Educating the Gifted: An Opportunity for Improving the Quality of Teaching and Learning in Classrooms

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Now more than ever, the subject of educating gifted students is garnering attention worldwide. Educational strategies for implementing are revealed by comparing results of international competitions and rankings, and are driven by the need for meeting the social challenges of the future. Whatever the objective for educating gifted students, it remains a complex and open-ended issue that must be broken down into manageable parts. And because the topic is ill-defined, all possible approaches should be considered and evaluated before determining how to proceed.

Implementing programs for gifted students requires solutions on multiple levels of the education system. I suggest streamlining the topic with five interacting, systemic levels (see figure 1). Each level requires its own definitions and clarifications. These should be coordinated and prioritized according to prominent goals and society- and culture-specific political objectives. The resulting vertical alignment between different levels and types of schools will enable smooth transitions in passing through the system from kindergarten to higher education. If a teacher recommends skipping a grade or another form of academic acceleration that requires transferring to a different learning environment, he or she must ensure that the new school or class includes a focus on educating the gifted, where the chosen student will be able to apply his or her preferred learning style and will be accepted by both peers and teachers via a corresponding, positive social-emotional atmosphere.

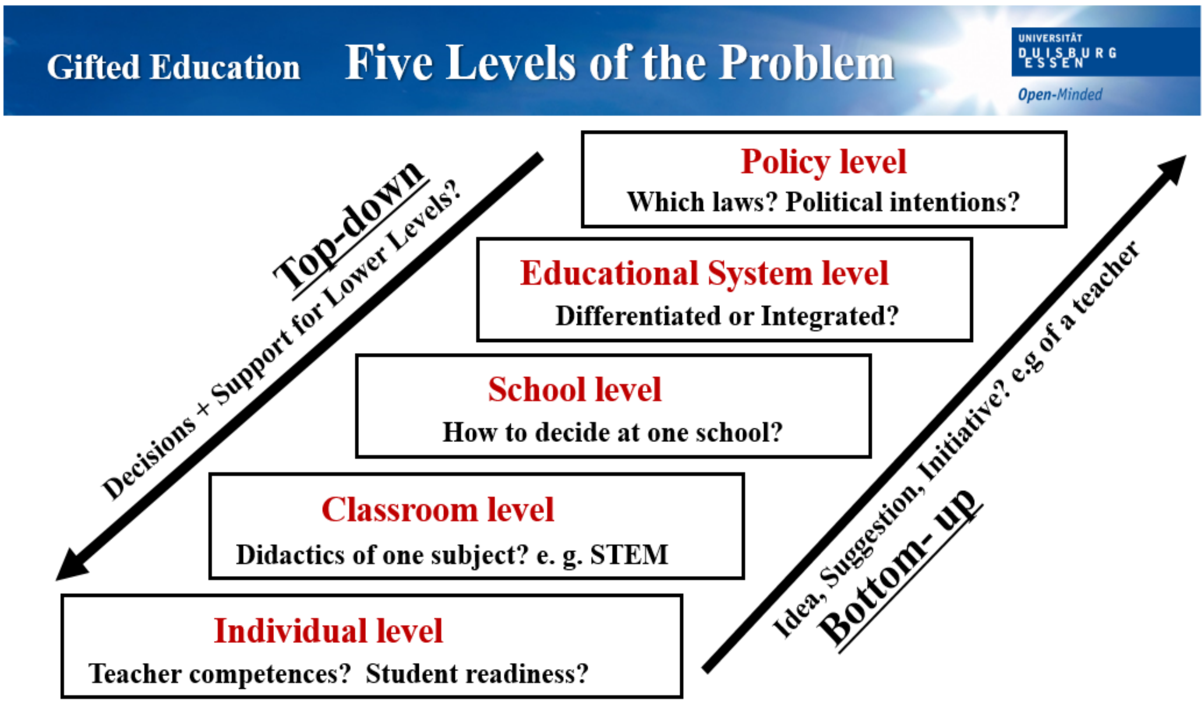

Figure 1: Defining and coordinating the education of gifted students at five levels.

In the context of the German education system, initiatives for turning awareness about educating the gifted into concrete solutions often starts from the bottom up. Highly motivated and engaged teachers want to establish gifted programs in their classrooms. Such instructor-driven strategies have positive effects on the professional development of the teachers and provide an effective way for acquiring expertise in innovating didactic methods. Research has shown that when such innovations are strictly prescribed from the top down (e.g., by the school district or principal), the result is often negative. According to King (2014), a teacher's sense of autonomy and professional self-efficacy may decline, which has consequences for his or her students' achievement levels.

Fortunately, teacher-initiated, bottom-up efforts are more encouraged now than in the past. Of the sixteen German states that have their own ministries of education, nearly all of them receive substantially more support for such initiatives. Furthermore, additional resources are now provided for facilitating gifted education programs at the classroom level. Taking measures for integrating gifted students and acknowledging their particular needs is now on par with efforts made for accommodating students with learning disabilities (Fischer & Müller, 2014; Preckel, 2007; 2013).

Integrating education for gifted students into traditional schools will help to raise the quality not only of these schools, but of the whole educational system. In order to attain this ambitious goal, addressing gifted programs at the classroom level is critical. Classroom-level integration is more authentic than offering an add-on, extracurricular program, which often neglects the details for developing the required teaching strategies (Reis, 2003).

Therefore, my contribution focuses only on what happens in the classroom. It is here that changes are needed in the established methods of teaching, in student tasks and materials and in organizational methods for teaching, as well as in the students' learning processes and strategies. Coordinating these changes will help to reduce the gap that exists between teaching and learning at both gifted and traditional schools. It will provide learning opportunities for a broader spectrum of students, which is essential for all classroom environments. Even schools for highly gifted students do not evade the issue of diversified cognition by merely establishing homogeneous classrooms (e.g., Marsh, et al., 1995).

It is important to view giftedness primarily as an individual variable. At the classroom level, the question is: How do we integrate, or even reduce, intellectual differences among students in a classroom or group? The answer depends upon how we define giftedness.

