Revealing the effects of cognitive education programmes through Dynamic Assessment

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The major objective of this paper is to demonstrate the effectiveness of dynamic assessment (DA) in revealing outcomes of cognitive education programmes. Three programmes based on mediated learning experience theory are reviewed: Feuerstein’s Instrumental Enrichment, Bright Start, and Peer Mediation with Young Children. In all three programmes DA was more effective than standardised tests in revealing their effects. The paper includes discussion of mediated learning experience theory and its relation to DA. The content and focus of the cognitive education programmes are described as are the specific test instruments selected for use in the DA sessions. The paper concludes by considering reasons why DA is not used more frequently in educational research.

Keywords: Dynamic Assessment; cognitive education programmes; mediated learning; cognitive modifiability; peer mediation

One of the reasons for using dynamic assessment (DA) in cognitive intervention research is matching the declared objective of such programmes (e.g., ‘learning how to learn’) with the required criterion of evaluation. The logical argument is that if the declared objective of the intervention is teaching children how to learn and to benefit from mediation, then the criterion outcome measure should be assessed by DA, which aims precisely to reveal the ability to benefit from teaching. DA measures do not simply target the same abilities that cognitive education programmes intend to develop. In other words, it is not a matter of merely tracking improvement in individuals’ performance of discrete tasks. Rather DA’s focus on cognitive modifiability entails learning how to solve problems across domains, including but not limited to those addressed in cognitive education programmes.

Given this affinity, it is surprising that many studies that endeavour to evaluate the effects of cognitive education programmes do not employ DA in their outcome measures. The main purpose of this paper is to argue, on the basis of a series of studies, for the appropriateness of DA for understanding development that occurs through programmes intended to promote cognitive abilities. A central construct in the approach to DA described here is cognitive modifiability. This may be defined as an ability to benefit from a learning experience and subsequently to change one’s cognitive performance in similar or more advanced learning situations (Feuerstein, Rand, and Hoffman 1979). The mediation strategies used within the DA procedure as well as within the cognitive education programmes are based primarily on mediated learning experience (MLE) theory (Feuerstein, Rand, and Hoffman 1979; Tzuriel

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Before turning to the specifics of the cognitive education programmes and the organisation of the DA procedures, some additional details concerning MLE theory and DA are provided.

**Feuerstein’s theory of mediated learning and Dynamic Assessment**

**Mediated Learning Experience (MLE)**

Mediated learning experience (MLE) is an interactional process in which parents, adults or peers interpose themselves between a set of stimuli and the learner, and modify the stimuli for the developing child (Feuerstein, Rand, and Hoffman 1979). An interaction can be defined as mediated interaction if it contains three basic ‘ingredients’: *Intentionality and Reciprocity*, *Meaning*, and *Transcendence*. These criteria are considered as necessary and sufficient for an interaction to be classified as MLE. The first five MLE criteria are described here briefly. For a detailed description see Feuerstein, Rand, and Hoffman (1979).

(a) *Intentionality and Reciprocity*: effort is required by mediators to create in children a state of vigilance, and to facilitate an efficient registration of the information, an adequate processing, and accurate responding. The reciprocity component is crucial to the quality and continuation of the mediation process. Children’s response to mediation enables mediators to adjust mediation and continue the process efficiently.

(b) *Mediation of Meaning*: mediators emphasise the significance and worth of a stimulus or event by expressing interest, affect, and enthusiasm. The significance of a stimulus can be conveyed nonverbally (e.g., facial expression) or verbally (e.g., illuminating a current activity and relating it to past events).

(c) *Mediation for Transcendence*: mediators must go beyond the concrete context and immediate needs of the child by reaching out for general principles and goals that are beyond the ‘here and now’ or the specific aspects of the situation. In formal teaching situations, parents or teachers might mediate rules and principles that govern a problem or a learned subject and show how they are generalised to other school subjects or daily life situations. Efficient use of this mediation might be shown when children generate a principle when confronted with new situations. Children transfer the rules and strategies learned previously to other problems varying in terms of content domain and level of complexity, novelty, and abstraction. The combination of all criteria becomes a powerful vehicle for the development of cognitive modifiability and widening of the individual’s need system.

(d) *Mediation of Feelings of Competence*: the environment of these interactions is arranged not only to ensure children’s success, but to interpret it in a manner that conveys to children their capability of functioning independently and successfully. This includes explaining to children the reasons for successes and failures, and rewarding them for attempts to master and cope effectively with the situation.

(e) *Mediation for Regulation of Behaviour*: the mediator helps to regulate the child’s responses to the demands of the task. This may involve either inhibiting impulsive tendencies or accelerating inefficient/slow behaviour. This mediation is of critical importance in helping the child register information accurately and control the need for immediate gratification, and it affects the process of mental activity in input, elaboration, and output phases of the mental act.

