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Dynamic Testing and Individualized Instruction: Helpful in Cognitive Education?

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An important theme in educational practice is to tailor instruction to the individual needs of children. Particular forms of group instruction may be effective for specific children; other children will profit most from a more individual approach. The contribution aims to focus on the question whether such tailored forms of instruction can be found in a dynamic assessment context and explores the potential usefulness of dynamic testing and instruction for cognitive education. The principal characteristic of dynamic testing or assessment is that children are explicitly provided with feedback, prompts, or training intended to enable them to show progress when solving cognitive tasks. Outcomes of dynamic testing and assessment could, in principle, provide educational psychologists or teachers with information regarding learning outcomes during intervention. Although it has been claimed that such approaches may have more to offer to psychologists or educationists than traditional standardized test outputs, not all approaches are suitable for this aim. This article focuses on the potential usefulness of the outcomes of the graduated prompts approach in dynamic testing and instruction. It can be concluded that a combination of both dynamic procedures is a very promising one, which needs further exploration in the future.

Keywords: dynamic testing; cognitive education; cognitive training; dynamic instruction; inductive reasoning

COGNITIVE EDUCATION

An important theme in educational practice is to tailor instruction to the individual needs of children. Particular forms of group instruction may be effective for specific children; other children will profit most from a more individual approach (e.g., Caffrey & Fuchs, 2007). The current contribution aims to focus on the question whether such tailored forms of instruction can be found in a dynamic assessment context and explores the potential usefulness of dynamic testing and instruction for cognitive education.

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Reigeluth and Moore (1999) define *cognitive education* as being "composed of a set of instructional methods that assist students in learning knowledge to be recalled or recognized, as well as developing students' understanding and intellectual abilities and skills" (p. 52). In these intellectual abilities and skills, they include metacognition. From this point of view, cognitive education could be seen to be equivalent to optimally child-centered (cognitive) instruction or teaching from a learner-centered design (e.g., Quintana, Shin, Norris, & Soloway, 2006). Jeltova and colleagues (2011) describe this form of instruction as *dynamic instruction*, which "occurs when the teacher actively intervenes in the course of learning in order to give active feedback while the learning is taking place" (p. 382).

Active, mental exploration of the learner is required in cognitive education or dynamic instruction because methods and/or teachers are supposed to *assist* students in gathering information and in developing their understanding and intellectual abilities. According to, for example, Adey (2003), active thinking of the learner is a necessity for cognitive change. Before a teacher, however, is able to assist students in their learning processes in the classroom, she or he needs to know what a child is capable of and what is the child's potential for learning. The teacher needs to learn to focus on the unique needs of learners (Quintana et al., 2006), whereby motivation, changes in cognitive and achievement skills, level of expertise, and responsiveness to certain aspects of intervention are core elements. This contribution focuses on cognitive change and individually based needs for instruction.

Given children's unique and most of the time variable learning progression (Siegler, 1996), the provision of comparable educational opportunities for all children requires a lot from teachers (e.g., Brown-Chidsey & Andren, 2012; Glover & Vaughn, 2010). Cognitive education seems to be related to, or result from, several interwoven, complex concepts such as cognitive development, learning, efficiency of learning, assessment and testing, transfer, and teaching or training (the use of) cognitive and metacognitive abilities and skills. Cognitive education could, therefore, profit considerably from thorough understanding of the individual processes of change in children's thinking (e.g., Siegler, 1996).

Dynamic Testing and Assessment

Criticisms of the traditional IQ test have helped to stimulate research on dynamic assessment and testing (for overviews, see Elliott, Grigorenko, & Resing, 2010; Grigorenko & Sternberg, 1998; Guthke, 1982; Haywood & Lidz, 2007; Lidz, 1987; Lidz & Elliott, 2000; Van der Aalsvoort, Resing, & Ruijssenaars, 2002; Wiedl, 2003). The principal characteristic of dynamic testing or assessment, in contrast to static testing or assessment, is that children are explicitly provided with feedback, prompts, or training intended to enable them to show progress when solving cognitive tasks (Elliott et al., 2010; Haywood & Lidz, 2007; Sternberg & Grigorenko, 2002).