Concepts of giftedness and consequences for identification and programming

Most often, giftedness is taken as a rather fixed and innate characteristic of a student, a fundamental ability or potential to learn. As a consequence, this potential must first be identified and then applied to corresponding levels of achievement via appropriate educational programs. These programs need to be adapted to both the student's current and prospective potential. Program design that uses this framework results in a responsive, service-oriented perspective on educating gifted students: First identify, and then offer relevant programs.

Alternatively, giftedness can be conceived as a variable, shifting characteristic, a potential that can be improved by instruction and not merely translated into academic achievement or performance. Using this approach, schooling should aim to raise the giftedness levels of all students. When giftedness is recognized, it only indicates the current level, not an absolute or permanent one.

A more active approach to educating gifted students will result from this perspective. First, objectives and corresponding programs are designed, then, students suitable for the programs are nominated using an identification procedure. It is not the program that will be adapted to the student, but the student to the program.

This concept of giftedness, as a potential that has to be promoted with all students, is the predominant perspective throughout the German education system. This does not preclude special programs for highly gifted students (Trautmann et al., 2018). However, the sequence can be reversed: First offer programs and instructional provisions, then, identify individuals or subgroups of students who are appropriately suited to the programs.

Summer schools for high-ability students, like the German School Academy, are among the best gifted education programs at the federal level in Germany. In these cases, teachers at secondary schools nominate students as participants. Each school can elect no more than two of their students, and program creators consider roughly 30-40% of these nominees. A large evaluation study has shown that teachers are quite adept at identifying candidates for gifted programming. Retrospectively applied ability tests revealed that all of the students who were recommended by the schools attained higher IQs with at least two standard deviations above the mean (Neber, 2004; Neber & Heller, 2002). Teachers in Arabic countries have similar abilities in recognizing intellectual aptitude at summer schools (Aljughaiman & Ayoub, 2017).

With this second approach to giftedness, definitions of what it means to be gifted not only provide information for identification purposes, but also contribute goals and objectives for teaching the chosen students. The characteristics specified in these definitions should be taken as changeable attributes of "giftedness", as something that must be acquired by implementing adequate methods of teaching and by redesigning the instructional components of existing classrooms, as well as through supplementary avenues.

The giftedness-as-goal view does not only apply to non-cognitive components (e.g., task commitment or social skills, including leadership as a sub-skill), but also to intelligence or cognitive ability, which acts as the most important, inveterate component of many definitions; e.g., as "above average ability" (Renzulli, 1977), or, in nearly all state definitions in the U.S. since the Marland report; Stephens & Karnes, 2000).

Using established identification procedures, intelligence or cognitive ability is measured by individual or group tests. Results that are considerably higher than the mean are taken as indicators that a student is gifted, and as a requirement for receiving a specialized education. However, research has shown that general or specific intelligence is not as stable or fixed as previously assumed. Conceiving intelligence or cognitive abilities as a fixed quality is currently considered to be a fundamental misconception and a serious limitation for applying available cognitive potential. Teachers who subscribe to this theory of intelligence—assuming that a student's level of giftedness cannot be raised incrementally—are inadequately designing their classroom instruction (Blackwell et al., 2007; Dweck, 2006) and do not provide differentiated lessons required for developing the potential of their students (Aljughaiman & Ayoub, 2017; Gallagher, 2019).

On the individual learning level, this misconception corresponds to the epistemological beliefs that knowledge is fixed, true, and unchangeable, and that knowledge is handed down by an authority. Such beliefs are cause for the individual student to not use his or her existing learning potential. With such low-level epistemological standards, even highly gifted students at the Hunter College High School in New York do not use their current learning potential, and, as consequence, will not further develop this potential through their own cognitive efforts (Neber & Schommer-Aikens, 2002). Education of gifted students should focus on this often neglected, sometimes unknown issue should measure such beliefs using available metrics, and should contribute to developing epistemological solutions for the non-use problem at both classroom and individual levels.

The Instrumental Enrichment Program (Feuerstein, 1990) has repeatedly demonstrated that IQs themselves can be sustainably modified and directly increased by about two standard units. For these reasons, dynamic assessment (Tzuriel, 2001) is recommended as a more useful identification tool for giftedness. Intelligence, as well as other non-cognitive components in definitions of giftedness, should be repeatedly identified and measured while the students are actively participating in a program because the program has the capability of improving such components. Measurements reveal only the current level of giftedness and not what is attainable through transformed instructional environments.

A further advantage of dynamic assessment is that the change in "giftedness" of an individual student can be recognized and monitored, as can the quality of the program itself. This is urgently required because, on the classroom level, teachers differ considerably in their program implementation, and they only develop this expertise over time. Dynamic assessment will inform the increasing competency of a teacher, the potential of the students and the implementation accuracy of the program. However, only measuring accuracy for formal aspects of a program, as in Foster et al. (2011), is insufficient (e.g., for how long, how often it is carried out, etc.). Repeated measurements of the quality of each component (e.g., the learning tasks) and the classroom learning processes of the students (e.g., questioning, hypothesizing, comparing and explaining) are required.

With the education of gifted students — compared to programs in the health sciences, for example — process- and component-related monitoring is still a neglected issue (Carroll et al., 2007; Shehnaz & Sreedharan, 2011). Available monitoring scales and questionnaires could be used more frequently to make evidence-based modifications and improvements (e.g., MacLeod & Fraser, 2010; the Arabic version of the "What-is-Happening-in-This-Class" WIHIC-questionnaire); or the classic social-emotional climate scale (Moos, 1974; Trickett & Moos, 1972).

Advances in brain research provide further arguments for the "program first" approach and for considering classroom instruction as an instrument for developing students' learning potentials, beyond transforming them into subject-specific achievements. Boaler (2013), a professor of mathematics pedagogy at Stanford University, summarized the recent evidence that classroom practices contribute to developing the regions of the brain that impact intelligence and enable higher thinking and problem-solving performance. He observed that schools "…frequently base their teaching practices on ideas about ability that have been shown to be incorrect" (p. 145). Accordingly, countries with the most successful education systems base their schooling practices on the belief that learning ability and intelligence can be enhanced by the scholastic programming in their schools (e.g., Sahlberg, 2011).

