted education in general. The explanations for the failures can be categorized into three groups: A program has failed because 1) it is fundamentally ineffective; 2) it is applied in the wrong context, or 3) it is incorrectly implemented.

As an alternative, systemic gifted education offers a considerably more differentiated apparatus for analyzing educational measures: it envisions five important additional possible causes of failure, which are very important in practice as well. We will now take a closer look at all of five reasons, including the three reasons cited by traditional gifted education and two additional reasons indicated by the systemic perspective. In concert, all of these explanations permit more effective explanations of why a potentially successful educational measure can remain ineffective.

The possible reasons for the ineffectiveness of current approaches to gifted education include:

Reason 1: The simplest case

The simplest explanation is that a particular educational measure is ineffective. This avowal of failure focuses on its fundamental lack of efficaciousness rather than inapprotioate conditions or happenstance, for example. However, abandoning current approaches strategies and moving on to new possibilities is anything but trivial. The modest effect sizes associated with the traditional strategies in gifted education raise the question as to whether they (perhaps with the exception of acceleration) really do represent the simplest case.

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Reason 2: Applied in wrong context

The strategies taken to develop excellence need to be based on a correct diagnosis of what an individual needs in order to develop. However, individuals are frequently assigned to educational programme without fully justifying these needs (Ziegler & Ziegler, 2009). In such cases, the educational measure can either fail to have a beneficial effect or, in the worst case, they can be detrimental.

Reason 3: Incorrect Application

Improper application can also cause educational programs to fail, rather than the program per se. For example, acceleration is sometimes introduced without sufficient pedagogical supervision or attention to the needs of the individual. This can lead to an underestimation of its potency as a strategy for the development of excellence.

The next two reasons are derived from a systems perspective.

Reason 4: Asynchrony

The selective encouragement of one system over another can lead to asynchrony. A partial change in a system may not suffice to effect permanently the desired change of behavior in a system. For example, motivating a student to study for an important math test, without providing adequate guidance on learning strategies may be of little benefit to her or him. Although a successful motivational activity will cause the student to invest more time in learning, a lack of proper contextualization of such efforts may not necessarily lead to better performance. As such, improper contextualization may even have a negative effect on motivation over the longer term.

For gifted individuals, it is important that support strategies be co-evolutionary or co-adaptive in nature. For example, as learning is completed successfully, the achievement needs

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to be anchored in an individual's self-efficacy beliefs and the learning environment needs to be redesigned to incorporate new learning opportunities in anticipation of the next step in the learning process. Furthermore, the teacher needs to be fully aware of the new level of competency and be aware of the need to adapt future learning activities at the appropriate level of difficulty and with the relevant feedback.

Reason 5: Structural Deficits

From the systemic point of view, a significant cause of the ineffectiveness of any strategy may be because the appropriate structures are lacking. The two most obvious examples of structural deficiencies in the context of school learning are a student's lack of the necessary prerequisite knowledge and a lack of attentiveness. If these components are not taken into account, then any strategies are likely to be ineffective.

We can observe also a dysfunctional structure working against the strategies used to encourage talented girls to participate in the domains of science, technology, engineering and maths (STEM) (Stoeger, 2004). For girls, this structure has its basis in the socialization processes that dictate their appropriate behaviors and careers, and the strategy involves the using exceptional female scientists as role models (Eckes, 1994). For example, Marie Curie, the (twice) winner of the Nobel prize, is often presented as such a role model but girls are not able to relate to her because her achievements make her appear inaccessible. Instead, girls develop the notion that to make it as a woman in the natural sciences would require a rare and unlikely sort of genius.

Interestingly, boys can be motivated to pursue a career in science after being exposed to models of successful female scientists (Ziegler & Stoeger, 2008b). For these boys, the depiction of highly successful female scientists leads them to conclude that success in science cannot be all that hard.

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Reason 6: Stimulus Deficit

Strategies in gifted education may also be ineffective because the level of input may have simply been too low to effect a change. For example, enrichment strategies may be ineffective because they are typically used on an occasional basis rather than as they are intended (Council of State Directors of Programs of the Gifted, 2001; Gagné, 2007). Stimulus deficits arise when an inadequate amount of time is allocated to a particular strategy, when the frequency level is too low, when the circumstances are unusual, or when individual students receive do not receive the required frequency of teacher feedback. An example of the latter occurs when teachers of large classes are not able to provide students with the feedback necessary for the development of a more effective learning style.

Reason 7: Hysteresis

Hysteretic systems are unaffected by unexpected changes in one or more components of the system. The following classroom example illustrates this point. Consider a female student who is hoping to correctly answer 80% of the questions on a test. If she achieves only a score of 78% she has fallen short of her goal. However, we do not expect her to alter fundamentally her study habits. From a systems perspective, we are observing a system which is not sensitive enough to react to a modest change.

Reason 8: Neutralization

From a systems perspective, gifted education is concerned with the development of a fully functional system. As a system, it should be remembered that systems have myriad ways to maintain their current state through processes of compensation, tending to hobble the development of learning. Two examples illustrate how the processes of compensation can work:

- A male student receives a poor grade in his geography test. Instead of attributing the grade to his insufficient preparation, he invokes bad luck as the cause of her poor performance. Such an attribution precludes any change in study habits and a continuation of the status quo.

- A female student is given special encouragement that is designed to raise her interest in physics. Yet when she watches television in the evening she only sees men working in STEM fields. Her sense of social reality neutralizes any attempts to encourage her interest.

The two examples make clear just how important it is for educators to consider neutralization effects when devising educational measures of encouragement.

3.3 Excellence Is the Product of a System

Many studies have examined how individuals have accomplished unusual achievements. Vaillant (1977), for example, observed that the most successful Americans did not usually distinguish themselves because of their exceptionality during their adolescence. However, they were educated in environments that offered a high degree of positive social encouragement. Roche (1979) corroborated Vaillant's observations through an analysis of the 4,000 persons listed as leaders in U.S. business and industry in the "Who's News" section of the *Wall Street Journal*.