According to Feuerstein, the MLE strategies used in parent–child interactions help children to internalise learning mechanisms, facilitate learning processes and self-mediation, develop deficient cognitive functions, and benefit from mediation in other contexts. Changes in cognitive structures are not automatic but depend to a large
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degree on appropriate mediation. Children who experience adequate mediation internalise this interaction, will use it later in various contexts, and will actively initiate and self-generate it.

**Dynamic Assessment (DA) of learning potential**

In this approach, DA refers to assessment – via a process of actively teaching – of an individual’s perception, learning, thinking, and problem solving. This process is aimed at modifying an individual’s cognitive functioning and observing subsequent changes in learning and problem-solving patterns within the testing situation (Tzuriel 2001). Unlike other assessments, where examiners seek to document an individual’s existing repertoire of cognitive abilities and make no attempt to change, guide, or improve the individual’s performance, the main goal of DA is to assess changes in performance **within the test situation**. The changes are taken as indications of learning potential, that is, future development that will be realised provided that a cognitive intervention is applied.

DA is motivated by the inadequacy of conventional, non-dynamic (sometimes referred to as static) tests to fully capture the range of relevant diagnostic information, including learning ability, specific deficient functions, change processes, and mediation strategies that are responsible for cognitive modifiability (for detailed reviews see, e.g., Feuerstein, Rand, and Hoffman 1979; Haywood and Lidz 2007; Haywood and Tzuriel 1992; Lidz and Elliott 2000; Sternberg and Grigorenko 2002; Tzuriel 2001, in press). To illustrate how DA may occur, and also to help readers understand the specific DA measures that will be referred to in the studies discussed later in this paper, I will describe four instruments commonly used in DA.

The **Children's Analogical Thinking Modifiability (CATM) test** (Tzuriel and Klein 1985, 1990) is composed of 14 items (arranged by four progressive levels of difficulty) administered in a sandwich format (assessment – teaching – assessment). The child is presented first with 18 coloured blocks (red, yellow, and blue) with different shapes (circle, square, and triangle) and sizes (small and big). After a preliminary baseline phase of teaching the test’s dimensions and basic rules for solving analogies, the child is presented with the test problems. For each task, the child is provided with three blocks and must determine which block from a pile completes the analogy (e.g., in the sequence Big-Red-Square: Small-Red-Square: Big-Yellow-Circle: (?) the child must select Small-Yellow-Circle). Cognitively, the task involves systematic exploratory behaviour, understanding of rules, control of impulsivity, simultaneous consideration of differing features, verbal tools to process information, and representational thinking. The child’s performance improvement from pre-teaching to post-teaching is taken as indication of cognitive modifiability. For a detailed description of the CATM test and research findings readers are referred to Tzuriel (2001).

Another assessment of analogical reasoning that targets the same cognitive capabilities is the **Analogies Subtest** from the **Cognitive Modifiability Battery (CMB)**. The CMB (Tzuriel 1995, 2000b) is a DA measure designed for kindergartners to fourth graders. The analogies subtest is constructed of a wooden plate with four squared ‘windows’ arranged in a 2 x 2 pattern, a set of coloured blocks (64), and a series of problems for each of the test’s phases. The examiner places blocks in three of the open ‘windows’ and asks the child to complete the analogy in the last open ‘window’, which always is to the child’s bottom right position. All analogies are based on four dimensions: colour, height, number, and position. Tasks are rendered more or less
challenging through combinations of some or all of these dimensions. As with the CATM, a three-stage sandwich format is followed, and improvement between the pre- and post-teaching phases is interpreted in terms of cognitive modifiability. For a detailed description of the CMB use and research findings see Lauchlan and Elliott (2001), Tzuriel (2001, 2000b), and Tzuriel and Shamir (2007, 2010).

The *Children’s Conceptual and Perceptual Analogical Modifiability (CCPAM)* test similarly addresses analogical reasoning but presents tasks involving material objects (in this case, cards) as well as tasks for which no such materials are available. These are referred to as construction analogies and closed analogies, respectively (Tzuriel and Galinka 2000; Tzuriel 2002). Both the construction analogies and closed analogies versions also include *conceptual problems*, which refer to functional, categorical, and part-whole relations, as well as *perceptual analogies* involving changes in colour, objects, and position. The construction analogies version presents learners with cards in a mixed order that they may sort in order to remove ‘distracting’ cards and use the remaining ones to complete analogies. For the closed analogy tasks, learners are required to think about the relationship between one pair of pictures (e.g., *Bird: Nest*), apply it to a second pair (*Dog: ____*) and choose the right answer (*Doghouse*) from the four given alternatives. For detailed description of the CCPAM and research findings see Tzuriel (2001, 2002, 2006), Tzuriel and Flor-Maduel (2010), Lifshitz et al. (2010), Lifshitz, Tzuriel, and Weiss (2005), Tzuriel and Shamir (2010), and Vakil, Lifshitz, Tzuriel, Weiss, and Arzuanoan (2011).