Giftedness-by-Instruction: Program-first approaches as a consequence

The concept of giftedness as a fixed potential has been replaced by one where giftedness is flexible, modifiable and can be promoted by instruction. As a consequence, effective program-first approaches for teaching and learning in classrooms have been developed. Two examples will further illustrate this approach.

The first is provided by Gallagher & Gallagher (2013), who implemented problem-based learning (PBL) into traditional sixth grade classrooms. PBL is a widely recommended and effective method for teaching gifted students in homogeneous and mixed-ability classes, increasing the creativity and innovation power of all students (e.g., Kanli & Emir, 2013; Neber & Neuhaus, 2013; 2017). In the Gallaghers' study, twice as many students revealed, and subsequently met, their learning potential in PBL classrooms as would have via traditional standardized testing. It may be inferred that many potentially gifted students fail to be identified when only traditional testing methods are used (Van Tassel-Baska & Stambaugh, 2007). Thus, programs for the gifted and highly gifted may themselves serve as identification tools. Further improvements will be made if expertise for implementing PBL and other inquiry-based models in classrooms are included in pedagogical programs.

The second example of a program-first approach comes from German primary schools, which cover the first four grades. Since roughly 2010, an increasing number of the sixteen ministries of education have allowed for flexible entry into primary schools and for the possibility of teaching the first two grades together. After a student has spent the first year in an integrated environment, the school determines whether he or she will continue as a second grader. If a student is shown to have higher-than-average learning potential, he or she could immediately jump to the third grade after only one year of primary school. Slower learners have the option of remaining at the entry level one year longer, thus repeating a grade without having to adjust to a completely new class. As in the first example of a program-first approach, a prior identification procedure is not required and students are able to skip grades at a young age. Furthermore, the needs of both highly gifted and lower-than-average students are met, and the subsequent potential for discrimination against both groups is reduced. Personal experiences and current evaluations of the program-first approach are thus far very positive. Students and their parents prefer this new flexibility. Teachers develop a broader spectrum of ways to determine their students‘ abilities, they acquire experience with how to teach heterogeneous groups, and they even improve their professional confidence (Klöver, 2014). Several education ministries in Germany are in the process of setting up centers for additional teacher training and developing materials for lessons in these age- and grade-mixed classrooms, in order to reduce teacher workload (e.g., easy and difficult versions of the same learning tasks, or simple and more advanced learning materials and texts about the same issues).

Establishing better learning environments: Utilizing opportunities at the classroom level

The second perspective on defining giftedness as a to-be-acquired potential makes it possible to include potential-acquisition as an objective and to consider it an important function of instruction. This applies to programs that are exclusively designed for already-identified, highly gifted learners, as well as for all other students. But there is a central problem with applying this perspective in classrooms: the nonuse problem. This means that available possibilities for acquiring knowledge and developing learning potential are not put to practical use in classroom settings. Simply put, it is a problem of general inertia.

What, exactly, is unused? With regard to individual student, it is the potential to think (learning through thinking); at the classroom level, it is the potential to communicate in such environments (cooperative learning); finally, even when educating gifted students, the available research on learning and instruction is often not considered and applied.

How to use these neglected approaches for acquiring knowledge in classrooms

Chi & Wylie (2014) summarized cutting-edge pedagogical research by performing meta-analyses on the quality of different processes for learning curricular content in classrooms. Which processes are most effective for classroom learning? Four methods of learning have been identified and labeled as the ICAP framework. The most effective approach to learning is Interactive (I), when students develop their knowledge by collaborating with others. Next is the Constructive (C) method, which means that knowledge is acquired via a process of individual, internal thinking. The other two categories require neither much thinking (corresponding to the lowest level in Bloom’s well-known taxonomy) nor communicating with peers. Active (A) learning involves routine activities such as rote copying of information. The passive (P) approach requires only being present and listening to the teacher. A and P correspond to what is called receptive learning, for example, comprehending and memorizing information presented by a teacher or textbook. I and C correspond to forms of cooperatively organized learning through discovery, which suggests transforming and augmenting the information presented, or learning by “going beyond the information given” (Bruner, 1973). The ICAP model provides a clear approach to giftedness-oriented teaching (see Figure 2).

Classroom instruction for gifted students should be implemented as cooperative discovery learning (CDL), focusing on constructive and interactive learning processes. CDL will transform classrooms into social-constructivist learning environments. Each student’s potential to think will be used for generating personally meaningful knowledge and will be further supported by involving the individual’s available potential for communicating in the classroom. Peers are no longer merely present or perceived as barriers or threats; instead, they provide causes, sources and support for thought-provoking processes. CDL, with its foundation in the learning sciences, will help to solve all aspects of the nonuse problem and could help to specify what is required for teaching gifted, talented and innovative students. It will contribute to the necessary expansion, differentiation and scientific development of educating gifted students by recognizing the progress that has been made in the learning sciences (see Van Tassel-Baska & Johnson, 2007).