In perhaps the most cited analysis in this field, Bloom's (1985a) account of interviews with 120 people who had distinguished themselves in various fields such as swimming, tennis, sculpture, piano, mathematics, and molecular genetics indicates that such people tended to be nurtured in learning environments which were highly effective and well suited to their individual needs (Bloom, 1985b).

Reflecting on the results of his own study of exceptional individuals, including Nobel laureates, and famous artists, Csikszentmihalyi (1996) concluded that excellence is not situated in the individual but rather a manifestation of a system which consists of the individual and their environment. In his view, one is "gifted" when a series of complementary

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factors co-occur, including a nurturing home environment, good teachers and schools, excellent learning conditions outside of school (e.g., good national programs for encouraging talent in selected domains), amongst others.

All subsequent studies have come to similar conclusions: individuals who have achieved excellence share environments that facilitate learning (Sosniak, 2006). Clearly, explanations which situate giftedness within the individual—the IQ concept for instance—represent a gross oversimplification. Rather, the learning environment plays a pivotal role in the development of exceptionality.

4. The Systemic Approach

Attempts to understand giftedness using a mechanistic perspective are based, we believe, on the erroneous premise that it is possible to understand the whole when each of the discrete components is understood. Systems theory offers an alternate perspective on the relationship between components and the whole: rather than explaining the whole when the components are understood; an understanding of the whole allows us to understand its components. In other words, systems theory focuses on the contextual organization of its components and not about the components *per se*. Thus, systemic thinking is always concerned with the context and can be considered the antithesis analytical thinking.

A contextual approach to understanding the development of exceptional achievement sees more than just the implementation of some sort of internal “talent software”. A staggering number of studies, some of which are cited earlier, make it crystal clear that individual pathways towards exceptionality are highly variable in nature. Each individual interacts with his or her environment uniquely and any achievements can be interpreted as the successful end-point of this interaction. Shavinina and Ferrari’s (2004) collection *Beyond Knowledge: Extracognitive Aspects of Developing High Ability* offers a plethora of such examples.

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4.1 The system concept: Some Introductory Remarks

The term *system* comes from the Greek σύστημα. It describes a stable configuration of interacting elements which together form an entity. Its entitativity is perceived on account of a unifying meaning or goal. Typical examples encountered in gifted education are groups of students in the same grades, classes, and schools as well as individuals' families and actiotopes. The characteristics and behavior of the system are determined by the characteristics, organization, and interactions of its component parts. At the same time, the characteristics and behavior of the system provide the structural parameters which control the system's components and their interactions. These are the structures which organize and preserve a system.

We do not as yet have a unified, universally accepted systems theory. The identification of a system as well as the focus of analytic attention on certain components and their interactions (and the resulting exclusion of other elements and their interplay) remain subjective decisions to be made by each researcher in accordance with the goals of her or his research interest. This lack of clarity has given cause to question whether a system can be understood as a real entity. Indeed, there are distinct advantages in viewing a system as a *model* of reality and thus as something which is inherently neither right nor wrong but rather more or less scientifically useful. This view raises an important question within systemic giftedness research about how one can meaningfully identify relevant systems. What belongs to a system? What exists outside of the system and thus belongs to the system*'s environment?* The latter question reminds us of the fact that each system is itself part of a group of systems which together manifest the characteristics of a higher-order system.

We do not claim to have ready answers to these questions. They have to be found by those scholars in research in gifted education researchers who seek the best educational approach for the development of exceptionality. Rather we want to point to the framework in

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which these answers have to be given. In doing this we will now look at six central concepts of systems theory, including equifinality, context dependence, interdependence, interconnectedness, levels of systems, and phase transition.

4.2 Equifinality

The mechanistic approach usually postulates a direct cause-and-effect relationship. One example of a mechanistic approach to giftedness is the WICS theory (Sternberg, 2003), where exceptionality depends on the interactions of three basic components, including highly developed intelligence, creativity, and wisdom. In contrast, systems theory assumes that one and the same outcome can be achieved from various starting points and can take a multitude of trajectories. In the domain of chess, the minimum IQ score necessary to become an international chess champion was estimated to be as low as 95 points (Grabner, Stern, & Neubauer, 2007; Moxley, 2009). Garry Kasparow, one of the all-time greats of chess, returned results on creativity tests which placed him behind the average college-preparatory high-school student (Ziegler & Phillipson, in preparation). In other words, the ensemble of conditions regulating high achievement is highly varied from case to case. Thus, one can only determine for each individual case which components must productively collaborate in order to acquire exceptionality.

4.3 Context Dependency

As we have already stated, systemic thinking is always contextual thinking. A child's personality as well as their intelligence, interests, and capabilities are always a reflection of the ontogenetic environment in which she or he has acted. There is a strong likelihood that a child who grows up in a family of musicians will learn an instrument; and a child of an avid chess player is more likely to become good at that game.

Within the field of giftedness research, Haensly, Reynolds, and Nash (1986) were the

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first to consider systematically the adaptation of the individual to specific environments. As we will demonstrate later, this idea is of central importance in the actiotope approach. Similar to the manner in which a species adapts to living conditions in its own ecological niche over the course of its phylogeny, some individuals continue to adapt to the circumstances within a particular talent domain until they achieve an optimal working relationship between themselves and the domain (e.g., Araújo & Davids, 2011; Davids & Araújo, 2010; Dunwoody, 2006). The end result is a functional action repertoire in one particular talent domain. In a very real sense, they become specialists within this domain, and would likely lose their competitive advantages if they were to venture beyond the given area of specialty: while Einstein ranked high among physicists, he was not preeminent among biologists.

Context dependency becomes more particularly apparent when component systems show very different responses to different environmental systems. Some school children, for example, have a hard time regulating their attention during instruction, but may demonstrate high levels of focus when working on computer games. A similar example is the different behaviors one individual may show when confronted with soccer (football) or school textbooks: for a young sports enthusiast, the soccer match may be more in line with her or his motivational system and thereby capture her or his undivided attention, but the school textbook may fail to elicit a comparable amount of interest, focus, or enthusiasm. Thus, the hope of measuring the degree of concentration or motivation with one particular test of concentration or motivation seems absurd, even if many psychological tests promise to do just thus. Such an outlook completely ignores the context dependency of systems.