A final instrument worth mentioning is the Seria-Think Instrument (Tzuriel 1999), which measures process-oriented cognitive behaviours in the mathematics domain. The test is based on a variety of arithmetic skills, especially seriating and math operations. The problems of the instrument require cognitive functions such as planning, self-regulation, systematic exploratory behaviour, simultaneous consideration of several sources of information, and need for precision and accuracy. The instrument is composed of a wooden block (12 x 12 x 10cm) with five rows of holes and five holes in each row, a set of cylinders (with varying heights), and a measuring rod divided equally into 11 units. The tasks involve insertion of the cylinders into the holes so as to get lines of cylinders with either equal height, increasing height, or decreasing height above the block’s surface level. The child is instructed to build the line of cylinders in as few insertions as possible. In order to avoid trial-and-error behaviour the child is encouraged to use the measuring rod as many times as he/she wishes. For most holes there is no way of knowing their depth without using the measuring cylinder. For a detailed description of the test and research findings see Tzuriel (2000a), Tzuriel and Caspi (2011) and Resing, Tunteler, de Jong, and Bosma (2009).

Having outlined these four key instruments that will be referenced in the empirical DA studies undertaken to reveal the effects of cognitive education programmes, I now turn to the three programmes in question: *Feuerstein’s Instrumental Enrichment (FIE)*, *Bright Start*, and *Peer Mediation with Young Children (PMYC)*. The major reasons for their selection are that they are all based on the MLE theory, all are characterised as programmes aimed at enhancing the child’s cognitive modifiability, and in all of them there is at least one study in which a DA approach was used to evaluate their effectiveness.

**DA in the context of cognitive education programmes**

Table 1 offers a comparison of FIE, Bright Start, and PMYC along six dimensions: theoretical foundation, major goals, type of instruments used in the programme,
Table 1. Summary of characteristics of three cognitive education programmes based on mediated learning experience theory.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Theoretical Basis</th>
<th>Instruments</th>
<th>Methods of Instruction</th>
<th>Target Population</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Feuerstein Instrumental Enrichment</strong></td>
<td>The theory of Structural Cognitive Modifiability using Mediated Learning Experience</td>
<td>Three levels: 1. Standard (ages six up) upwards. 2. Extension for academically trained people. 3. Downward extension for children four to eight including children with special needs</td>
<td>1. Classroom appreciation 2. Individual exercises 3. Bridging through mediated learning experience strategies</td>
<td>Children, adolescents and young adults with or without learning difficulties.</td>
<td>Depending on level of functioning. Two years, three hours per week for regular students. Two years, six hours per week for students with special needs.</td>
</tr>
<tr>
<td><em>(Feuerstein et al. 1980)</em></td>
<td></td>
<td>1. Set of 15 paper and pencil instruments 2. Teachers' training materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bright Start</strong></td>
<td>Feuerstein Vygotsky Piaget Haywood</td>
<td>1. Eight curriculum units 2. Manual for parent participation 3. Teachers’ training materials</td>
<td>1. Small group activity 2. Large group activity</td>
<td>Kindergarten to Grade 2 and Children with learning difficulties</td>
<td>One year, four to five lessons per week (20 minutes each). Two years for children with intellectual disabilities or other difficult problems (e.g., autism spectrum disorders).</td>
</tr>
<tr>
<td><em>(Haywood, Brooks, and Burns 1986)</em></td>
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<tr>
<td><em>(Tzuriel and Shamir 2007)</em></td>
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Note: The principal methods of instruction for all programmes are mediational teaching and group discussion: these aspects share most in common across the programmes.
methods of instruction, target population, and duration of the programme. Except for the FIE programme, all the programmes include additional theoretical foundations and vary in terms of the other characteristics. Because of space limits other programmes are not included in this article and readers are referred to the relevant research literature (e.g., Tzuriel and Eiboshitz 1992; Tzuriel and George 2009). In what follows, each programme is briefly described and the empirical DA studies investigating the programme’s effects are summarised.

**Feuerstein’s Instrumental Enrichment (FIE) Programme**

The FIE programme is a cognitive educational programme in which mediated interaction around a variety of instruments is aimed at developing cognitive functions and enhancing the cognitive modifiability of varied populations of children with learning difficulties. The FIE programme is based on *Structural Cognitive Modifiability and Mediated Learning Experience* theory (Feuerstein et al. 1980), according to which enhancing cognitive modifiability – or the capacity to profit from mediation – allows the child to learn additional and even more complex cognitive operations and strategies than those taught in the programme.