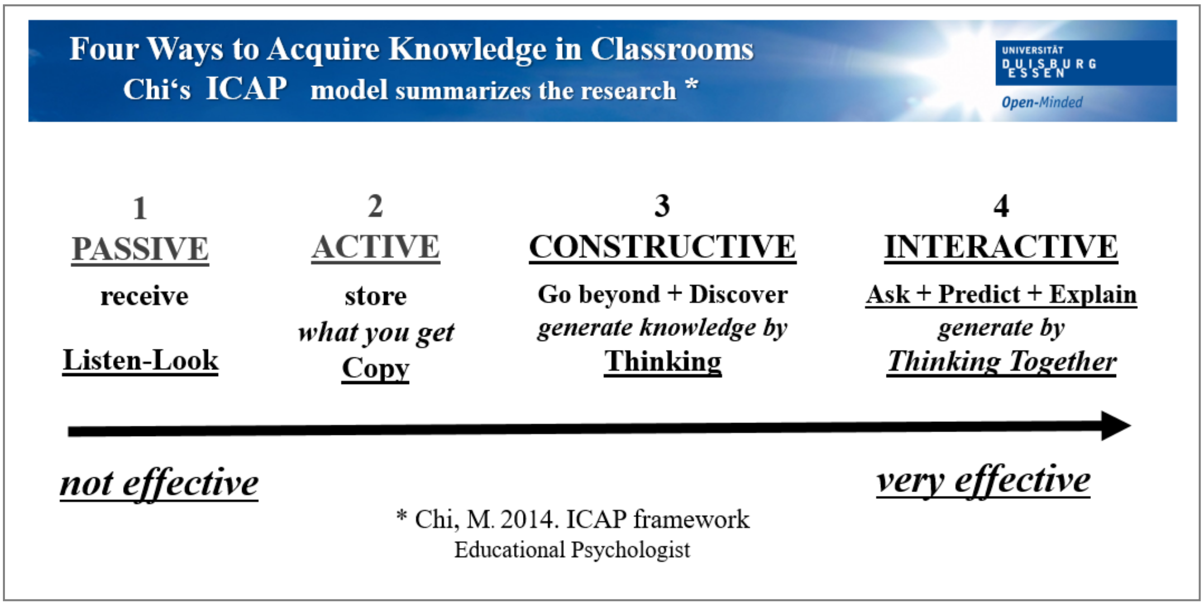

Figure 2: The ICAP framework: Thinking and interacting as cognitive classroom processes.

Cooperative Discovery Learning (CDL): Cognitive processes for generating collaborative knowledge

Process-oriented instruction enables—even obligates—students to think on their own and interact with others in order to generate knowledge. This is not a completely new concept; several noteworthy researchers contributed to introducing this discipline in schools. One of the first was J. P. Guilford (1950), who proposed the idea that all students are able to think divergently and to define and solve problems in creative ways at all levels of schooling. Benjamin Bloom and his group have also helped to raise the general level of thinking in classrooms, and their method is still a frequently recommended approach for teaching gifted students. Most importantly, the research-based contributions of Jerome Bruner (1973) have been crucial for integrating thinking into classroom-based learning. He was the first to explicitly establish the causal links between students' thinking processes and the quality of the knowledge constructed by these processes. His framework for learning through discovery has become fundamental for developing and designing various teaching methods for the education of gifted pupils. According to Maker & Schiever (2006, pp. 129-164), Bruner provided the basis for many existing models, referring explicitly to Maker's own discovery model, Hilda Taba's teaching strategies, or Renzulli's enrichment model (Renzulli, 1977).

A fourth contributor who's been critical for infusing thinking into classrooms is Ann Brown. Along with Annemarie Palincsar, she developed reciprocal teaching as the first cooperative learning practice expressly designed for distributing thinking processes. She did so by prescribing, and systematically rotating, process-oriented roles within pairs and small groups, using texts as the predominant informational source at schools. By combining cooperation and thinking processes, subject-specific knowledge (the contents), more general learning competences (in this case, reading strategies), and even social skills (including leadership skills) are simultaneously acquired (Palincsar & Brown, 1984). Separate enrichment programs that are often provided for single, rather decontextualized competences (e.g., creative thinking abilities, leadership skills, reading and writing strategies) become superfluous with CDL. Such skills and competences will be simultaneously acquired through subject-specific curricular knowledge.

Ann Brown and her group continued to expand this concept for designing and organizing instruction. The so-called Fostering Communities of Learners (FCL) approach integrates teachers, students and grade-levels, as well as neighborhoods and parents, into knowledge-generating communities (Brown & Campione, 1994; Bransford et al., 2004). Even Web 2.0-based learning environments explicitly apply FCL principles (Slotta & Najafi, 2015).

Implementing these research-based developments helps to design environments for gifted learning with more detailed and flexible components than are currently offered in special programs or traditional classrooms. As a consequence, a broader spectrum of abilities and individual differences can be integrated in these environments. This may also contribute to better solutions for addressing the differences in learning levels within homogeneous gifted schools and classrooms. Marsh, et al. (1995) recently found the Big-Fish-Little-Pond (BFLP) effect in such classrooms. This means that the ever-increasing individual differences in scholastic achievement cannot only be found in mixed-ability classrooms, but also in homogeneous classes with only highly gifted learners. In a more recent study, Bui et al. (2014) found evidence that being admitted to a school for the gifted could negatively impacts the students' confidence more than staying at a mixed-ability school. Considering such effects, the new models for addressing individual scholastic differences should be implemented via improved teacher training programs for gifted education instructors, which are urgently required by alGhawi (2017) in her informative overview on the current status of gifted education in the UAE. Coleman & Gallagher (1995), who studied conditions for using cooperative learning practices in mixed-ability classrooms, found that the effective use of such methods is strongly dependent on intensive teacher training that includes expert demonstrations and modeling. Staff development programs resulted in widespread cooperative learning use at all levels, including advanced classes for high-ability students. Implementing cooperative learning using thought-provoking, challenging problems and projects set forth by trained teachers had positive effects on the achievements, motivation, and social skills of both below average and highly gifted students. These early results provide further evidence that implementing classroom instruction for gifted students requires mastering a wider spectrum of methods and instructional components that can be varied, orchestrated, mixed, and adapted by teachers. Implementation, modification and differentiation of cooperative methods for use in process-oriented discovery learning (CDL) is particularly important to include in curricula for training teachers of gifted students (Bruening & Saum, 2020; Pehmer, Groeschner & Seidel, 2015; Preston et al., 2015).

Undoubtedly, the aforementioned contributions facilitated the ongoing transition from traditional product-oriented teaching, which only focuses on measurable outcomes, to a process-oriented instruction format, which emphasizes internal thinking processes. Cooperative methods organize these processes in terms of think (individual), pair (group), share (whole class) sequences for engaging each student and elucidating their thinking processes. Lothar Bruening and Tobias Saum provide an impressive range of methods and procedures for organizing classrooms in these ways (Bruening & Saum, 2021).