4.4 Interdependence

Interdependence means that manifestations of behavior and changes do not happen in isolation. The effects of the behavior of individual system components are not a localized matter; each event within a component always has an effect on the larger system. Various

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types of feedback effects are not exceptions but the rule. The consequence of this insight is that the idea of a local intervention is a misnomer since even the most focused intervention always affects the entire system.

The most elemental intervention in gifted education is telling someone that she or he is gifted. Freeman (2006a, 2006b) has shown that this information alone is sufficient for causing serious disturbances within the larger system. These can manifest themselves as, for instance, developmental difficulties, behavioral abnormalities, and serious problems within the family. Some effects are of course desirable. Looking at a sample of “talented” young people representing various domains, Csikszentmihalyi, Rathunde, and Whalen (1993) noticed that their learning environment reacted to such a proclamation of giftedness in a supportive and encouraging manner. Typically, these young people were required to help out less in the home so they would have more time for the development of their talents.

The idea of interdependence also applies to the relationship between systems and their environment. A well-known example is the lack of reliability in the instruments used to identify gifted individuals. One of the reasons affecting reliability is that the scores from these instruments are dependant on the person who is doing the testing- a phenomenon recognized by Catell in 1937. When instruments were used by different testers, variations in the test results of the same person ranged from 13 to 40 IQ points (Michel, 1971).

4.5 Interconnectedness

Interconnectedness complements the concept of interdependence. The latter term reminds us of how manifestations of behavior do not occur in a “vacuum”. Rather, the interconnectedness of the components within the network stresses the fact that a change in any one component can affect a series of secondary changes, the consequences of which are indicative of the system in which the initial change took place. Thus, the effects of a given change are not coincidental, but reflect an orderly reaction of a system to a given change.

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An analysis of the higher frequency of high-level achievement in particular social systems illustrates the veracity of the concept of interconnectedness. Consider, for example, the high number of internationally renowned professional pianists who hail from China; the initial amazement one senses when first thinking soon passes when one learns that around 50 million people in China take playing the piano very seriously (Charness, Krampe, & Mayr, 1996). Already the sheer size of this number describes a network of a size large enough to guarantee a certain number of world-class experts. But that is only half the story. We know that such a large network of people involved in the same pursuit will also bring together individuals with various types of expertise, thereby increasing further the probability of the system producing individuals demonstrating exceptionality.

Furthermore, the large network of serious piano players in China begets increases in musico-pedagogical and musico-didactic knowledge; teaching materials (collections of études, for instance) are improved; connoisseurs increase in number; a system of standards enforcement develops and improves (e.g., music critics); the social appreciation of this area of endeavor increases; and more money is invested in supporting and encouraging the best pianists. A country with a good system of encouraging talent in a particular area can allow for the parallel development of an entire series of minutely coordinated processes. All of these processes are geared toward increasing the likelihood of a talented individual achieving exceptionality.

The concept of interconnectedness can also be quite helpful when examining circumstances which have traditionally been viewed from the perspective of personalities. Continuing with music-related examples, examination of the question of why great musicians often grow up in the families of musicians offers a good sense of how this perspective can help. Lehmann and Gruber (2006) argued that musical dynasties such as the Bach family are not necessarily based on a hereditary predisposition to musicality: a simplistic genetic explanation is implausible since the female lines in the family history do not necessarily

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reflect instances of musical giftedness. A plausible explanation is offered by the home environment which, over generations, was typically characterized by the presence of musical encouragement and a larger tradition stressing craftsmanship as the family’s economic foundation, with sons learning the professions of their fathers. The plausible explanation turns on a process of learners working their way (and being guided) into their parents’ and older relatives’ professional and social networks.

The idea of interconnectedness also makes sense at the level of the individual. If a girl who is learning to play the violin is praised for her interpretation of a particular piece, the consequences extend beyond the development of musical competency. For instance, she reacts to the praise with positive emotions; this provides her with further motivational encouragement; her interest in similar works increases; her violin teacher then plans the next step in her training and considers programming the piece she played well or a similar one for her next public performance.

4.6 Various System Levels are Crucial for the Development of Excellence

A systemic view starts with the notion that individuals are combinations of various component systems. In gifted education we know a lot about the component systems of an individual, and for each component there is an associated research tradition. The metabolic system is negotiated with concepts such as physical fitness, nutrition, and rest and relaxation. Our ideas about well-being, dealing with stress and fear, for example, describe the psychological-emotional system, whereas memory, learning, and intelligence reflect the cognitive system. Not only are there interactions between these systems, each component system can be subdivided into subsystems.

Of course, individuals can be considered partial systems within larger systems. We should keep in mind, however, that the same individual can hold a different relevant position within each system in which it is integrated. As described previously, systems theory reverses the traditional notion whereby a whole can be explained by the description of its parts in isolation. Elements can only be understood by considering their place within a system. Depending on the respective system, a gifted girl can also be a sister, granddaughter, student, member of the swim team, or best friend. In each instance she demonstrates different typical behavioral characteristics, and an understanding of the nature of these characteristics depends on understanding the particular component system. It is important that her place in each of these systems be viewed contextually so that favorable learning conditions can be established in many, if not all, of these systems. So if we want to assess whether an individual can achieve an exceptionality within one domain, we need to look at more than just the effectiveness of her or his cognitive subsystem, and include, for example, the level of educational quality achieved within her or his school class, school, and family as well as in the respective educational system and country.

4.7 Phase Transition

Following the tenets of classical physics, linear thinking assumes that events can be explained in terms of explicit causes and that the effects of particular events are also linear. However, with biology firmly established as a branch of science on par with physics, there is now little doubt that such concepts are outmoded (Kauffman 1995).

