

Why Teachers Need Metacognition Training?

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The goal of this paper is to explore the cognitive and metacognitive skills of teachers engaged in cognitive training. One of the best-known stand-alone cognitive programs is "Instrumental Enrichment" (IE) developed by Feuerstein, Rand, Hoffman, and Miller. Similar to other cognitive programs, the main emphasis on IE research has always been on the change that occurs in students' performance. Little is known of teachers' acquisition of IE problem-solving skills and even less of their metacognitive performance associated with this acquisition. In the present study, 28 teachers were pre-and post-tested before and after 90 hours of IE training. The tests included items similar but not identical to those used during the IE training. The analysis of pre-test problem solving demonstrated that a relatively large number of teachers experienced difficulty in solving at least some of the IE tasks. The even greater difficulty was observed in the teachers' articulation of their problem-solving strategies in a written form. The comparison of pre-and post-test results indicates statistically significant improvement not only in the teachers' cognitive problem solving but also in their metacognitive skills. These changes, however, did not reach the level of a complete cognitive or metacognitive mastery. The possible reasons for differences in the two sub-groups of teachers are discussed.

Keywords: metacognition, cognitive skills, reflection, teachers, "Instrumental Enrichment".

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Introduction

The goal of this paper is to explore the cognitive and metacognitive skills of teachers engaged in cognitive training.

It became almost a truism to claim that in the 21st century it is impossible to limit the school instruction to already existing disciplinary knowledge because of the new – but at each given moment – still unknown challenges facing the graduates of our schools. There exists a wide consensus regarding the need to teach not just disciplinary but also more general cognitive and metacognitive skills. It is these skills that may help school graduates to tackle future learning challenges (Greiff, Wustenberg, Csapo, et al, 2014). Metacognition is often considered to be the highest level of mental activity involving knowledge, awareness, and control of one's lower-level cognitive skills, operations, and strategies. Amongst the more basic metacognitive skills is the ability to plan and monitor one's problem-solving actions, predict possible outcomes and compare them with actual solutions. Students' ability to reflect upon their own learning and problem-solving strategies is considered to be an indicator of a successful educational process. Some of the major criticisms directed at traditional educational models are associated with the apparent inability of these models to foster students' reflective and metacognitive skills (Burden and Williams, 1998).

Certain educational approaches, such as the Vygotskian "Learning Activity" approach (Zuckerman, 2003; 2018) place the development of reflective and metacognitive abilities at the center of the primary school curriculum. According to this approach, the difference between successful and unsuccessful educational processes can be evaluated by the students' ability to reflect upon their own goals, means, and methods of action, to examine a given problem from the other's point of view, and to perform self-evaluation using clearly defined criteria. The "Learning Activity" model offers a curriculum-based approach because in this model the development of metacognitive skills is embedded into the curricular teaching of mathematics, language, or other school subjects. Of course, in this model, the curriculum itself is radically transformed. It is no longer based on the provision of disciplinary information and the development of narrow curricular skills but is guided by the idea of the development of scientific (academic) concepts (Davydov, 2008).

There are, however, other models that propose to develop students' cognitive and metacognitive skills during specially designed thinking skills lessons (Higgins, 2015). Such lessons require only minimal curricular knowledge and the materials are content-neutral. It is assumed that more general cognitive and metacognitive skills acquired during these lessons can then be "bridged" to various curricular areas. One of the best-known of

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such stand-alone programs is “Instrumental Enrichment” (IE) developed by Feuerstein, Rand, Hoffman, and Miller (1980). The IE was first conceived as a method for developing learning potential and problem-solving skills in socially disadvantaged adolescents, many of them belonging to ethnic minority groups. These students’ low levels of cognitive performance and scholastic achievement were interpreted by Feuerstein and his colleagues as a consequence of inadequate amount or type of mediated learning experience during the pre-school or school-age period. The IE program was thus designed as a remedial and enrichment program that would provide students with the mediated learning experience, correct their deficient cognitive functions, teach them the necessary basic concepts and mental operations, foster metacognitive reasoning and turn these students from passive recipients of information into active learners. Later on, it became clear that the IE program can benefit not only the socially disadvantaged students but a wider range of learners including typically developing children, adolescents, and young adults. One of the main advantages of the IE program for high-functioning populations is its strong emphasis on the development of not only cognitive but also metacognitive skills (Kozulin, 2000).