Other objectives of FIE are to: (a) remediate deficient cognitive functions considered to be the causes of academic failure; (b) provide verbal and conceptual tools that are necessary for processing information and performing cognitive skills; (c) develop an intrinsic need system for adequate cognitive functioning and relative independence of external conditions; (d) produce meta-cognitive processes; (e) produce task-intrinsic motivation; and (f) change the individual’s perception of him/herself from passive recipient of information to an active generator of information. The FIE programme includes 15 paper and pencil instruments, each consisting of a set of problems with increasing levels of difficulty. For each instrument, a set of teaching procedures is suggested, including as a major component ‘bridging’ learned principles to domains and contexts that are beyond the original domain presented. The effects of the FIE programme have been investigated by several researchers (e.g., Bradley 1983; Feuerstein et al. 1980; Kozulin 2005; Samuels et al. 1984; Savell, Twohig, and Rachford 1986; Shayer and Beasley 1987; Tzuriel and Alfassi 1994).

The FIE programme was evaluated by Tzuriel and Alfassi (1994) using several DA measures from the *Learning Propensity Assessment Device* (LPAD, Feuerstein, Rand, and Hoffman 1979). The FIE and LPAD are two applicative systems deriving from the structural cognitive modifiability and MLE theory. None of the cognitive domains used in the DA measures overlapped with the instruments used in the programme. That is, the DA measures were not directly assessing the abilities that had been the focus of the FIE programme. The sample was composed of 94 students who received the FIE programme and 98 students in a comparison group. All children came from low-SES (socio-economic status) families and were in grade 7 at the start of the study. The design of this study, as portrayed in Figure 1, represents a model where DA, reflecting cognitive modifiability, is administered before and after a cognitive education programme.

In the pre-intervention stage both groups were administered a DA measure based on the *Raven’s Standard Progressive Matrices*. The Raven test was administered twice, once before and once after a teaching phase. The teaching phase included mediation of principles and strategies of solving similar problems – the five example problems (A–E) of the Set Variation-II (i.e., this test is part of the
Figure 1. The design of the FIE study (Tzuriel and Alfassi 1994).
LPAD). The improvement from pre- to post-teaching on the Raven test was taken as an indication of cognitive modifiability prior to the intervention. The FIE intervention was then implemented for two consecutive academic years with the experimental group and amounted to 130 hours of intervention using seven to 10 of the programme’s instruments. The comparison group was exposed to an enrichment programme oriented toward teaching basic academic skills. At the end of the intervention three measures from the LPAD were administered: Set Variation-II, the Representational Stencil Design Test, and the Organiser Test. In order to compare the effects of the intervention on different groups of initial cognitive modifiability, the whole sample was divided into three groups based on gains on the Raven test given before the intervention (low, medium, and high). MANOVA of Treatment x Initial Cognitive Modifiability (2 x 3) was carried out with the Set Variation-II, the Representational Stencil Design Test, and Organiser-Gain as dependent variables. The findings show an overall significant interaction of Treatment by Initial Cognitive Modifiability. A univariate analysis revealed that from the three tests only the Organiser-Gain scores contributed significantly to the interaction. The interaction for the Organiser-Gain scores is presented in Figure 2. The results indicate that the programme was more effective for those who initially demonstrated low cognitive modifiability than for those who show medium or high levels of initial cognitive modifiability. The highest gap between the experimental and comparison groups was among students in the low initial gain subgroup. Students participating in the experimental group who also showed initial low gain scores showed the highest pre- to post-teaching improvement (gain) on the Organiser test given after the intervention whereas the parallel comparison subgroup showed a small decrease. Pearson correlations between the full scale of Raven gain scores (pre-intervention) and the Organiser gain score (post-intervention) were .43 (p < .001) in the comparison group as compared with .03 (ns) in the experimental group. It seems that the intervention not only improved in general the cognitive modifiability of children participating in the programme but also changed their rank order on a cognitive modifiability measure. In the comparison group, on the other hand, there was a significant similarity in the rank order of children before and after the intervention. The relatively higher correlation in the comparison group is explained by a lack of meaningful cognitive changes in this group. The implications of these results are that the FIE programme not only improved the cognitive skills of students but also improved their learning to learn skills as was indicated by the DA findings.

A different use of DA was carried out by Kozulin (2005) who focused on predictive validity of DA in respect to students’ sensitivity to FIE. This study was conducted with primary school students who immigrated to Israel from Ethiopia. Students were pre-tested at the beginning of the year using a DA version of Raven Coloured Matrices: the Raven test was given twice in a group format, before (pre-test) and after a training phase using the Set Variation-I instrument (i.e., Set Variation-I is part of the LPAD). For the purpose of the study a specific learning potential index was developed. This index was operationalised as a combination of the gain score and the approximation to the maximal obtainable score (for details of the formula developed see Kozulin 2005).