Unlike linear models, systemic thought focuses on the sorts of networked, typically nonlinear processes described above. If, for instance, we are interested in encouraging the technical and technological interests of gifted girls, the two ways of thinking suggest fundamentally different approaches. Strategies designed to facilitate this encouragement have primarily focused on just these interests (Stoeger, 2004). However, such an approach is too shortsighted, as we saw when discussing the concept of interconnectedness. Consider a girl who has decided to read a book on a technical subject, simultaneously making a decision against pursuing other possible activities such watching television, listening to music, and socializing.

Clearly, steps taken to encourage interest in technical pursuits need to reflect also a larger set of realities. First, such steps need to be informed by an awareness of a larger network of typically possible interests and activities within which the technical topics need to appear most desirable. Second, the effects of increased amounts of interest are not linear. Let us assume that the levels of interest in certain post-secondary courses of study are quantified according to a six-point scale on which the minimum is zero and the maximum is five. The technical interest of a particular student is 4.03, his interest in language is 4.04, his interest in math is 4.16, to name just a few examples. Even a relatively slight increase in his technical interest of 0.14 might be enough to displace medicine as his major of choice. At this point his decision "tips" in favor of another field.

Applying analytical constructs adapted from classical physics would not make sense at this point. If the measurement of increased technical interest had been 0.10, 0.30, or 0.15 instead of 0.05, we would not have observed a difference in the effect proportional to the measured difference in interest—in fact we would not observe any difference in effect. People working on the theoretical and practical aspects of gifted education should heed this example when they are tempted to follow such concepts that might make sense in the realm of the problems dealt with by the classic natural sciences.

Phase transitions are the norm, not the exception. When a student finds out, for example, what score he earned on a test, the experience may cause abrupt (not gradual) increases in his self-confidence and motivation, leading to a sudden expansion of his action repertoire. Perhaps the same boy is teased by another child in his class, unleashing sudden effects such as defensive actions or feelings of sorrow. One of the most crucial tasks for future research is to understand how conditions leading to certain phase changes can be regulated and created in a controlled manner.

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5. The Actiotope Model as a Systemic Conception of Giftedness

The most salient feature of high-achieving people is their constant ability to perform with a high level of competency (Ericsson, 1999, 2009). This is the point of departure for the actiotope model. It explains, first, how an excellent action repertoire arises and, second, how it is used. Last, it offers insight into which measures are most apt for encouraging the development of high achievement. In the process, the actiotope model takes advantage of various synergies offered by a number of scientific disciplines.

As organisms, humans display the characteristics of an open system which, in turn, consists of various subsystems. A person's characteristics and behaviors are the result of innumerable successful adaptations to environments (e.g., Gibson & Pick, 2000; Vicente & Wang, 1998; Ziegler, 2005).

Many of these adaptations occurred before a given individual was born. The human species accustomed itself to numerous different climatopes, ecotopes (i.e., the inanimate parts of ecosystems), and biotopes. The nature and development of a human being's organs, susceptibilities for various illnesses, sleep patterns, language capacity, limits to running abilities and so on can only be understood in terms of a species which adapts itself to its environments.

Humans, of course, are more than just biologically-defined organisms. As social beings, they adapt also to their sociotopes (Grassinger, Porath, & Ziegler, 2010). In other words, as we will explain in more detail below, humans adapt to environments which are defined by concrete situations and established social preconditions. Our musical examples serve us well here, too. Even listeners without formal training can recognize significant differences when listening to and comparing the works by Quantz, Hasse, the Marcello brothers, both Scarlattis, Cimarosa, Lotti, Galuppi, Caldero, Jommelli, Parpora, Albinoni, Tartini, Händel and Vivaldi, on the one hand, with works by The Birds, The Kinks, Motörhead, Nirvana, The Police, The Who, Rolling Stones, Sex Pistols, David Bowie, George

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Michael, Phil Collins, Cat Stevens, Peter Frampton and Elton John, on the other hand. The members of the first group share a common musical heritage, including time in Venice during the 18th century spanning a period of 50 years. The second group consists of bands hailing from London in the second half of the twentieth century.

All of the musicians and composers enjoyed a musical socialization which included access to one of the preeminent musical action repertoires of their respective times. All demonstrate an active adaptation to the music of their social environment. The assumption appears highly plausible that the two groups of aforementioned musicians, were they to have been born in the eighteenth instead of the twentieth or in the twentieth instead of the eighteenth century, would have developed in completely different directions.

Despite their shared characteristics, however, we can also observe clear differences among the work of the musicians and composers *within each* of the two periods. Even cursory listening will reveal differences between, for example, the music of the Rolling Stones and the Sex Pistols. In this sense, action repertoires are not simply indicative of a given time period: they also reflect the characteristics of highly individual styles. Indeed, they are undeniably the result of progressive adaptations to a particular actiotope (Ziegler, 2005).

An individual's actiotope reflects qualities that are more than unique. Many of the characteristics observable in an individual's actiotope will only be explicable in terms of the concept, as described above, of an individual belonging simultaneously to various system levels (ecological, biological, and social systems). The following definition of an acitope captures this notion:

> An actiotope consists of the acting individual and the environment with which he/she interacts in his/her actions.

5.1 The Component Perspective

A system is made up of interacting elements. The actiotope model envisions four

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components which, together, enable intelligent actions:

1. the action repertoire,
2. goals,
3. the environment, and
4. subjective action space.

Before we discuss each of the components, we want to make clear that the actiotope model represents an analytical frame of reference for the investigation of *all types* of premeditated behavior, which we understand according to Sternberg and Salter (1982) as "goal-directed adaptive behaviour." Thus the intelligent behavior of animals or artificial intelligence systems falls within our analytic purview. The internal conceptualization or structure of each of the model's various components is an object of investigation for a number of disciplines including biology, sociology, psychology, neurology, information science and social geography, because each of these components, logically, consists of numerous systems and subsystems. This illustrates the need to buttress the analysis of human actiotopes components (in particular when exploring their development towards excellence) with further theories from areas such as motivation and interest (which are particularly important when working on the "goals" component).