The learning potential concept, lying behind dynamic testing and assessment, goes back to the ideas and definitions of intelligence by Binet (1908/1916) and Thorndike (in Thorndike et al.,1921) as "the ability to learn." Recent researchers in the field of learning potential research and dynamic assessment have however been influenced more directly by either *Feuerstein's* theory and subsequent development of the learning potential assessment device (LPAD) and instrumental enrichment (IE) or *Vygotsky's* theory of the zone of proximal development (ZPD) including his statement that one should not just measure the level of intellectual functioning but also detect the *best instructional level* for the child because "this measure gives a more helpful clue than mental age does to the dynamics of intellectual progress" (Vygotsky, 1962, p. 103; see also Feuerstein, Rand, & Hoffman, 1979; Feuerstein, Rand, Hoffman, & Miller, 1980; Haywood & Lidz, 2007; Sternberg & Grigorenko, 2002; Vygotsky, 1978).

Binet (1908/1916) became convinced that the intelligence test he and his colleagues developed did not always give an appropriate picture of the child's cognitive potential. He believed it should be possible to raise a child's level of cognitive development depending on individually determined constraints to a higher level by means of training, particularly by teaching the child how to learn (e.g., Brown, 1985). Buckingham (as cited in Thorndike et al., 1921) pointed out that whatever intelligence is defined, " . . . we are justified from an educational view in regarding it as ability to learn, and as measured by the extent to which learning has taken place or may take place" (p. 273). Selz (1935) concluded that it would be necessary to study the thinking process itself in detail to examine the actual intelligence of the person. Selz has described research in which children were given specific training in thinking where they were taught specific solution procedures for several problems according to the principle of the *kleinstmögliche Hilfe* (i.e., the smallest amount of help necessary to reach the solution).

Dynamic testing is based on the assumption that test outcomes derived after the provision of some form of (individualized) intervention are more likely to provide a better indication of a child's potential level of intellectual functioning than conventional static test scores alone (e.g., Lidz & Elliott, 2000; Sternberg & Grigorenko, 2002; Wiedl, 2003). Although both learning potential tests and dynamic assessment procedures each show large differences in structure and content, they all have at least two elements in common: (a) They stress the same defining aspect of intelligence as "ability to learn"; and (b) they give children training, instruction, or individualized hints or prompts to improve their performance on problem-solving tasks. The concept of dynamic testing or assessment is generally used for describing various approaches all linked by "dynamically" providing feedback and instruction as part of an assessment procedure. This form of feedback is either fixed, that is, it is the same for all children tested, or individualized, that is, it is applied in a tailored fashion related to the child's ongoing performance in the test situation (e.g., Elliott et al., 2010). This intervention component within the testing situation itself represents a significant departure from most conventional testing procedures, which usually prohibit any forms of (more or less individualized) assistance or feedback other than the strictly described test instructions, as decribed in the manual, such as task introduction and explanation, motivating the child in general, and so forth (e.g., Hessels-Schlatter & Hessels, 2009).