Following the DA a cognitive-educational intervention called CoReL (Concentrated Reinforcement Lessons) was implemented. The programme, which lasted for nine months, included five weekly lessons of FIE, five hours of intensive Hebrew, and
five hours of intensive math. It is important to mention that although the FIE programme contains a broad range of cognitive tasks, not one of them is similar to the Raven test. All facets of intervention were infused with the principles of MLE, which serves as a theoretical basis for the programme. At the end of the school year the students were tested again (post-test) using the Raven Coloured Matrices. Regression analysis for post-test on pre-test produced a much lower correlation ($R^2 = .08$, slope = .22, $t = 1.02$, ns) as compared with regression analysis of post-test on learning potential index ($R^2 = .68$, slope = .101, $t = 5.08$, $p < .0003$). Thus, learning potential index emerged as a significantly stronger predictor of post-test scores than the students’ pre-test scores.
The Bright Start programme

The Bright Start programme (Haywood, Brooks, and Burns 1986, 1992) was designed for preschool children and for children in the early grades of school who experience learning difficulties. The objectives of Bright Start are: (a) to increase the children’s learning effectiveness and ‘learning how to learn’ skills; (b) to develop efficient cognitive processes and thinking skills; and (c) to prepare children for school learning. Bright Start was designed originally for use with normally developing children, who were at high risk of school failure (e.g., children from poor or low SES families, of ethnic minority status, or inner-city residence). This population has been extended to include children with mild to severe intellectual disability, emotional disturbance, and other developmental, neurological and sensory impairments (Haywood 1995).

Unlike many other preschool programmes, which are content oriented and emphasise development of basic skills, Bright Start targets basic cognitive processes and metacognitive operations that appear to be prerequisites to academic learning in the primary grades. The programme includes five interconnected components: understanding of the theoretical base, mediational teaching style, seven cognitive ‘small-group’ curriculum units, a cognitive mediational behaviour management system, and a programme of parent participation. A cognitive, conceptual approach is taken to implementing the curriculum such that in a unit emphasising sequences, lessons explicitly introduce the concepts of sequentiality, order, and abstraction, while at the same time activities are designed to emphasise cognitive functions including comparison, classification, ordering by rules, relating past to present experience, and spatial and temporal relations.

Haywood et al. (1986) have argued that in spite of the proliferation of such programmes for kindergartners (e.g., Weikart and Schweinhart 1997), too many children arrive at first grade unprepared to master the primary curriculum, and they often wind up in special education classes. Many of these programmes fail to take into account the vast individual differences among preschool children, as well as the basic cognitive functions and transfer skills that are essential for school achievement.

Although the Bright Start programme has been the topic of a good deal of research, only three studies to date have employed DA (Samuels et al. 1992; Tzuriel et al. 1998, 1999). Due to space limitations, I limit my remarks to two of these studies in order to highlight the effects of Bright Start on children’s cognitive modifiability as measured by DA.

Samuels et al. (1992) compared children participating in the Bright Start programme for one year to a general preschool programme oriented towards acquisition of basic skills. Both groups were evaluated by standardised and DA measures. The children were between the ages of four and five and a half years at the beginning of the study and exhibited at least a one-year delay in two or more major areas of functioning (e.g., language and fine motor). Each child attended one of two preschool programmes for two-and-a-half hours per day, five days per week for a ten-month period. Children were administered the CATM test and the Peabody Picture Vocabulary Test-Revised (Dunn and Dunn 1981) at the beginning of the programme, at the end of the preschool year, and at the end of a follow-up year. Each of the three CATM administrations included a pre-test, teaching phase, and a post-test. The teaching phase of the CATM involved individualised mediation directly contingent upon the perceived needs of the child.
Utilising an analysis of covariance with the CATM pre-test scores as the covariate revealed no significant difference between the children participating in the two programmes. The findings of the standardised receptive language failed also to differentiate between the children of the two programmes. An intriguing result of this study however was that proportionally more children participating in the Bright Start programme were placed later in regular rather than in special education settings, as compared with children participating in the skills-based programme. Following this finding the researchers compared the DA and standardised tests of children who were referred to regular versus special education settings. The findings revealed that the post-test DA scores were consistently higher for the regular-stream children than for the special need-stream children. This difference was most evident at the follow-up phase, one year after the end of both programmes. Thus, children who were independently placed in programmes based on their school achievements were found to have benefitted more from mediation provided during DA than were children placed in special education. The researchers concluded that by simply examining results from standardised tests, one does not get a complete picture of the potential of the child. In other words, high modifiability on the CATM was related to school success, albeit, only as measured on the third administration (follow-up).