However, with highly gifted students, cooperative methods are only more efficient than working alone if they are used in concert with thought-provoking assignments (Patrick et al., 2005). Cooperative learning assignments that employ only simple, well-defined tasks with a single correct answer do not challenge gifted students, nor do they stimulate curiosity or provide meaning for these students to reach their highest potential (Bahar & Maker, 2015; Neber et al., 2002).

The IPKA Model: An integrative framework for planning and implementing classroom instruction for gifted students

The causality between instruction (I), internal thinking processes (P), the resulting internal knowledge (K), and subsequent knowledge-based achievements (A) as the products of classroom education are illustrated by the Instruction-Process-Knowledge-Assessment (IPKA) model. I have developed this model as an integrated framework for planning and delivering classroom instruction (figure 3).

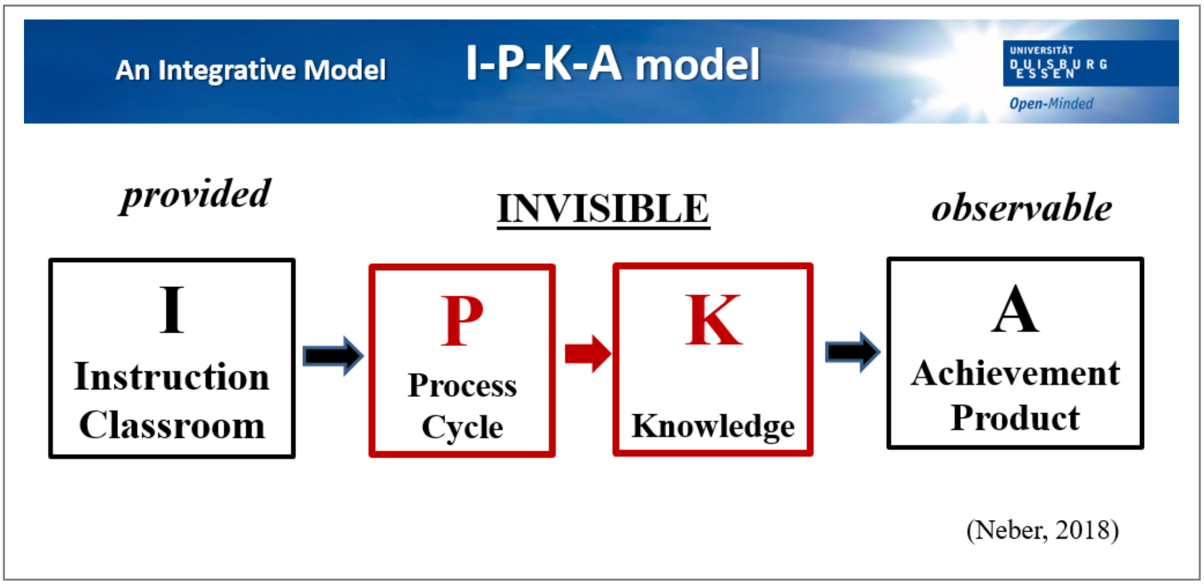

Figure 3: The I-P-K-A model as an integrative framework for CDL in classrooms (Neber, 2019).

Quite astonishingly, irrespective of these evidence-based results about the central role that thinking plays in learning—and 70 years after Guilford's speech—the education system is still criticized for its inability to develop critical thinking skills in traditional classrooms and schools. For example, Ron Ritchart from Harvard Graduate School of Education (Ritchart, 2015) suggests that in order to "make thinking apparent" much more effort will be required in classrooms. In Germany, J. Kaube (2019) recently published a bestseller that asks "why schools teach everything but thinking." In order to improve this situation, classrooms must be progressively transformed into social-constructivist environments by implementing cooperative discovery learning practices. Current achievements within the gifted education community may help.

Gifted education could contribute to the movement of replacing product-oriented with process-oriented teaching, allowing all students to develop their full potential for generating personal knowledge. Teaching models that have been developed for gifted students may be used for supporting this transformation in all types of schools. Indeed, available models, at least their most successful instructional components, provide "opportunities for improving the quality of teaching and learning in classrooms" of all schools.

Teaching models, such as problem-based learning or the enrichment-cluster, combine cooperative learning and challenging tasks that require all kinds of thinking (e.g., divergent, convergent, heuristic, and intuitive, as well as logical and metacognitive thinking). Figure 4 provides a sample of well-known models. All of them implement recommended social-constructivist learning environments (VanTassel-Baska, 1998) and rich discovery-oriented and inquiry-based classrooms that promote giftedness by and for learning.

Despite the differences between specific procedures, these models realize common characteristics that qualify each as an example of cooperative discovery learning. CDL is a conceptual framework for teaching that is defined using seven characteristics (see Figure 6).

Discovery cycles for process-oriented teaching in classrooms

From the beginning, discovery learning has been confused with open education, which presumably obligates students to build knowledge on their own, without any guidance. This, however, is a fundamental misconception. Nevertheless, it is currently used as an argument for attacking and rejecting discovery learning, thereby favoring what is assumed to be extremely structured, directly guided instruction for all students (e.g., Kirschner et al., 2006; Stokke, 2015). However, the assumption that direct instruction is the opposite of discovery learning is another fallacy.