Although various programs for teaching cognitive and metacognitive skills are by no means recent (Bruer, 1993), the question of how to introduce these programs into the school curriculum and how to prepare teachers who will teach them remains very much open (Zohar & Barzilai, 2015). To be able to teach cognitive and metacognitive skills teachers should have good knowledge about various elements of thinking, cognition, and metacognition, to be skillful in analyzing various tasks in terms of their cognitive and metacognitive requirements, and finally to possess pedagogical strategies for mediating this expertise to students. As demonstrated in the study of Zohar and Lustov (2018) teachers’ acknowledgment of the importance of metacognitive skills in science teaching does not mean that these teachers possess the necessary knowledge about metacognition or pedagogical strategies for teaching the relevant metacognitive skills to their students. The need for proper cognitive and metacognitive skills of course is not limited to teachers who teach curriculum-based programs, these skills are no less needed for teachers who teach the stand-alone cognitive lessons. Unfortunately, research of such programs focuses almost exclusively on their effectiveness in developing students’ skills, while the question of teachers’ proficiency remains mainly unanswered.

It is for this reason that the present study focuses on the cognitive and metacognitive skills of teachers who studied the “Instrumental Enrichment” (IE) stand-alone program as a part of their in-service professional development.

Similar to other programs, the main emphasis on IE research has always been on the change that occurs in students’ performance. Little is known about teachers’ acquisition of IE problem-solving skills and even less about their metacognitive performance associated with this acquisition. When students achieve good results af-

ter being exposed to the IE program, it is assumed that one of the main contributing factors is the teachers’ skillful mediation of the program to their students. A study by Alvarez (quoted in Kozulin, 2000) confirmed that there is a significant correlation between the students’ post-IE cognitive performance and the quality of mediation demonstrated by IE teachers. In those classes where IE teachers showed the poor quality of mediation, the students’ results were barely higher than in the control group that received no IE at all.

The quality of mediation, however, constitutes only one aspect of the teachers’ mastery of the IE program. One of the important but mainly neglected aspects of this mastery is teachers’ ability to solve IE tasks and reflect upon their own problem-solving. The study of Kozulin (2015) with in-service teachers in South Africa demonstrated that even after a lengthy IE training process 47% of the teachers were unable to solve more challenging IE tasks. It must be remembered, that these tasks are intended for average 14-18 year high-school students rather than college-educated teachers. The above findings together with the paucity of the data about teachers’ problem solving and metacognitive skills, prompted us to pose the following research questions:

- 1) What was the level of spontaneous cognitive problem-solving skills of the teachers before IE training?
- 2) What characterized the initial metacognitive performance profile of trainee teachers and how this profile changed after the IE training?

“Instrumental Enrichment” (IE) program and teacher training

The IE program (Feuerstein et al 1980) is one of the most elaborate content-neutral cognitive programs. IE materials include 14 units of paper-and-pencil tasks that cover such areas as analytic perception, comparisons, classification, orientation in space and time, syllogistic reasoning, and others. These units are called “instruments” because they provide students with cognitive and metacognitive tools for enhancing cognitive functions and operations, selecting optimal problem-solving strategies, and developing a reflective attitude toward their own learning. In each one of the units, the material starts with relatively easy tasks that progressively become more difficult. Fig. 1 shows a sample of the task similar to the more challenging tasks that belong to the unit “Comparisons”. The students are expected to respond to the instruction (“In each one of the two frames, make a drawing that is different from the model in those aspects indicated by the underlined words”) while paying attention to the model and the underlined words. The task requires several cognitive and metacognitive skills, starting with rather simple such as the analysis of the model in terms of the parameters indicated in the frames and ending with more complex such as the realization that the task includes not only explicit but also implicit instruction. The explicit instruction of making drawings that are different from the model in the aspects indicated by the underlined words also includes an im-

PLICIT message that the drawing should be identical to the model in all other respects.