5.1.1 Action Repertoire

The action repertoire is the totality of actions of which a person is, in theory, capable of displaying at any given point in time. An individual will, however, only realize a small portion of these actions. The extent of an action repertoire varies considerably among individuals. A child in preschool, for instance, typically possesses a mathematical action repertoire which is restricted to a few numerical operations covering only a limited number of integers. During the first years of school, a child's mathematical action repertoire expands to include basic arithmetic. Basic algebraic and geometric operations follow in later years. The

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development towards excellence can, therefore, be understood as a long-term learning process during which an individual acquires the repertoire which will eventually allow for excellence.

5.1.2 Goals

Individuals have needs which they are compelled to satiate (e.g., hunger, security, recognition). The fulfillment of such needs requires that they set a goal for their behavior—eating an apple, for instance. The process of setting goals is not as simple as people often assume. One example is food: knowledge of which substances can satiate hunger is culturally dependent and must be passed on from one generation to the next (Scapp & Seitz, 1998). The effectiveness and success of translating needs into action goals varies greatly. Numerous well-known examples illustrate how individuals doggedly pursue dysfunctional goals over long periods of time (e.g., Seligman, 1975; Staw, 1976). Such goals may be wholly incommensurate with the expected need fulfillment, or they may be unattainable. If one keeps these possibilities in mind when considering the process of ascertaining an action repertoire of excellence, it quickly becomes apparent that some goals which, when pursued, are capable of effecting expansions of an individual's action repertoire over an extended period of time eventually turn out to be lacking in adaptivity. One can, for instance, envision a sort of education strategy which is heavily predicated upon competition which produces a girl who is best in her class. In such a strategy, the girl may well rest on her laurels once she has attained this goal for lack of other motivational input (cf. Dweck, 2006). Other sorts of higher-order goals would have been possible, but as this strategy failed to integrate them, they will not be achieved.

Gifted education needs to ensure, first, that functional goals are being pursued in the area of expanding an individual's action repertoire. Second, that such goals are of a nature which allows them to be happily integrated into the individual's overall system of goals; otherwise the person who is being served by the system of gifted education will, sooner or

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later, rebel against that system. Third, the continued development of the goal-setting and goal-regulating system needs to be a priority, since the goal system needs to be constantly adapted to an ever-expanding action repertoire. Put simply, every successful learning step unveils the possibility of new and attainable goals.

5.1.3 Environment

Systemic approaches assume that individuals and their (social) action context cannot be meaningfully examined in isolation from one another. They need to be viewed as one analytic unit. The examination of environmental factors can, nevertheless, consider the varying degrees of dependence/independence which may characterize the way in which individuals and their social action context are related, since the systems envisioned by the actiotope approach are meant to be understood as *models* of reality. Therefore, we suggest three complementary views of the environment:

1) It makes sense for giftedness research to start by consulting existing systemic views of the environment. For example, a substantial body of research exists on the systems family and school, from which gifted education can benefit.

2) Particularly important is that aspect of the environment which we understand as the talent domain, because we understand the process of development towards excellence as a progressive process of adaptation to a talent domain. Piano, chess, tennis, physics—each of these domains encapsulates an almost dizzying spectrum of possible successful actions. Yet the novice will only be capable of availing her- or himself of a small fraction of these possibilities.

For most talent domains domain-specific curricula exist which, as a sort of socialization, regulate the expansion of an individual's action repertoire. Such curricula compel the individual to develop her or his action repertoire; they evaluate the development process through positive and negative sanctions of behavior. Many talent domains reflect

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long-term processes of improvement. Learning to play the violin, for instance, involves instructional methods and materials which have been developed, disseminated, and improved over centuries. In Central Europe, professional instructors are ubiquitous, serving to improve continually their students' action repertoires. It is quite possible that the very best virtuosos of bygone centuries would be outclassed by today's leading performers.

3) The actiotope model goes beyond the analysis of the "classic" systems of family and school class/grade postulated by the social sciences; it also adds more to the list than just the idea of talent domains. The actiotope perspective also considers the environment from the perspective of learning and learning opportunities. We avail ourselves of the concept of the *sociotope* to this end (Latin *socio* means of the community; Greek *topos* means location; Grassinger et al. 2010; Ziegler, 2008; see also Phillipson, in press).

A sociotope offers an objectively defined action space; in other words, each sociotope entails a specific set of possible actions. You can swim in a swimming pool, but under normal circumstances you cannot do figure skating. The opposite is true of an ice-skating rink. Such objective circumstances are understood to be implemented. Among all the objectively possible actions conceivable for a given sociotope only a small fraction will actually be realized by individuals acting in that sociotope. We can speak in this case of behavior patterns which typically correlate with certain sociotopes. All sorts of behaviors are imaginable during flute class, but generally flute class is about people (often children) playing the flute, even though, for instance, flute playing could be combined with dancing. In math class, kids calculate and hardly ever sing. Thus, it appears that certain behaviors become institutionalized within certain sociotopes. The institutionalized behaviors normally reflect some sort of logical connection between the nature of the locale and the sanctioned activity (the kitchen is where we make meals; the bathroom is where we see to our regiments of personal hygiene). During their socialization, individuals develop a rich action repertoire of socially acceptable behaviors which are linked to certain sociotopes; they also learn to repress other possible

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behaviors in certain contexts (e.g., getting to class too late and being disruptive during instruction) in a process which is known as internalizing.

5.1.4 Subjective Action Space

The fourth component of the actiotope is subjective action space (cf. Ziegler & Stoeger, in press). In a sense analogous to ideas about problem space in classic decision-making research, subjective action space is conceived of as a sort of cognitive space in which an individual can generate and make decisions about behavioral possibilities. This cognitive process takes several factors into account: an individual's action repertoire, the nature of a given situation, and an individual's current needs and concomitant goals. The subjective action space generates optimal behavioral possibilities from the sum of possibilities which the other three actiotope components provide.