Tzuriel et al.’s (1999) objective was to determine whether there are generalised effects of the programme on cognitive modifiability and on reading comprehension and math skills in Grade 1. A sample of kindergartners received the Bright Start in their classrooms (n = 82) and was compared to a group of children (n = 52) who received a basic skills programme. The Bright Start programme was applied for 10 months, consisting of 20-minute small-group lessons taught three times a week. Group comparison on CATM pre- and post-teaching scores was carried out at the end of the intervention, and in a follow-up phase one year after the end of the programme. A MANOVA of Treatment (experimental vs. comparison) by Phase (pre- vs. post-teaching) by Grade (K vs. Grade 1) was carried out on the CATM scores. The analysis revealed a significant triadic interaction of Treatment by Grade by Phase, which is portrayed in Figure 3. For comparative reasons the CATM scores at the start of the programme are also plotted in Figure 3; however, the analysis is based only on students who participated in the follow-up.

Figure 3 shows both static and DA results. The static tests results are portrayed in CATM scores before and after the intervention. The findings show that children in the experimental group made higher improvement on the CATM scores (Set A) from pre-intervention (K PRE A) to post-intervention (K POST A) phase. When the CATM was administered in a DA procedure, the findings were intriguing. While at the end of the programme the comparison children improved their performance from the pre- (K POST A) to post-teaching phase (K POST B) more than did the experimental children, in the follow-up year (Grade 1) the trend was reversed! The experimental group showed higher improvement from pre- (GR1 FOL A) to post-teaching (GR1 FOL B) than did the comparison group.

These follow-up findings were interpreted as an indication of a ‘snowball’ effect of the ‘learning to learn’ treatment. According to the ‘snowball effect’, treatment effects gain power with time without any additional treatment, which is to be expected when the treatment is designed to enhance ‘learning to learn’ skills. Further support for the ‘snowball effect’ was found when cognitive modifiability indices were taken as the dependent variable. Cognitive modifiability indices were calculated by regression
analysis in which the residual post-teaching scores were derived after controlling for the pre-teaching score (see Embretson 1992).

The Peer Mediation for Young Children (PMYC)

The PMYC programme is a relatively new peer-assisted learning model that draws on both Vygotsky’s (1978) concept of zone of proximal development and MLE theory (Feuerstein, Rand, and Hoffman 1979). The concept of peer mediation was developed recently (Shamir and Tzuriel 2004; Shamir, Tzuriel, and Rozen 2006; Shamir, Tzuriel,
and Guy 2007; Tzuriel and Caspi 2011; Tzuriel and Shamir 2007, 2010) following studies about the effects of mother-child MLE strategies on children’s cognitive modifiability (i.e. Tzuriel 1999, 2001). The PMYC programme is not based on teaching a specific content but is rather a process-oriented programme designed to teach children how to mediate effectively irrespective of the mediated content. The PMYC has three main objectives: (a) to enhance a mediating teaching style and (b) cognitive modifiability of tutors, and (c) to facilitate performance and learning skills of young children who are mediated by their experienced tutor peers. The principal assumption is that teaching for peer-mediation will both elicit better mediating skills from the tutors and improve cognitive skills in both tutees and tutors. The mediation skills acquired and internalised as a result of the intervention will enable children to apply them in future learning contexts, whether when teaching peers or being exposed to new learning experiences.

In Tzuriel and Shamir’s (2007) study, all mediators in Grade 3 (n = 89) were administered at the end of the programme the Analogies Subtest from the CMB (Tzuriel 1995, 2000b). The Analogies, administered by adult examiners, included pre-teaching, teaching, and post-teaching phases. The pre-teaching score was taken as an indicator of the programme’s effect on solving problems and the post-teaching score as the mediators’ propensity to benefit from an adult mediation and consequently improve their analogical performance.

The findings showed that the mediators in the experimental group scored higher on both pre- and post-teaching scores than did the control children. Repeated measures ANOVA of Treatment by Time (2 x 2) was carried out on each of the Analogies sub-scales: Testing and Transfer. The findings showed significant interaction of Treatment by Time (see Figure 4) for the Transfer (i.e., more difficult)
problems, $F_{(1, 84)} = 25.98, p < .01$. Mediators in the experimental group not only showed higher performance than children in the control group on the pre-teaching analogies but also improved their performance higher than children in the control group on the post-teaching phase. These DA findings clearly indicate that mediators in the experimental group internalised the mediation principles and knew how to benefit from mediation given to them in a different context and consequently improved their performance higher than children in the control group.