The IE program can be used both during individual remedial learning sessions with children who experience cognitive difficulties and as enrichment lessons in the regular classrooms. The whole-class IE lessons are taught as a separate subject for 2 to 5 hours per week. IE applications with different groups of learners including regular, underachieving, learning disabled and gifted students generated considerable research literature. One can even claim that IE is the most researched of all content-neutral cognitive programs (see Kozulin 2000).

Teacher training in IE includes a series of lectures, seminars, and workshops ranging from about 90 hours (for the first 7 units) to 200 hours (for all 14 units). The training includes a theoretical part that encompasses Feuerstein’s concept of mediated learning, the analysis of cognitive functions during the three phases of the mental act (Input, Elaboration, and Output), and the goals of the IE program implementation. One of the sub-goals of IE explicitly refers to the development of not only cognitive but also metacognitive skills of students including the elaboration of the place of metacognition in their thinking processes. The applied part of teacher training includes the cognitive analysis of the IE tasks in each one of the units, preparation of IE lesson plans, and simulation of classroom IE teaching. The IE units vary in terms of their main cognitive objectives, e.g. orientation in space, comparison, classification, etc., and the modality of tasks – pictorial, geometric, schematic, verbal. The length of IE booklets of tasks ranges from 12 to 30 pages. It is assumed that teacher training that lasts 90 hours is sufficient for not only familiarizing teachers with all tasks in the first 7 units of IE but also imparting on them the didactics of mediation of the IE program. Feuerstein et al (1980) pointed to the essential difference in the teacher-student relationships when it comes to content-neutral IE tasks. While with typical curricular tasks (literature, mathematics, science, etc.) teachers have a built-in advantage over their students because teachers’ experience in curricular areas is much greater than that of the students, with the IE tasks, the “distance” between teachers and students is smaller – cognitive tasks are relatively new to both teachers and students. This closeness of positions helps to turn the learning process into less instructional and more meditational.

In the present research, the participating teachers were trained in the IE theory and the use of the first 7 of the IE units. The main interest for us was in three of these units because the pre-and post-training evaluation of teachers’ performance was conducted targeting the skills associated with these units: “Organization of Dots”, “Orientation in Space”, and “Comparisons”. In “Organization of Dots” tasks the “hidden” geometric shapes should be found in the cloud of dots. “Orientation in Space” focuses on the ability to assume the perspective of a depicted person or object (e.g. arrow) and identify the location of other objects relative to this reference system. The unit “Comparisons” includes both verbal and non-verbal tasks that require systematic comparison of various images and concepts (see Fig. 1).

Methodology

The study was conducted with two groups of educators who received IE training. Twenty-eight educators participated in all stages of the study including pre-and post-tests, and the training itself. In Group 1 the pre-test came after the participants received a theoretical introduction to IE and workshop experience with “Organization of Dots” tasks. In Group 2 the pre-test was made after a theoretical introduction but before workshop experience with any of the IE tasks. At the pre-test, all participants were presented with three types of tasks (“Organization of Dots”, “Orientation in Space”, “Comparisons”), similar but not identical to the IE tasks taught during the training. The teachers were asked to solve the tasks and write down their problem-solving strategies.

Even though educators in Group 1 had the advantage of already having studied some of the “Organization of Dots” tasks the t-test of the pre-test total scores of the two groups was not significant and the data of the two groups were merged. The author and an additional experienced IE trainer checked the correctness of problem-solving. The evaluation of the teachers’ ability to describe their problem-solving strategies included the following parameters: the relevance of the strategy for solving specific tasks, the completeness of the list of all required strategies, and the precision in their description.