Intelligence

In my work on dynamic testing, Campione, Brown, and Ferrara's (1982) definition of intelligence was very helpful in thinking over the dynamic testing construct: "Intelligence is the efficiency of new learning, couched in terms of the ability to profit from incomplete instruction and of the intimately related ability to transfer old learning to new situations" (p. 398). This definition has close resemblance to "the ability to learn in the absence of direct or complete instruction" (Dearborn, as cited in Thorndike et al., 1921) and Binet's (1908/1916) ability to learn. Let us assume that a child's path of intellectual development can be defined in terms of the efficiency with which new learning occurs. This is not only a matter of the speed with which information is processed but, more importantly, is also the way in which cognitive activities are performed and the more or less efficient way in which the various process components are selected, sequenced, and modified. New information has to be linked to existing knowledge, and, in this whole intellectual process, self-regulatory, metacognitive skills—such as planning, monitoring the solution process, and controlling one's own solution procedures—play a fundamental role (Campione et al., 1982; Resing, 1997, 2006; Sternberg, 1998). The flexibility with which these metacognitive skills can be applied must also be seen as an important aspect of intellectual functioning. Cognitive education aimed to enhance these processes of intellectual development in children must take into account and focus on these specific thinking abilities, including their large individual variability (e.g., Adey, 2003; Siegler, 2007). Outcomes of dynamic testing and assessment could, in principle, provide educational psychologists or teachers with information regarding learning outcomes during intervention. Teachers should be able to adapt their teaching processes parallel to the outcomes of dynamic testing, for example, by knowing if and how much children profit from specified forms of intervention during dynamic testing. Although it has been claimed that such approaches may have more to offer to psychologists or educationists than traditional standardized test outputs, finding ways to gather complex process-based information not only in a flexible, scientific fashion but also in a practical fashion has proven to be challenging (Bosma & Resing, 2010; Elliott, 2003; Grigorenko, 2009; Resing, Elliott, & Grigorenko, 2011).

Dynamic Assessment and Testing Related to Individual Learning Outcomes

Lidz and Elliott (2000) give in their introductory chapter of their book on dynamic assessment models an overview of several dynamic tests and assessment instruments, ranging from clinical and individualized intervention to very standardized, sometimes adaptive, instruction. Most dynamic assessment and testing systems aim to gauge the individual's potential level of performance rather than what can be achieved independently (Resing & Elliott, 2011). Ongoing, individualized mediation, mostly grounded on the work of Feuerstein and colleagues (e.g., Feuerstein et al., 1979; Feuerstein et al., 1980) often yield interesting qualitative information, assumed to be indicative of the cognitive modifiability of a child. This use of nonstandardized interventions, however, prevents solid interpretation of the results of the empirical studies that have been employed (e.g., Sternberg & Grigorenko, 2002). Furthermore, both the test–retest reliability and the reliability of progress (change) measures remain questionable (Büchel & Scharnhorst, 1993) if test users do not have a protocol of how to act. Using such a form of dynamic assessment makes it, therefore, rather difficult to provide parents or teachers with transparent and objective information regarding a child's potential for learning.

However, not every form of standardized dynamic testing is helpful in the objective search for on-the-spot learning processes during assessment as well. Budoff, for example, trained older learning disabled pupils in how to solve Koh's Block Design Test (e.g., Budoff, 1987; Budoff & Corman, 1974). Pupils were trained in relatively large groups, with instruction on paper, and all got exactly the same, short, standardized training procedure including very strict task-specific hints. Although the trained pupils did show more progression in their solving behavior than untrained pupils, the test scores after training do not fully provide us with information regarding the individual learning steps and processes of the group members. Participants in the dynamic test could, based on their learning progression, be categorized in groups as learners, nonlearners, and high scorers, but it is questionable if this labeling will give teachers enough information to build their cognitive education upon. Besides, progression in skills as a consequence of training tells us that some learning has taken place but does not give insight in the learning process and progression itself.

In other formats of dynamic testing, children are typically provided with feedback, prompts, or training geared to enable them to show individual differences in their progress when solving cognitive tasks. The Adaptive Computer Assisted Learning Test Battery (Guthke & Beckmann, 2000), for example, makes use of standardized sets of prompts and indicates learning progress during the test, provides information regarding to five typical types of learners, and ends with an indication of the child's potential to learn from the prompts provided. Swanson's (2000) Cognitive Processing Test makes use of standardized sets of prompts focusing on sequential processing strategies related to working memory (WM). The dynamic test provides an index of processing potential, which can be used to more accurately identify learning disabled pupils (related to reading and math).