A more sophisticated approach was applied in a recent study (Tzuriel and Caspi 2011) where cognitive modifiability, at the end of a cognitive intervention programme, was measured by DA with process-oriented measures. Specifically, the authors investigated the effects of the PMYC programme on the planning behaviour and self-regulation of young children using a novel DA measure: the Seria-Think Instrument (Tzuriel 2000a). The Seria-Think Instrument contains two process-oriented indices: number of insertions and number of measurements. The effect of the PMYC programme on cognitive modifiability was analysed by a one-way MANCOVA where the dependent variables were the scores in the post-teaching phase, and the covariate variables were two pre-teaching measurements (one before and one after the intervention). The findings indicate that the children in the experimental group improved their functioning significantly as compared with children in the control group on the Seria-Think Instrument, $F_{(3, 90)} = 3.29, p < .05, \eta^2=.10$. The measures that contributed to the overall Treatment main effect were number of insertions, $F_{(1, 88)} = 10.21, p < .01, \eta^2=.10$, and number of measurements, $F_{(1, 88)} = 5.19, p < .05, \eta^2 = .06$. Thus, it was shown that the PMYC improved cognitive modifiability not only on a performance-oriented measure but also on a process-oriented measure.

**Discussion**

The main objectives of the studies described above were to assess the effectiveness of the cognitive education programmes in improving the children’s cognitive modifiability and ‘learning how to learn’ skills. The findings of these studies confirm in general the expectations about the programmes’ effectiveness as well as the efficacy of DA measures in revealing children’s cognitive modifiability. Children participating in any of the cognitive education programmes showed greater improvements on DA measures given at the end of the programme or in a follow-up phase than did control children receiving a substitute skills-oriented programme.

The DA findings, across different studies, indicate clearly that children in experimental groups benefited more from the mediation given to them within the DA procedure than did control children. The significance of the greater gains of the experimental children should be evaluated in relation to two facts; first, that the tests given tap a different cognitive skill than those taught in the programme, and second, that the standardised tests in most studies failed to reveal the effectiveness of the programme. Application of DA as a central evaluation method reveals that the contribution of the cognitive education programme was not simply supporting the development of a particular skill practised during the programme but it involved teaching children how to benefit from mediation in a different setting and consequently improve their cognitive performance across other domains. Cognitive improvement as a function of knowing how to utilise mediation is supported by other findings, not reported in this paper, showing that experimental children participating in a programme for peer mediation acquired mediation strategies that were used with their peers (Shamir

While the findings reported so far should encourage more widespread use of DA, there are some methodological and policy issues that I would like to call attention to. Among these, one of the most striking is the variety of definitions in terms of goals and measurement orientation (Karpov and Tzuriel 2009). With regard to DA goals, some researchers perceive DA as a comprehensive holistic system that integrates, in addition to measurement of learning potential, the assessment of specific deficient cognitive functions, mediation strategies that prove to be efficient and non-intellective factors that affect cognitive performance (Tzuriel 2001). Others focus on more limited goals of measuring change in the cognitive domain (Guthke and Wingenfeld 1992). In terms of techniques of measurement, some adopt a clinical approach, trying to avoid quantifying the learning potential (Feuerstein, Rand, and Hoffman 1979), whereas others are keen on relying on psychometric techniques and meeting the metric requirements of standardised tests (Guthke and Stein 1996; Guthke and Wingenfeld 1992; Kozulin 2005; Waldorf, Wiedl, and Schottke 2009). It seems that the current situation with DA resembles the one with standardised tests of intelligence: everybody uses these tests to measure intelligence, but nobody knows exactly what intelligence is. Similarly, in DA one would wonder what we indeed know about learning potential? How exactly is it evaluated? Is it similar across different domains or cognitive operations?

In terms of method, most DA researchers are using the test-teach-retest model (‘sandwich’) whereas others are using a graduated prompt approach (e.g., Campione and Brown 1987; Resing et al. 2009), or a clinical qualitative approach (Tzuriel 2001). Researchers using the test-teach-retest approach are facing some methodological problems such as ceiling and regression to mean effects. Attempts to cope with these problems involve the development of specific statistical solutions. One of the common solutions is to calculate the residual post-teaching scores after controlling for the pre-teaching score using regression analysis (see Embretson 1992). For different techniques of calculating reliable change indices see Kozulin (2005) and Waldorf, Wiedl, and Schottke (2009).

One of the problems researchers might face when using DA before and after the intervention is over-repetition of the same test. For example, DA requires at least two exposures to the same test materials for pre- and post-teaching besides the teaching phase. In some cases this procedure is carried out twice, before and after an intervention. Over-repetition might create, in addition to a ceiling effect and regression to the mean, a decrease of motivation to take the test, and feelings of familiarity leading to diminished alertness and lack of cooperation. In order to overcome the repetition problem one should consider using a more challenging test version (e.g., more complex but requiring the same cognitive principles and strategies), using novel visual stimuli and/or a different modality of test presentation. Using a different modality should be done cautiously as it might create a problem of interpretation of the pre- to post-intervention changes. For example, one might ask whether the expected pre to post improvements in performance are attributed to the intervention effects or to modality effects.