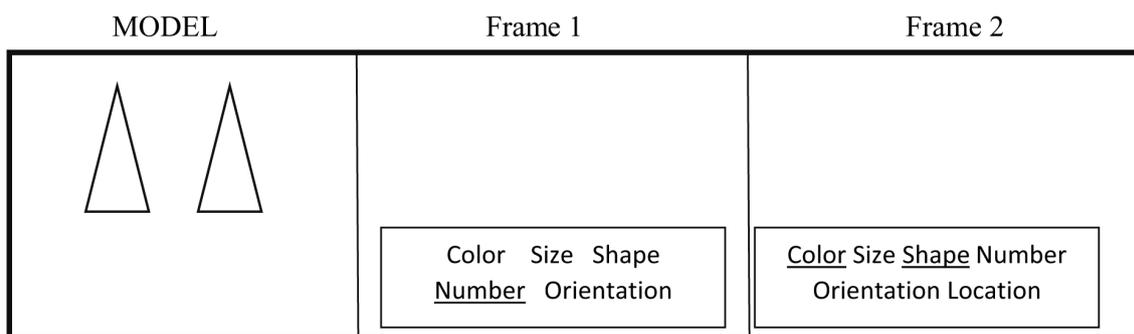


Fig. 1. Sample task of “Comparisons”

Results

The analysis of pre-test problem solving (see Table 1) demonstrated that a relatively large number of teachers experienced difficulty in solving at least some of the tasks. The even greater difficulty was experienced by teachers in articulating their problem-solving strategies in a written form. Because the reflection results in the two groups were significantly different at the pre-test they have been analyzed separately (Table 2A and 2B). In Group 1 a relatively high level of reflection was demonstrated only regarding “Organization of Dots” that had been already studied by this group before the pre-test. Strategy reflection in all other tasks in both groups was low, ranging from 22.9% to 39.3%. All relevant strategies were described by a very small number of participants, while strategy descriptions provided by many educators were vague, inconsistent, or irrelevant. One can thus conclude that before the IE training the problem-solving skills of at least some of the trainee teachers were not very effective and that their reflective skills regarding cognitive tasks required substantial improvement.

The second set of data was collected from the two groups eight months later after they finished a 90-hour course of IE training. The course included material that corresponded to cognitive tasks similar to those used at the pre-and post-tests. The results indicate statistically significant improvement in IE problem solving as reflected in the total score (see Table 1). The post-training results reached a 93% success rate in “Organization of Dots”. At the same time the average score in the “Orientation in Space” stayed practically at the same level of 82%.

There was also a significant improvement in the participants’ metacognition and their ability to describe

one’s own problem-solving strategies. In this respect, the results differed in two groups (see Tables 2A & 2B). The metacognitive skills of Group 1 at the pre-test were slightly higher than in Group 2 (39.4 vs. 25.8). As mentioned before, this can be attributed to the fact that Group 1 received some training in “Organization of Dots” before the pre-test. At the post-test, however, the Group 1 average score was only 50.9 while Group 2 advanced to the average total score of 65.9. The change was statistically significant only in Group 2. Results of the strategy reflection of individual participants in both groups remained widely different as reflected in large standard deviations, but particularly in Group 2. In two other post-tests (“Orientation in Space” and “Comparisons”) teachers in Group 2 demonstrated a significant change in their metacognitive skills and ability to formulate their problem-solving strategies.

Discussion and conclusions

The fact that the solution of IE tasks was not trivial for some of the trainee teachers corresponds to the original intention of Feuerstein et al (1980) to place teachers and students in closer position vis-à-vis the IE tasks that, unlike mathematics or literature, do not belong to the professional field of the teachers. At the same time, the fact that the average “Comparisons” problem-solving score for pre-training teachers was only 59% indicates that the teachers’ previous educational experience failed to prepare some of them for cognitive problem-solving.

Even more significant was the wide gap between the satisfactory level of teachers’ problem solving and the low level of their metacognitive reflection. If one accepts that teachers are expected to be particularly skilled in

Table 1
Average problem solving scores in two groups of teachers at the pre- and post-tests (SD in parenthesis)

	Dots	Space	Comp.		Total
Pre-test	2.57 (0.88)	2.55(0.8)	1.18 (0.86)		6.3 (0.84)
Post-test	2.80 (0.31)	2.46 (0.74)	1.78 (0.5)		7.04 (0.52)*
Max. score	3	3	2		8

N = 28, * t = 3.38; p < 0.05.