The information delivered by dynamic tests as described previously would seem valuable as a first input for cognitive education because it might provide insights for teachers regarding not only the level at which the individual, or groups of children, are functioning but also the process about how children come to the right conclusions and information regarding which forms of feedback are helpful or not. Gaining information during the assessment session about how children respond to structured assistance and how their strategy use changes as a result of feedback has the potential to be considerably helpful for educators confronted by a child having difficulties in learning. However, finding ways to gather and tap this information in a scientific, standardized fashion and then provide this in a meaningful way to teachers to date continues to be challenging and is certainly not possible for all forms of dynamic testing or assessment (Bosma & Resing, 2008, 2010; Elliott et al., 2010; Grigorenko, 2009).

Process-Oriented Dynamic Testing

In my own research on dynamic testing, the graduated prompts approach has a central position. Graduated prompting may be seen as a dynamic testing method that is as adaptive as possible, by different forms of prompting and scaffolding, but at the same time using standardized protocols for instruction. Grigorenko and Sternberg (1998) described this form of dynamic testing as primarily focused on the child's actions rather than on task features; but of course, both elements could be combined. The standardized approach of giving prompts depending on the needs of the child is assumed to give more information on how the child solves the task problems. Research with this form of dynamic testing has shown that both the number of prompts children need and their posttest scores are good individual predictors of future school success (e.g., Caffrey, Fuchs, & Fuchs, 2008; Sternberg & Grigorenko, 2002). In line with the pioneering work of Campione, Brown, Ferrara, Jones, and Steinberg (1985), we defined the child's potential for learning, in part, in terms of a learning criterion, for example, the minimum number of prompts needed for independently solving the test items after training. Scaffolding involves structuring all aspects of the task situation in such a way as to enable a test taker to solve task elements that could not be solved without any assistance and provided as necessary. Assistance is then subsequently reduced, at least if the child's ability to solve tasks independently increases.

The graduated prompts approach has a firm tradition in dynamic testing studies (e.g., Campione & Brown, 1987; Fabio, 2005; Ferrara, Brown, & Campione, 1986; Resing, 1997; Resing & Elliott, 2011; Resing, Tunteler, De Jong, & Bosma, 2009). Often, these authors in their dynamic tests have included tasks that have to be solved by inductive reasoning, which can be defined as a rule-finding process that can be achieved by searching for both similarities and differences between objects being compared. Inductive reasoning is considered to play a core role in cognitive development and in learning and instruction in general (Goswami, 1996; Kolodner, 1997). It therefore seems a very important general cognitive ability to be trained in dynamic testing. In the next paragraphs, three short summaries of studies we performed in dynamic testing, including graduated prompts techniques (and scaffolding), present our recent findings.

Dynamic Testing and Fine-Tuned Measuring of Solving Processes

In a recent study, employing the graduated prompts approach (Resing et al., 2009), we aimed to explore whether dynamic testing of indigenous and ethnic minority children could provide information concerning changes in their strategy use while solving seriation tasks (Seria-Think; Tzuriel, 2000). It was hypothesized that dynamic testing with graduated prompts and trial-by-trial-assessment could aid understanding of the development of children's strategy use. Participants were 54 indigenous Dutch and 55 ethnic minority children with a mean age of 7.5 years. A stepwise graduated prompts training was designed in which the experimenter observed and recorded all the steps and strategies the child showed, either spontaneously or elicited during training, to solve the seriation problems. If the child could not independently solve the task, the experimenter provided the minimally needed number of prompts chosen from a predetermined standardized set of metacognitive and cognitive prompts. Trial-by-trial testing provided information of how strategy use developed during training. Children in the experimental group showed significant progression toward the employment of more advanced solving strategies. Ethnic minority children showed most strategy change during training, initially needing more prompting but progressively requiring less. The study provided insight into strategy use during and after training for children from the two conditions.