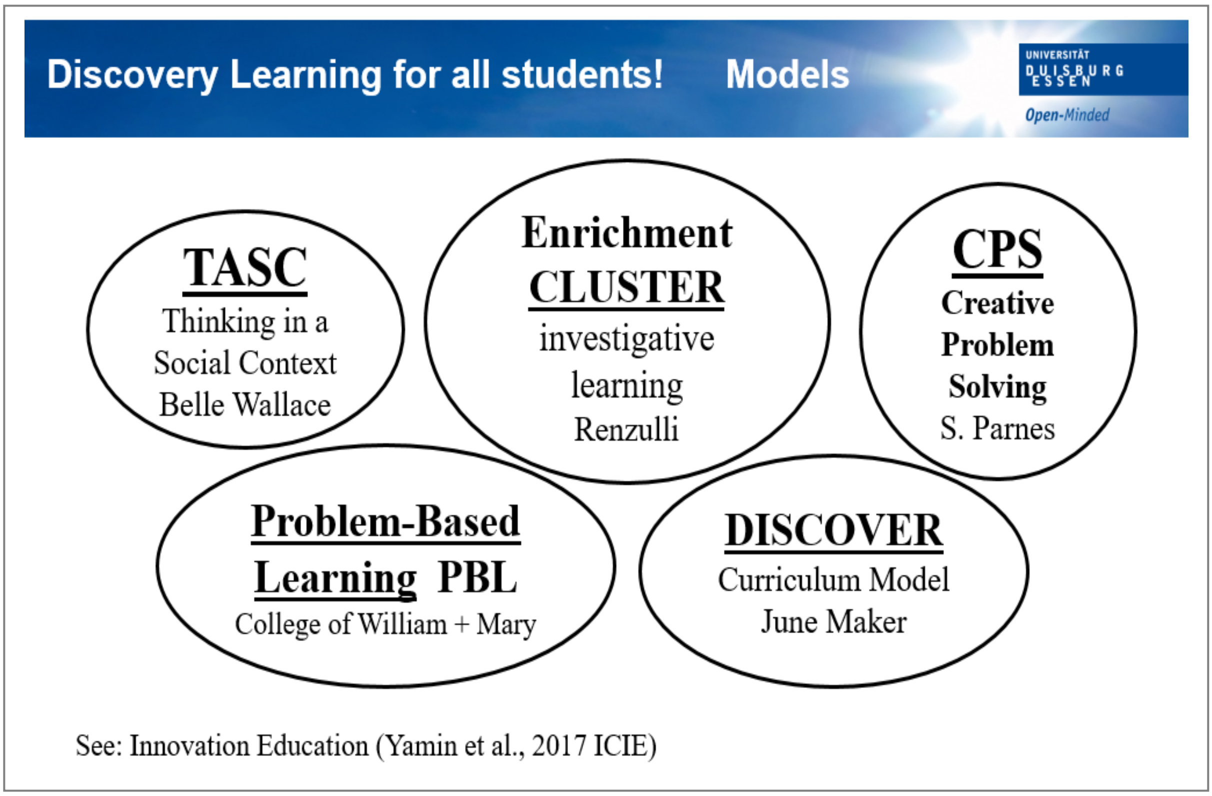

Figure 4: Teaching models in gifted education: organizing knowledge generation through cooperative learning.

In contrast to these false assumptions, discovery and CDL can be implemented in extremely structured ways because a fixed level of guidance is not a defining feature of these approaches. On the contrary, the level of guidance can be flexibly altered and adapted. It is not the behavior of the student or the accuracy of his or her achievements, but the internal thinking that matters. Process-orientation is the most important characteristics of cooperative discovery learning. It may be realized, for example, by process-oriented feedback or pausing for reflection during lessons. Recent research shows that process-guidance is even required with highly gifted students. These students do not automatically or spontaneously use their available potential to think, for instance, by formulating their own questions and hypotheses (Estes & Dettloff, 2008; Verduijin-Meijer, 2016).

Figure 5, below, summarizes the possible sequence of steps (thinking processes) that are required for generating knowledge. The function of CDL as an instructional template is to stimulate, guide, support, and distribute these processes among the students. Such processes are not only required for learning by experimentation, or for learning by design, but also for learning with texts (see Palicsar & Brown, 1984). Other atypical learning opportunities, such as visiting botanical gardens or zoos with parents, rely on these processes (Eberbach & Crowley, 2017).

In Figure 5 you will find a simplified illustration of this discovery cycle. For example, instructing students to “visit an aquarium and discover which fish they have” is an ill-defined learning task. Both divergent and alternative solutions are possible, and the task requires asking additional, more specific questions, like, “Is a cattlefish a fish?”

CDL not only requires the formulation of internal questions, but the students have to answer these in terms of assumptions or hypotheses. From the example above, please refer to the step that reads, “Yes, a cuttlefish is a fish.” Upon further investigation, the students will realize (supported by learning materials and the teacher) that this answer is false and requires new knowledge to help explain why it is so. In this case, discovery learning is used to organize a Predict-Observe-Explain (POE) cycle (see figure 5), which, in turn, enables learning via productive failure. Productive failure as a method for generating knowledge is a current focus in further developing discovery learning (Abrahamson & Kapur, 2018). It is already being prescribed and used in some engineering programs in Singapore (according to these authors).