The processes of generating behavioral possibilities and selecting an action from these is error prone in the sense that actions can be unsuccessful. There are various crucial reasons for this, among these:

- an individual may often incorrectly assess her or his own action repertoire (boys tend to overestimate their behavioral competencies in mathematics, and girls often underestimate their skills in the same area);
- possibilities for action may go unused in a given situation (a schoolgirl may think of a good solution at too late a point in time);
- needs are translated into inappropriate goals (a boy who plays the class clown in an attempt to get more attention and respect, but whose behavior causes him to experience even more rejection).

Each step in a learning process and each expansion of one's action repertoire increases the number of realistically achievable goals in any given situation of similar character. Gifted educators thus need to make sure that learning steps are well integrated into the subjective

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action space of each pupil. A particularly instructive example is that many girls persist—despite demonstrating competency levels in math and natural sciences on a par with those of boys—in their belief that they must undertake more substantial efforts in order to learn as much as their male counterparts (Ziegler, in press). The example reminds us of just how important it is that expansions of the action repertoire be accompanied by concomitant expansions of the subjective action space.

5.2 The Systems Perspective

Systems always have a structure. The structure reflects 1) the system components, 2) the relationships and interactions among these, and 3) the nature and number of the interdependencies of the system and its environment.

It is clear that the components of an actiotope correspond closely. Consider the following simple examples:

- People look for environments that are compatible with their goals. When you are hungry, you will not be surprised to find yourself heading towards your refrigerator.
- Within one's subjective action space, actions tend to be selected which appear practicable within a given environment. Swimming motions make sense in a swimming pool, climbing movements normally do not.
- Apartments and homes have amenities suited to the goals and needs of the people who inhabit them.
- If the structure within a system remains stable over a long period of time (e.g., in a school) and the system remains in a state of equilibrium, then we are observing a good fit between action repertoire, goals, environment, and subjective action space.

Over the entire course of the long learning process which precedes the achievement of excellence in a given domain (often a period of many years), the entire actiotope needs to be systematically and continuously modified (many examples can be found in Ericsson,

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Charness, Feltovich, & Hoffman, 2006). Action repertoire, goals, environment, and subjective action space undergo a continuous process of change. In technical terms, we can say that the actiotope remains in a *metastable* condition in which it is constantly moving from an older into a newer temporarily stable condition. As such, these conditions are ontogenetic way stations of sorts set between moments in which individual learning steps are mastered. The mastering of learning steps requires a co-evolution of effectively compatible system components, which is by no means a given. Systems can easily founder and lose their effectiveness. We will illustrate this with an example, drawn again from the domain of chess (Brady, 1973, 2011).

Bobby Fischer is considered to be one of the best chess players of all time, winning the chess world championship after a hard-fought match. When he was eight, Fischer's adaptation to the domain of chess was characterized by his study of the chess matches of the greatest chess masters. By comparing each of his moves with the solutions recorded for the grandmasters, he had found a source for excellent feedback. Each expansion of his action repertoire in chess led to co-evolutions in goals, subjective action space and environment as follows:

1) Goals

He recognized the chess-specific goals connected with each move.

2) Subjective action space

Fischer came to understand the strengths and weaknesses of the chess moves made by the grandmasters. In his next match he was able to use the knowledge to his benefit: he was quickly able to discount weaker moves from his subjective action space and review the applicability of better options to the move at hand.

3) Environment

Fischer's childhood learning environment soon ran out of adequate opponents. His mother purchased classified newspaper advertisements to find chess opponents for her eight-year-old

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son. Young Bobby quickly found sponsors who helped him expand his chess action repertoire by a degree which, at that point in time, was unheard of.

This co-evolution led to an extreme modification of his actiotope where a) his chess action repertoire reached a world-class level; b) he could realistically pursue the goal of becoming the world champion of chess; c) he was constantly surrounded by chess grandmasters and an endless supply of chess literature; and d) within his subjective action space, he almost exclusively focused on the game of chess.

Our discussion of Bobby Fischer touched upon two concepts which need to be further explained. The modifiability of an actiotope describes its potential for the co-evolution of its components (see also Ziegler, Fidelman, Reutlinger, Vialle, & Stoeger, 2010). If, for instance, an appropriate learning sociotope for an impending learning step is lacking or if a gifted individual lacks motivation for the next step in the learning process, then their actiotope is not modifiable. Stability in an actiotope signals a situation in which the actiotope's components are co-adapted and complementary in nature. This can only be a metastable condition, however, since the talent domains in which individuals work towards excellence require a long-term process of actiotope development. Thus it is of particular importance that the actiotope, as a whole, not be destabilized by additional work-related responsibilities, family problems, or illnesses, for example.

5.3 The Dynamic Perspective

It is important to think about how co-evolutionary developments of the actiotope components are possible within a given talent domain. We envision a model consisting of five conditions of successful adaptation.

5.3.1 Goal Validity

If an individual is to be effective within a talent domain, she or he must be capable of

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assessing whether a particular action has led to the desired learning goal or if she or he has at least come closer to a certain goal. Such actions can be repeated or they can function more like a stepping stone on the way to further, more successful actions.

Individuals are often unsure whether an action was successful. A violin student who fails to recognize when she or he is playing grossly out of tune will not become a leading professional violinist. A soccer player who has a suboptimal kicking technique stands almost no chance of becoming a striker for a professional soccer team. A student who cannot say whether he has done a good job of studying for a test will probably perform poorly. In particular, mentors, be they violin teachers, soccer coaches, or art teachers, are capable of providing valuable feedback in the area of goal validity (Grassinger et al, 2010; Gruber, Lehtinen, Palonen, & Degner, 2008).

5.3.2 Ecological Validity

A female basketball player who wants to maneuver a basketball around a member of the opposing team has to decide which move is most appropriate. When schoolgirls are preparing for an oral examination, they should take care not to invest their study time in activities designed to prepare people for multiple-choice tests. In other words, one and the same action is not just as effective in every situation. It is thus important that individuals recognize for each situation anew which actions are best suited to succeeding.