In a second study of inductive reasoning (Resing & Elliott, 2011), our key objective was to examine strategy use in more detail. Specifically, we sought to examine how a form of process-oriented computerized dynamic testing, using electronic tangible materials and incorporating a series of graduated prompts and scaffolding techniques, could provide insights into children's potential for learning. Potential for learning was defined in terms of successful outcomes and strategies employed by individual children while solving complex inductive reasoning tasks (figural series completion). It was hypothesized that our graduated prompts approach would reveal differential changes in strategy patterns of seventy seven 7- to 9-year-old children and in their need for differing prompts to help them solve the problems. These two elements—it was anticipated—could identify differential potential for learning on the part of the participants. Children in the experimental group received a series of inputs consisting of a pretest, two training sessions, and a posttest, all involving series completion tasks; the controls were administered all tests but received no training. All test sessions were undertaken individually using a specially designed program incorporating an electronic console and tangible materials with sensors inside. As a consequence of training, children significantly outperformed controls on the series completion task. Significant individual differences were noted in terms of the children's response to assistance. Furthermore, dynamic testing increased analytical and reduced trial-and-error solution strategies. After training, a significant proportion of the children employed strategies that had been identified as optimal, although a sizeable minority still demonstrated rather idiosyncratic approaches.

In a third study (Resing, Xenidou-Dervou, Steijn, & Elliott, 2011), we again examined whether children would show different change patterns in their strategy use when administered several series completion tasks presented within a dynamic testing format using a graduated prompts approach with scaffolds. The same electronic console using tangible objects with sensors enabled the detailed recording of children's responses and solution times. It was hypothesized that children who received training (i.e., who were involved in dynamic testing) would progress to more advanced strategy use than nontrained children, and that this would be evident for both verbal and behavioral measures of strategy use. We also sought to examine whether more advanced strategies would be employed by children with higher levels of WM capacity. It was found that the group of dynamically tested children tended to shift their verbal strategic behavior to a more advanced level. When examining the behavioral measures, it was found that some children showed the same pattern of progression; but others, who already had performed at an advanced level in the pretest, shifted their strategy to a heuristic form. WM capacity did not appear to play an important role in differentiating between trained groups. Dynamic testing, using electronic console and tangibles with sensors, enabled us to identify strengths and weaknesses in the children's approach to learning.

Process-oriented dynamic testing, such as that illustrated by the three studies described previously, is a challenging and complex enterprise in part because both interindividual and intraindividual differences become salient when using such a method (e.g., Siegler, 2007). Cognitive education could be built on and fine-tuned along these measures derived from process-oriented dynamic testing. These test outcomes give insight in the quantity and quality of the prompts and scaffolds children need or repeatedly need. Two children with equal static baseline scores (e.g., IQs of 85) can show differences in the number of prompts needed, in the slope with which these needs for prompts diminish, in the quality of the prompts (do they need metacognitive instruction or modeling), in their solving behavior (do they show trial-and-error solving patterns or do they analyze the task before they start; are they able to verbalize what they have done during problem solving), and so forth. Process-oriented instruction cannot stand alone; assessment and instruction components should be integrated, and it is important to ascertain which, individually based, forms of help children need to be able to progress beyond a certain level of learning (e.g., Ashman, 1985).

Cognitive Education: An Example of Dynamic Instruction

The goal of process-oriented assessment of the potential for learning of the child is not to close the gap permanently between the child's current and potential functioning. This only becomes, at least partially, possible when the child participates in a much longer and much more intensive cognitive training program, for instance, one of the various "teaching-to-think" training programs such as described by, for example, Moseley et al. (2005) and Hu et al. (2011). A second approach, therefore, may involve the combination of dynamic testing with educational programs based on dynamic instruction. A study combining such results, both with a strong emphasis on standardized but dynamic instruction, is briefly described in the next section.