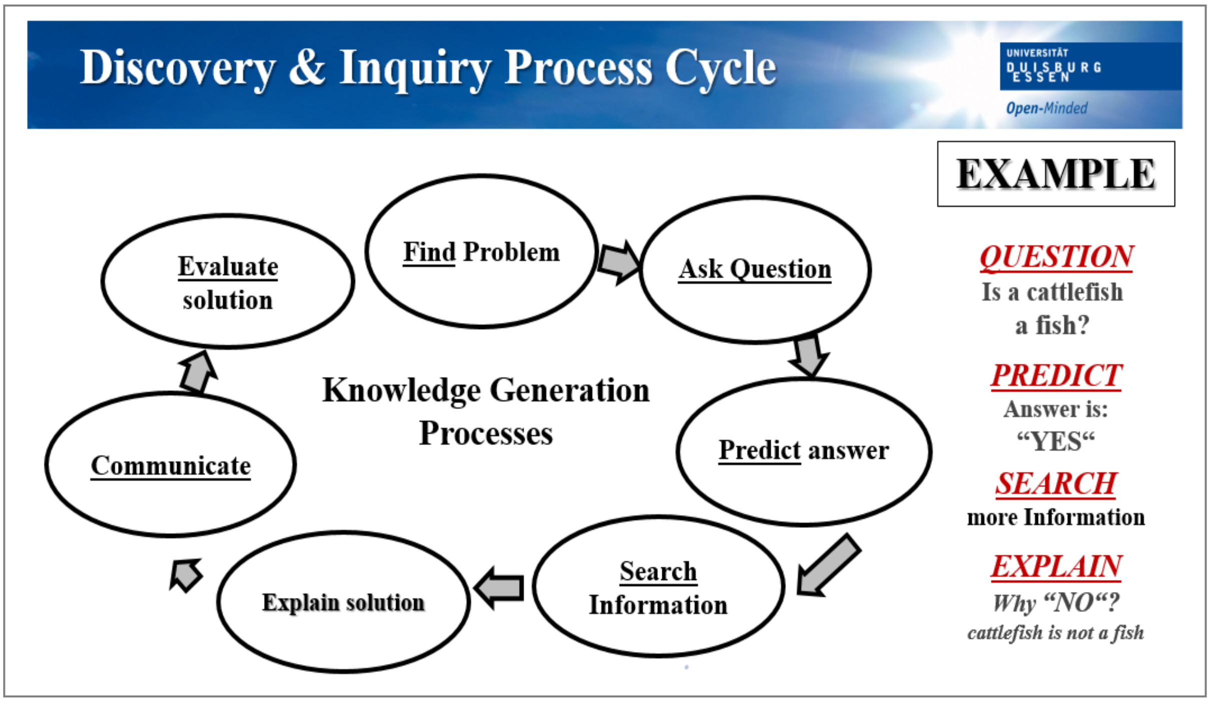

Figure 5: The Discovery Process Cycle: Process-oriented instruction.

Defining characteristics of Cooperative Discovery Learning (CDL)

Taken as a whole, CDL (or Discovery-Oriented Instruction) is a general model, a framework for designing and providing instruction in classrooms and groups. CDL as a concept is defined in terms of the following seven characteristics (represented in Figure 6). Each of them is implemented to varying degrees in the teaching models for educating gifted learners above (see Figure 4).

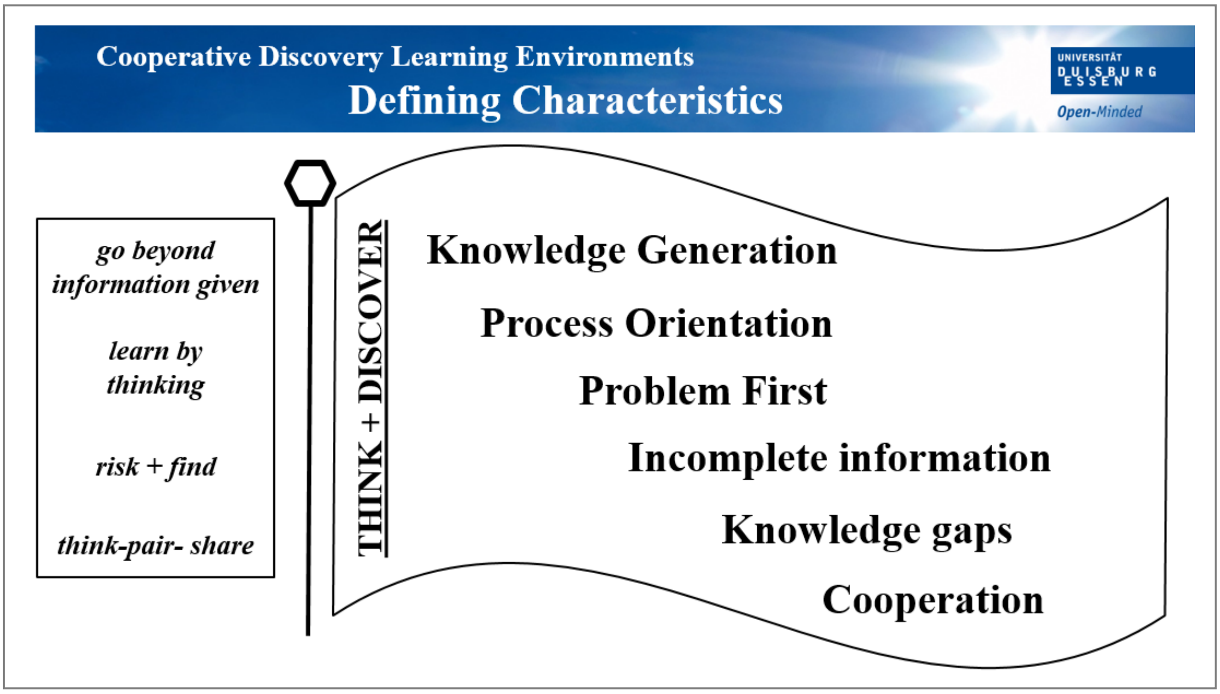

Figure 6: Cooperative Discovery Learning: The CDL flag with seven defining characteristics