Systemic education aims to establish strategic links between theory and practice. People working in gifted education often try to account for ecological validity by working to expand the action repertoire of their pupils in those areas which are most likely to maximize the effective use of their action repertoire in the selected goal contexts. Well-known didactic approaches include the anchored instruction and the cognitive apprenticeship approaches (Cognition and Technology Group at Vanderbilt 1994; Collins, Brown, and Newman 1989).

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5.3.3 Replacement Validity

Working towards excellence is always predicated upon the adaptivity and flexibility of the actions being taken in a given talent domain (Araújo & Davids, 2011). Striving towards excellence is not just about finding and unlocking the potential of new possible actions. It is also about replacing older, less effective actions. However, it has been observed that after an initial investment of roughly 40 or 50 hours, a learner reaches a competency level which they find satisfactory; at this point a majority of people become mired in a pattern of "arrested development" which holds them at their current performance level (Ericsson 1998). Surmounting such developmental plateaus demands a great deal of effort from all stakeholders in gifted education (the gifted learners, their teachers, their mentors, and others). The process of overcoming such developmental malaise requires more than just extra effort, however. Profound didactic insight is also important since new actions need to be more effective than the ones they are meant to replace. Such necessities are particularly apparent when, for instance, it is time to move on from arithmetic to algebra or when, after having learned the Rutherford atomic model, we move on to the Bohr model; or when learning the game of tennis moves from general "play" to systematic training of the sport's canonical strokes.

Achieving exceptionality requires numerous replacements. Individuals who are both capable of achieving this level and are developing in that direction are always on the lookout for better action alternatives. People working in gifted education tend to favor action alternatives such as the use of better learning strategies, more beneficial attributions for successes and failures, and more effective volitional techniques.

5.3.4 Anticipatory Validity

During the long and sometimes painstaking development of an actiotope, numerous preparatory learning steps have to be taken to ensure that other learning steps can happen at later points in time. For example, we learn English as schoolchildren because it anticipates the requirement to read international scientific literature when studying at college. Ice hockey players can only improve their playing skills once they have reached a certain level of competency in ice skating. The professional success of future research scientists depends in part on whether they work on their social skills during adolescence and early adulthood since they will eventually need to work in research groups. Furthermore, the development of an actiotope is also characterized by unforeseeable setbacks, developmental plateaus, and other critical events.

An actiotope that is anticipatively developed will be better able to overcome learning obstacles. If, for instance, we recommend that a gifted student transfer from her or his regular school to a boarding school for the gifted, we need to feel confident that the girl or boy also possesses the social skills necessary for effectively dealing with the new separation from the family home. If a theoretical physicist finds herself stumped by a certain problem, it may become apparent, in hindsight, that she was not anticipative enough in the choices she made about math classes during college. In sum, those working in gifted education need to show extreme thoughtfulness when helping their pupils to plan their educational careers.

5.3.5 Learning Pathway Validity

Exceptional achievement in many talent domains requires extremely well developed levels of performance and depends, accordingly, on many learning steps. An individual is very unlikely to be able to traverse these steps on their own. Reaching this level of performance requires the active involvement of many other persons, including teachers, parents and mentors, as well as sociotopes that support learning (Phillipson, in press). A learning pathway is thus constructed of a series of necessary learning episodes.

Many individuals fail to achieve their learning goals and fall far short of excellence, despite making a Herculean effort. The attainment of exceptionality requires clear goals, a well-planned learning pathway as well as long-term, high-quality learning feedback on issues pertaining to the conditions of successful adaptation, including goal validity, ecological validity, replacement validity, and anticipatory validity.

The most important practical consequence of learning pathway validity is that decisions in gifted education must not be based on a single diagnosis and isolated, individual recommendations. Educators need, first, to be ready to help map out the learning pathway towards achievement goals and, second, accompany learners down these pathways.

6 The Basic Principles of a Systemic Gifted Education

Current approaches to gifted education are constrained by a structural flaw; the need to select and place (Ziegler & Stoeger, 2004b). The first step in this approach is to select gifted individuals from a larger pool of students, with the second step being the placement of these students into programmes based on one (or more) of the current strategies in gifted education. Since these programmes are only available in some cases (i.e., at certain schools, in certain regions), their application is often only temporary rather than sustained.

As an alternative approach, systemic gifted education has no choice but to begin within the existing framework. What remains fundamentally different, however, is that a systemic approach is not focused on the issues of selection and placement. Rather, systemic gifted education focuses on the creation of highly individualized opportunities, allowing individuals to develop their action repertoire through interaction with specific, individually tailored learning environments. In order to show how the focus and goals of systemic gifted education differ, we will describe the five most important differences between the systemic and current approaches to gifted education.

6.1 Focus on the Interactions between Person and Environment

Part of understanding the workings of a given system is learning about the neighboring

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systems with which it interacts. In this sense, we conceive of the development of an action repertoire capable of producing excellence as a very successful adaptation to specific environments (Araújo & Davids, 2011; Ziegler, 2005). Thus, the goal of gifted education cannot be limited to the development of the individual, but must include the interaction of the individual *and* their environment (i.e. actiotope). Here, we must remember that this interaction occurs as part of a system, with the relationship between individual and environment being only one amongst many possible interactions.

Arbitrarily attaching labels such as “talented” or “gifted” to individuals is neither conducive to research nor to gifted education. Nevertheless, such terms remain useful to facilitate the communication between research and practice. In accordance with Ziegler (2005), we recommend that the terms talent and gifted be used to represent points on the pathway to exceptional achievement. Specifically, a person is talented in one (or more) domain(s) when they have demonstrated precocious achievement, reflecting an action repertoire exceeding that of a similarly aged cohort. At this point, the person has a possibility of reaching exceptionality in one or more domains.

A person is gifted when they have achieved a critical state in this pathway. At this point, their action repertoire is sufficiently well developed that they have a very high probability of achieving exceptionality in one domain. Despite referring to the individual, we emphasize that both being talented or gifted depend on the interaction between the individual and environment.