Resing and Roth-Van der Werf (2002) designed a study in which *dynamic testing* and *dynamic cognitive instruction* in the classroom were combined. The relationship between assessing and training inductive reasoning skills was explored by the use of two instruments: the learning potential test for inductive reasoning (LIR; Resing, 1993, 2000) and a Dutch adapted version of the Cognitive Training Program for Children (Klauer, Resing, & Slenders, 1996). The ideas behind both instruments were similar: Both strongly emphasized the use of a graduated prompts training method with metacognitive (and transfer) aspects of training across multiple contexts, both in format and in content. The study aimed to go beyond measuring the latent cognitive abilities of the child. Often, one wishes to instruct teachers how to build upon these to develop the children's potential (e.g., Grigorenko & Sternberg, 1998). Research using a combined dynamic testing and cognitive education approach appeared to offer the opportunity to gain insight into the possibilities of training children to become more advanced users of general inductive reasoning processes.

An adapted version of Klauer's program (Klauer et al., 1996) was used, including a very detailed prescribed and standardized way of dynamic instruction. Transfer was trained with the help of paradigms. Paradigmatic transfer was supposed to occur if certain reasoning structures, which had been taught and learned on the basis of prototypic or exemplary rules ("paradigms"), were successfully applied to other tasks. This form of transfer, however, seldom occurs spontaneously (Detterman & Sternberg, 1993). Many problems related to the measurement of transfer concern the process of recognizing "problem isomorphs" (e.g., Bassok & Holyoak, 1993; Brown, 1982). Even if all training and transfer conditions are fulfilled, it often remains difficult for children to independently relate that what already has been learned to new tasks. They are particularly interested in solving *new* tasks, and it generally does not occur to them to search for relational similarities between new and previously learned tasks, although in principle, they would be able to do so (e.g., Opfer & Thompson, 2008). To realize transfer effects, it thus seems necessary to practice paradigmatic transfer actively. The problem solver not only needs to "learn how to learn" but also to "learn how to generalize" or "to come to transfer" (Klauer & Phye, 2008).

The study, among others, examined whether children's inductive reasoning skills became more advanced as a consequence of a dynamic instruction program aiming at the enhancement of inductive reasoning processes, whether they paralleled the way children profited from the dynamic testing procedure, whether the dynamic test measures were good predictors of the later outcomes of the cognitive training program, and whether thorough training of a whole variety of inductive reasoning programs lead to better transfer. Participants were 155 second graders (aged 7–9 years old) split into four conditions: dynamic testing plus cognitive training, cognitive training, dynamic testing, or merely completing all pretests and posttests. The LIR, consisting of two inductive reasoning tests (visual exclusion and verbal analogies), has a sandwich format, meaning that intervention is given between a pretest and a posttest, and the training follows graduated prompts procedures emphasizing the teaching of both metacognitive and task-specific (cognitive) strategies (see, for detailed information, e.g., Resing, 2000). The sequences of prompts were based on task analyses and structured according to the principle of "kleinstmögliche Hilfe" (Selz, 1935).

Whereas instructors in the original cognitive training program were given global advice about how to proceed, in the version we developed, trainers followed standardized scripts. The cognitive training material consisted of 120 inductive reasoning problems divided over