Table 2A
Average strategy reflection scores at the pre- and post-test in Group 1. N= 14 (SD in parenthesis)

	Dots	Space	Comp.
Pre-test	52.1 (36.3)	26.8 (24.9)	39.3 (35.6)
Post-test	56.8 (27.6)	37.56 (25.5)	58.6 (26.6)
Max. score	100	100	100

Table 2B

Average strategy reflection scores at the pre- and post-test in Group 2

	Dots	Space	Comp.
Pre-test	29.4 (20.7)	25.0 (25.9)	22.9 (25.8)
Post-test	68.9 (33.4)*	66.1 (39.9)*	62.9 (33.1)*
Max. score	100	100	100

N= 14; (* p < 0.05).

analyzing and explaining the problem-solving process of their students, the fact of the difficulty in reflecting upon their own problem solving indicates that the metacognitive aspect was severely neglected during their previous professional training.

Teacher training of the IE program proved to be effective in improving the teachers' problem-solving skills. At the same time, one might expect the 100% success rate (rather than the actual 88%) in the post-test tasks that corresponded so closely to the items studied during IE training. The change in the teachers' metacognitive awareness of their problem-solving strategies was very different in the two groups. Although a positive trend was observed also Group 1, in no one of the tasks did this trend reach a statistically significant level. On the contrary, in Group 2 that started with a lower level of metacognitive awareness, real progress took place that resulted in significant changes in strategy description in each one of the tasks. This disparity can be attributed to the different mediational styles of IE instructors who worked with these two groups. The instructor of Group 1 apparently placed greater emphasis on cognitive skills and the didactics of teaching IE tasks in the classroom. The instructor of the Group 2 seems to understand that the path to better cognitive skills of students lies in the

enhancement of metacognitive skills of teachers and invested more time and energy into the development of teachers' reflective abilities.

The current study has certain limitations. First of all, the sample size is relatively small – 28 teachers. Secondly, the two groups were pre-tested under different conditions, one already learned some of the IE tasks, while the second one has not. Thirdly, it would have been preferable to have closer monitoring of the training process in two groups, beyond the equality in the training time and the material. As mentioned above, the difference in the metacognitive gains made by the members of the two groups might be attributed to the difference in the emphasis placed by the two trainers.

Two main conclusions can be made based on the present study. The first is that many teachers come to content-neutral cognitive training with a relatively low level of metacognitive and reflective skills. This finding confirms the previous findings of Zohar and Barzilai (2015) regarding teachers' metacognitive skills in curricular subjects. The second conclusion is that IE training is efficient in improving the teachers' general metacognitive skills, but this improvement apparently critically depends on the mediational emphasis made by the cognitive program trainers.

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Зачем учителям обучаться метакогнитивным навыкам?

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Цель данного исследования — изучить когнитивные и метакогнитивные навыки учителей, участвовавших в тренинге по программе «Инструментальное обогащение» (ИО). Эта программа, разработанная Фейерштейном, Рандом, Хоффманом и Миллером, является одной из самых известных автономных когнитивных программ. Как и в случае других когнитивных программах, основной упор в исследованиях ИО всегда делался на изменения, происходящих в успеваемости учащихся. Мало что известно об изменении в навыках учителей при решении проблем ИО и еще меньше об их метакогнитивных способностях, связанных с этими изменениями. В настоящем исследовании участвовали 28 учителей, которые были протестированы в начале и после 90 часового тренинга по программе ИО. Тесты включали элементы, похожие, но не идентичные тем, которые использовались во время обучения ИО. Анализ решения задач при первом тестировании показал, что относительно большое количество учителей испытывали трудности в решении хотя бы некоторых из задач ИО. Еще большую трудность для учителей представляло изложение своих стратегий решения задач в письменной форме. Сравнение результатов первого и второго тестирования указывает на статистически значимое улучшение не только в умении учителей решать когнитивные задачи, но и в их метакогнитивных навыках. Однако эти изменения не достигли уровня полного когнитивного или метакогнитивного мастерства. Обсуждаются возможные причины различий в подгруппах учителей.

Ключевые слова: метакогниция, когнитивные навыки, рефлексия, учителя, «Инструментальное обогащение».

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