6.2 Co-Evolution of All the Elements

Systemic gifted education assumes that developmental goals cannot be reached if attention is only focused on the development of a single element. Each localized change has implications for the entire system, with secondary, albeit often unintended effects, alongside primary effects. Hence, a systemic gifted education needs to be holistic, designed to develop

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the entire system along meaningful lines without posing a threat to the system's stability.

In the context of the actiotope model of giftedness, this means that the action repertoire, goals, environment, and subjective action space need to be further developed in a manner which allows all of the components to interact meaningfully with one another at every step in the developmental process. It is not enough to just expand the developmental horizon to include the environment. A number of additional changes are necessary. First, we need to understand how an individual and her or his environment are to interact and how both can be further developed during and through their interactions to the end of achieving the next learning step. Second, the construct "environment" needs to be better understood. Gagné's (2004) model, for instance, deconstructs the environment into various catalytic processes. By definition catalysts energize processes without changing their makeup in the process. This static conceptualization of the environment may cause us to overlook the remarkable dynamics which such processes set in motion in learning processes, because—to cite one example—the same gifted student cannot expect to be offered the same learning stimuli every day; rather, her or his learning environment will be carefully developed according to her or his abilities from day to day.

Current approaches to gifted research contain many examples of how processes of co-evolution are by no means simple and of how even small changes can bring forth unexpected results. For example, Heller (2004) concluded that the process of labeling children as "gifted" poses one of the most serious problems in gifted education, noting risks such as "social isolation, [the] development of egocentric attitudes and behaviors, endangering or disturbing [...] personality development and self-concept through extreme achievement pressures or too much responsibility" (p. 308).

6.3 Resource Orientation

A central focus within systemic education is on the expansion and improvement of the

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resources and competencies available within each system. Indeed, resource orientation is one of the main characteristics of systemic approaches.

From the perspective of gifted educators, a considerable number of essential resources needs to be made available to the actiotope: appropriate instructions, learning competencies as well as information on a number of related variables: on the validity of the goals, the ecology, the replacement strategies, and the anticipatory steps involved in a given educational measure; on the gifted individual's emotional and social stability; on her or his motivation; and on her or his social learning environment.

Ziegler (in press b) has advanced a new way of systematizing the resources which are suggested for gifted education in particular: the term educational capital is used to described those resources involved in initiating and regulating learning which are available both to society and the individual. Learning capital denotes those resources used for initiating and regulating learning to which only the individual has access.

6.4 Constructing Learning Pathways Rather than Identifying Gifted Individuals

Practitioners of gifted education often worked along the lines of well-intentioned trial and error, as though they were mining for gold: the gifted are somewhere out there, and one must simply locate them by looking around enough and using adequate testing. By contrast, systemic gifted education is based on the premise that the issue is not to track down the gifted but rather to develop talents (defined as systems comprising individuals and their environments) in a co-constructive process. Thus "identification" has a markedly different meaning in a systemic approach.

The process of identification normally navigates the thorny issue of achievable learning goals by making a simplistic prognosis about the future based upon the status quo. Such a prognosis is usually the result of a single diagnostic session (Ziegler & Stoeger, 2008a). Rather, the decision to provide a person with a gifted education should be based on

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the co-evolutionary constructions of learning pathways which are substantiated through theories of learning. Such a decision-making process needs to be accompanied by an appropriate gifted education specialist and re-evaluated whenever necessary.

The duration of a learning process culminating in exceptionality poses an enormous pedagogical challenge. Didactic planning needs to extend across time frames which are much longer than those commonly used for interventions and didactic measures of encouragement in traditional gifted education. This applies to much more than just the cognitive learning aspect. Successful mastery of each successive learning episode needs to be supported by the availability of appropriate learning sociotopes, instructions and feedback, for example. Learning pathways that take this into account can offer realistic expansions of a given action repertoire which continue up to the realization of a particular learning goal.

6.5 Dynamic-Interactive Regulation Instead of Gifted Education

The systems approach assumes that the magnitudes relevant for gifted education are simply too complex and thus incomprehensible from the analytical perspective offered by classical scientific notions of cause and effect. In gifted education we are dealing with networks of actions and their dynamic interactions with individuals' subjective representations of their action repertoire, goals, and environments. The interactions furthermore reflect primary and secondary effects which are accompanied by a variety of feedback-loop effects and autochthonous mechanisms of amplification. The notion that teachers, with a few isolated words of encouragement or interventions, could have a lasting positive influence on the course of an individual's development is a well-intentioned myth. What is desperately needed is a support system characterized by continuous interaction in which those working in gifted education see themselves as a part of the developing actiotope of each gifted individual and behave accordingly.

If these ideas are correct, then we should observe better outcomes in gifted education

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when based on dynamic-interactive processes. Although evaluations of programmes based on this process are only beginning, the reported outcomes are very positive. In one such evaluation, (Grassinger et al., 2010) concluded that mentoring can produce long-lasting effects when tailored to both the needs of the mentee *and* their specific environment.

7. Conclusion

Current approaches to gifted education are based on the erroneous assumption that it is possible to understand the development of exceptionality by first identifying the components of giftedness. Once identified, it is sufficient to implement strategies that focus on the development of one or more of the key components. We have presented arguments that the deficiencies in our current approach to gifted education are because our conception of giftedness is based on mechanistic models.

The actiotope model of giftedness, on the other hand, represents a substantial improvement to understanding the development of a complex phenomenon such as exceptionality. Based on systems theory, the actiotope model is based around four components, including action repertoires, goals, subjective action space and the environment. The continual expansion of a person's action repertoire depends on the interactions of their goals, subjective action space and the environment.

Accordingly, gifted education based on a systems approach represents a paradigm shift from current approaches. We redefine the terms talented and gifted within a systems framework. We also argue that the basic principles of a systemic approach to gifted education require attention to the interaction between the person and their environment, a focus on the co-evolution of all elements in the system, closer attention to the continual expansion of resources and competencies within the system, and the construction of an individualized learning pathway rather than the need for identification.

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