With regard to cognitive education, DA researchers face the challenge of assessing process-oriented measures. Since one of the declared goals of many intervention programmes is changing thinking processes, a novel DA approach should be adapted focusing on assessment of the modifiability of the cognitive process per se rather than performance. Such an approach was used by Tzuriel and Caspi (2011), using the
Seria-Think instrument in evaluating the PMYC programme. A pressing issue when considering such change, however, relates to conceptualising how change indicators in DA may be used to predict future changes in ability. Put another way, if future cognitive changes are conceived as self-perpetuating, autonomous, and self-regulatory then how can we predict them? Once an individual acquires the capacity for change it is difficult, if not impossible, to predict the ‘trajectory’ of his/her development. On the one hand, it is assumed that an adequate experience with mediated learning strategies prepares the individual to benefit from learning in future contexts. This means that we can predict learning processes by the type and amount of mediation previously given to the individual. On the other hand might one ask whether or not an individual has a single ZPD or different ZPDs for different domains or abilities? If there are different ZPDs how are they interrelated? Does a cognitive education programme enhance their interrelatedness? Yet another major question is how can we integrate scientific requirements for predictability within a theory that is based on the unpredictability of changes?

Conclusion

As the point of this paper has been to argue in favour of the benefits of employing DA in cognitive education programmes, I would like to conclude by considering why it is that DA has not been more widely accepted and employed in educational assessment. A question that is asked very often by clinicians and researchers is why DA, considered as being so accurate, informative, and rewarding, is not more widely applied in research as well as in clinical practice? Several researchers have tried to grapple with this question (e.g., Feuerstein, personal communication; Karpov and Tzuriel 2009; Haywood and Tzuriel 2002). The answers proposed overlap to a certain extent and relate to conceptual issues, training traditions, and pragmatic concerns.

Among psychologists following the traditional psychometric approach, many still believe (to varying degrees) that intelligence is a fixed entity. They perceive the manifested level of the individual as reflecting his/her ability rather than perceiving the individual as having potentials for learning and change following intervention. Loyal to a deterministic hereditary concept of intelligence, they find it difficult to use DA, which derives from a belief in the cognitive system as an open system given to meaningful structural changes throughout the life cycle. Changes within DA are perceived as superficial and temporary, not reflecting the individual’s ability to learn and change cognitive structures in the future. Haywood and Tzuriel (2002) have already written that there is a certain inertia inherent in psychologists’ satisfaction with being able to do what they already know how to do, and to do it exceptionally well. Even so, what is not worth doing is not worth doing well!

Another apparent reason for not using DA is very simple: DA is not taught in graduate schools (yet!). Most psychologists are trained in graduate schools to use conventional static tests whereas DA is taught in workshops as an additional training. Many psychologists usually conceive of the DA skills of the individual as secondary skills and cognitive modifiability as a peripheral, complementary concept. The understanding and evaluation through specific and detailed learning processes are not part of the graduate school curriculum.

Finally, there is the pressing problem school psychologists often confront: the ‘client quotas’ problem. Since DA is far more time consuming than is static testing, (10–20 hours versus 2–3 hours, respectively) supervisors very often do not permit
extra time for DA or limit its use in the best case scenario. In some settings DA is used as an ‘under-the-table’ informal procedure. Even when DA measures are added to psychometric tests as complementary measures, they are carried out partially, thus losing their effectiveness. Another pragmatic problem is that schools personnel, who ultimately receive the psychologists’ reports, typically do not understand DA concepts, and do not yet know how to interpret the data or implement the recommendations, and psychologists have not been good enough about helping them on that score. Both psychologists and teachers are more content oriented than process oriented as DA requires. It should be noted that these conceptual, training, and pragmatic reasons are interrelated. The question of what should be done is complex as the answer depends on a myriad of interrelated factors. Haywood (2008) suggested that the most urgent task is to explore and incorporate new models of the nature of human ability within the curriculum of graduate schools. He suggested, as one such model, a ‘transactional’ perspective on human ability with three major dimensions: intelligence, cognitive processes, and motivation, especially task-intrinsic motivation. The concept of intelligence, then, is not seen as useless or as antithetical to the notion of cognitive processes, structures, or strategies, but as a construct that does not explain all that we know about individual differences in learning and performance effectiveness. We can supplement its explanatory value by adding the dimensions of cognitive processes and motivation. One should proceed from the intelligence model about the nature of ability to define more specifically the cognitive processes that we wish to assess, and only then construct instruments for assessing individual differences along that set of processes.

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References