6 inductive reasoning classes including problems that could be solved by six corresponding strategies or paradigms: general reasoning structures, which are applicable in different content domains. Based on prescribed solution and prompts schemes used by the teachers, children learned (a) to acquire knowledge regarding a range of concepts such as similarity, difference, attributes, and relationships; (b) to identify the six problem types and (c) to classify the various problems into one of these classes; (d) the prototypical solution rules by using paradigms; (e) how to solve the problems using these rules and control their answers; and (f) to generalize their solution and control processes to new problems. The instructional method can best be described as based on guided discovery learning, requiring an active learning orientation on the part of the child. The training script paralleled that of dynamic testing. At the beginning of the training, the children were given the opportunity to discover the conceptually different types of basic problems, problem characteristics, problem solutions, and monitoring strategies on their own. Then, the trainer guided the problem-solving behavior of the child using schemes and standardized prompts. These prompts and helpful suggestions were specified and ordered from general, abstract, metacognitive to specific, concrete, cognitive ones. The intention of these training procedures was to let children make use of the smallest number of prompts possible to go through the solution procedure. Pretransfer and posttransfer tests were selected on the basis of their varying degrees of superficial similarity to the training tasks. Tasks could look like the trained tasks, for example, both containing geometric analogies; tasks could also be unlike the trained task but having the same underlying solving processes, for example, including visual versus verbal analogies. The term *superficial* refers here mainly to the way tasks are presented and the context from which they are derived. In the version of the program that was used, tasks were mostly presented as pictures of concrete objects and situations from the children's world. Transfer tests including the same kind of material and deriving from similar contexts were considered superficially equivalent when the format was equal and superficially similar when the format differed. Tests consisting of symbolic or abstract geometric materials were considered superficially dissimilar. Dynamic testing comprised six 15-min training sessions within a period of 2 weeks. During the cognitive training program, children were trained in pairs twice a week. The training comprised 11 sessions lasting 30–45 min each.

After cognitive training and dynamic testing, children became more advanced in visual inclusion, verbal exclusion, and even scored more highly on a noninductive but superficially similar reasoning task, that is, the most concrete inductive transfer tests, which had the least challenging solution components. Children seemed to notice that the principles with their relatively simple component structure, such as those which were learned in the dynamic testing procedure, could be applied when solving the new transfer tasks. Children who followed both training procedures also performed significantly better on transfer tests, which were superficially dissimilar, such as seriation, visual analogies, and matrices, consisting of abstract material; the inductive reasoning rules are more difficult. It was concluded that a relatively intensive training program in which inductive reasoning had been taught along different lines and with different aims—a combination of a dynamic learning potential test and a cognitive training in inductive reasoning—resulted in positive training effects. Children also learned to slow down, to reduce their errors, and to evaluate their answers and monitor their performance. They worked more systematically and analytically, and thus improved their task performance (Resing & Roth-Van de Werf, 2002).

Both instruments and procedures—dynamic testing versus dynamic cognitive training—provided valuable information regarding inductive learning processes. Such information could be used to inform teachers about the learning possibilities of their pupils and to provide them with concrete suggestions on how to awake and develop their inductive reasoning potential—a central aspect of cognitive development necessary in solving school tasks such as categorization, concept formation, arithmetic, grammar, and spelling learning (Goswami, 1996).

Dynamic Testing With Graduated Prompts Techniques in Special Education

In a recent study (Resing, Bosma, & Stevenson, 2012), we evaluated the use of dynamic testing based on graduated prompts techniques in a clinical educational setting. We studied whether it would be possible to administer a dynamic test based on graduated prompting to a small, atypical group of children with complex behavioral and psychiatric problems, developmental disabilities, and, mostly, very weak school performances. We examined differentiation in individual change patterns in children's use of solving strategies when presented with a figural analogies task and explored the relation between existing academic measures (intelligence, school achievement) and dynamic testing outcomes. Data revealed that these children were able to solve figural analogies and showed differentiated progression lines in their accuracy in solving the task after training. Trained children employed more sophisticated problem solving after graduated prompts training, and individual differences in progression paths from pretest to posttest were apparent. Groups of children differing in the number and type of instruction needed during training could be identified. IQ scores and teacher ratings of school performance were highly correlated, although IQ scores showed no relationship with objectively measured school achievement scores. Dynamic test scores revealed lower correlations with teacher ratings of school performance but were the best predictors of school achievement. Although our sample of children was quite small, we concluded that dynamic test measures gave the best indication of the children's scholastic achievement and in their potential for learning.