1. Knowledge-generation means that the to-be-acquired knowledge is at least partially generated by the student. In the earliest version, students received non-abstracted examples as learning materials and had to infer (by inductive reasoning) the abstract knowledge.
2. Process-orientation, which is now required in all Science, Engineering, Technology, and Mathematics subjects (STEM) (e.g., Moog, et al., 2014), means that teaching, and all of its instructional components, should focus on the thinking processes of the students. The function of these processes is to generate knowledge as organized structures by abstracting, elaborating, or further deepening prior, self-attained knowledge. This applies to experience- or evidence-based skills in the same way (e.g., questioning skills; Neber & Anton, 2008). Figure 5 illustrates the internal processes required for generating knowledge as a discovery or inquiry cycle.
3. Problem-first instruction means that the students get tasks, problems or challenges without having the required knowledge or skills for answering, solving or mastering these challenges. If the required knowledge will be explicitly provided (e.g., by lecturing or direct teacher instruction), it is done only after the students have first struggled with the problem (for educating gifted students, the problems are preferably complex and ill-defined). Problem-based learning (PBL) is the best example of this approach (e.g., Neber & Neuhaus, 2017).
4. With knowledge availability, the students should have a prior but basic familiarity with the subject (e.g., definitions or rules). They should use this incomplete knowledge for formulating their own questions and hypotheses about the given assignment. Guesswork should be excluded in favor of knowledge-based, educated guesses, predictions and hypotheses. Accessing prior knowledge for these processes is required for restructuring, differentiating, or even replacing their already existing knowledge (Gijlers & de Jong, 2005).
5. Incompleteness as an instructional approach means that the teacher, textbook, domain experts and parents do not provide complete, well-organized information that is required for solving the problem. As a consequence, the teacher has to develop a new role and act as a tutor (Vygotsky, 1978). Evidence shows that this is quite challenging, takes time and should be a meaningful component of corresponding teacher training programs (Verduijn-Meijer, 2016).
6. Cooperation means that cooperative learning methods are applied when orchestrating the thinking and solution processes required for generating knowledge. This means more than just learning in groups. All of these methods organize sequences of think-pair-share phases, ensuring that each student contributes to the achievements of the group (Bruening & Saum, 2019), and are strongly recommended for teacher training.
7. Progressive implementation is required because of the complexity of the CDL framework. This includes varying the levels of guidance and structure. First, a high level of guiding the learning processes (e.g., by direct instruction) is required. Then, the level should be progressively reduced; this should be done quickly with higher achievers to prevent over-scripting, and more slowly for less-than-average learners in order to mitigate the cognitive load. Progressive implementation can be realized, for example, through the Process-Oriented Guided-Inquiry Learning (POGIL) method (Hanson, 2006). I have developed Object-Generating-Instruction (OGI) as a similar approach (Neber, 1997), which is currently more refined in mathematics education. Progressive implementation allows for a mixed-methods approach to instruction (as in POGIL or OGI), as well as flexible combinations of learning processes and strategies for developing "expertise for the future" (Durkin, Rittle-Johnson & Star, 2015).

Common standards of teaching in traditional schools and gifted programs enable integrative solutions

The current standards for university-based education programs in traditional curricula and the recently revised standards for teachers in gifted education are closely aligned. Both aim to provide competences for implementing new ways of teaching that involve the cognitive abilities of all students, as well as teaching a broad diversity of students within the same classroom – including students with higher learning aptitudes. Replacing the restrictive traditional instruction with more varied and flexible learning environments is a common goal across all schools.

For example, the National Council for Teaching Mathematics' (NCTM, 2000) recommendations for standard math classes include contextualized, authentic problems that are of genuine interest to students, higher levels of intellectually challenging tasks, and more adequate support for students, which encourages them to collaborate and cooperate, leading them to discover important concepts and acquire problem-solving skills on their own (Harris & Hofer, 2009). These suggestions have similar applications when teaching highly gifted students.

This is another indicator that the standards for university-based teacher education overlap with the recently revised standards for those wishing to work with gifted students. Van Tassel-Baska, who has chaired the committee that governs these standards, emphasizes competences for integrative teaching in heterogeneous classrooms, including skills for learners with differing intellectual potentials and cultural backgrounds (Van Tassel-Baska & Johnson, 2007). According to these leading authors, deep connections to both general and special education are required, and they call for strong links to research on learning and instruction in other domains. Cognitive science is considered to be particularly important for attaining higher levels of understanding, problem-solving and collaboration among gifted students. In the past, these links have been excluded, and gifted education represented a closed system for research and development on giftedness. The old standards for educating teachers of the gifted have been revised in this respect, making it possible to benefit from the achievements of research and development on schooling and instruction in the learning sciences.

These converging developments will help in opening the previously closed community of gifted educators. Conversely, standard education will profit from what has been attained via the education of gifted students. Such developments present possibilities for creating innovative classrooms of the future that are more flexible, diverse, interactive and challenging; they emphasize the strengths of all students while paying particular attention to students with a greater ability for acquiring knowledge, thereby developing their competences as well as their identities and personalities (Neber & Sennebogen, 2011).

Public schools, in particular, could profit from already existing programs, services, and differentiated solutions. Models for educating the gifted could be used as blueprints for traditional schools and may provide the required support for teachers in meeting the needs of the potentially underserved high achievers and gifted learners in their classrooms. Encouraging these teachers and strengthening their willingness to accommodate their students' needs are prerequisites for effective implementation of gifted programs in public schools and classrooms (Coleman & Gallagher, 1995; Tebbs & Subhi-Yamin, 2006).

In Germany, more and more traditional schools are aware of the possibilities and available blueprints provided by gifted education programs. In particular, many secondary schools currently offer a variety of internal and external differentiations (acceleration as well as enrichment) that have been developed in the domain of gifted education. For example, the Helmholtz Gymnasium in Bonn, a secondary school, offers multilingual classes with three, instead of two, languages (Latin, French, Spanish or Chinese), and the possibility of earning an International Baccalaureate in addition to the German Abitur. In science, intensified physics, chemistry, and computer science courses with more credit hours per week and additional advanced study groups are offered for extraordinarily high-achieving students. Similar programs exist for the arts and music (including membership in orchestras). In addition to these curricula enrichments, all kinds of accelerations are possible, inclusive grade skipping (maximally three grades are allowed), or early college entrance. Meanwhile, most of the secondary schools in Germany offer similar solutions and further support and services that attract not only highly gifted or high-achievement learners, but all students (and their parents).

The limited number of state-controlled, gifted schools in Germany is not actively creating initiatives to support these ambitious developments at traditional schools. However, various states and ministries are beginning to implement classes specifically for those identified as highly gifted students at selected secondary schools. In Bavaria, for instance, eight schools have been chosen. These also serve as counseling and dissemination centers for all other schools, as well (Bavarian State Ministry for Education, 2019). Overall, there is a strong tendency for blending different kinds of German schools into integrated institutions that provide adequate and flexible solutions for all students.

Conclusion

The information contributed in this text could help in further developing gifted and talented education programs on the classroom level and progressively implementing them by applying the discovery-oriented framework.

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