Cognitive Education: Dynamic Testing and Individualized Dynamic Instruction

Before successful, effective learning and problem solving can optimally take place, educational psychologists and teachers would have to become aware that individual children have specific repertoires of strategy activities that can be addressed by cognitive education. According to Ashman and Conway (2002), Brown (1982), and many others, this repertoire of strategic activities appears to be an important variable in cognitive education. Children vary a lot in what they know, which strategies they choose and use in solving tasks, and how they generalize that what has been learned to other related tasks (e.g., Opfer & Thompson, 2008; Siegler, 2007). Children show much, or some, or hardly any learning during the training part of dynamic testing. They sometimes need only metacognitive, self-regulatory skills if they need a starting point for solving; at other times, they need modeling over and over again. They show a lot of variability while solving tasks, or they show hardly any variability, and this behavior might be task specific as well. Our studies in dynamic testing, cognitive training, and dynamic instruction result by their dynamic character in better knowledge about learner characteristics and learning activities of the child. Although this is not an easy step, these learning outcomes most probably could be used as input for further dynamic teaching to individual children or groups of children in the classroom. Before this can happen, educational psychologists will need to bridge the gap between the knowledge derived from controlled dynamic testing and training in standardized situations at one hand and classroom teaching.

Ashman (1992) already studied process-based instruction that was constructed on the basis of an integrated assessment-teaching procedure with the aim to enhance information processing abilities in children. Other steps in that direction are made by Delclos, Vye, Burns, Bransford, and Hasselbring (1992) as well. Bosma (2011) discussed outcomes of dynamic testing with the teachers of the children involved in the dynamic assessment procedure, but most teachers did not change their teaching based on the information provided, although they found these outcomes very interesting. Our study in special education shows that teachers sometimes have a picture of children that is based on static measures, such as intelligence test outcomes, and have less eye for the, sometimes even small, learning progressions of the child (Resing et al., 2012). Evaluation of the assessment results with teachers of the children involved in the assessment procedure could provide teachers with findings of dynamic testing that can be helpful in the development of further classroom instruction.

D. Fuchs et al. (2007) propose the use of dynamic testing instead of static response to intervention (RTI) measurements. They describe RTI as a method providing both identification of children with learning disabilities and early intervention to at-risk children. After a first study, they conclude that practitioners, using dynamic testing measures that include rather detailed information about the child, might identify young at-risk children for early intervention more easily than by using traditional RTI measures. According to D. Fuchs and his colleagues (2007), "DA seemed to tap into aspects of young children's reading performances that the other [RTI] measures did not" (p. 62). Grigorenko (2009) also discusses the relationship between both concepts. L. S. Fuchs and colleagues (2012) report the extra predictive value of dynamic testing in comparison to a math word problem screener: The high numbers of false positives resulting from the static screener were practically reduced to zero when dynamic testing outcomes were included in the prediction. They plead for a two-stage screening for math problem-solving difficulties in children, including dynamic testing. The next step in such identification of children at-risk procedures could be the introduction of learning measures—derived from dynamic testing—in the cognitive education for these children.

In the context of cognitive education, a conclusion may be that to attain a lasting effect of education and for the possibility of occurrence of transfer effects, it is necessary to design a cognitive education program, which takes into account that both cognitive and metacognitive strategies should be taught in good harmony with each other, preferably by using a graduated prompts or guided discovery approach; that children should not only learn how to learn but also "learn how to reach transfer"; that children need to practice actively also with transfer problems; and that these forms of dynamic instruction in the classroom have to be flexible, multiple situated, and with a variety of materials. Dynamic instruction methods would be based on outcomes of individual or group dynamic testing procedures. In conclusion, we can say that the combination of dynamic testing and instruction procedures is a very promising one not only to teach children general inductive reasoning skills for problem solving but also in a subject area as math. This combination, in particular, needs further exploration in future.

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