Chapter 6

Challenges in Addressing Metacognition in Professional Development Programs in the Context of Instruction of Higher-Order Thinking

Anat Zohar and Elina Lustov

Additional information is available at the end of the chapter

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Abstract

This study investigates challenges in addressing metacognition in professional development (PD) programs addressing instruction of higher-order thinking (HOT). A set of semi-structured interviews was conducted with 18 instructional leaders who had prominent roles in large-scale implementation programs designed to teach HOT. Most participants (n = 15) expressed the opinion that metacognition is valuable in teaching HOT yet, reported that metacognitive teaching is rare in wide-scale efforts to implement HOT. They explained that the major reason for this gap is teachers' fragile knowledge of metacognition. The analysis shows a deficiency in teachers' general metacognitive knowledge, deficiency in the more specific metastrategic knowledge (MSK) regarding individual thinking strategies, and deficiencies in relevant pedagogical knowledge. Implications are discussed.

Keywords: metacognition, higher-order thinking, professional development, teachers' knowledge of metacognition

1. Introduction

This chapter investigates challenges in addressing metacognition in large-scale professional development (PD) programs addressing instruction of higher-order thinking (HOT). The theoretical background will briefly address higher order thinking and metacognition and then turn to discuss teachers' knowledge and professional development in these contexts.

1.1. Teaching higher-order thinking

Many studies document the significance of metacognition for students' learning and achievements (e.g., see [1, 2].) The present study explores metacognitive instruction in the area of teaching higher order thinking (HOT). In general terms, HOT refers to cognitive activities that are beyond the stage of recall and comprehension/understanding, according to Bloom's taxonomy [3] and according to more recent revised models [4, 5]. Applying analyzing, evaluating, and creating are key elements at the HOT level. Examples of cognitive activities that are classified as HOT also include constructing and evaluating arguments, asking research questions, dealing with controversies, making comparisons, designing, controlling variables, drawing conclusions, corroborating information sources, and establishing causal relationships [6]. The underlying assumption of this chapter is that HOT must be taught according to the infusion approach, that is, to be integrated with the content and rich conceptual frameworks of the various school subjects [6, 7].

Despite numerous projects aimed at fostering HOT, most classrooms worldwide are still predominately characterized by pedagogy of knowledge transmission that focuses on lower-order cognitive levels. Several researchers note that scaling up the "thinking curriculum" is a huge challenge that is still awaiting educational systems all over the world [8, 9]. These studies show that we still need to explore new ways to implement HOT in schools. Metacognition is essential for such implementation efforts.

1.2. Instruction of metacognition as part of programs designed to teach higher-order thinking

There is ample evidence showing that metacognition has a crucial role in learning and instruction of HOT. In order to explain the intersection of these two concepts, a brief overview of the concept of metacognition is called for. Flavell and his colleagues [10] distinguish between two major components of metacognition: metacognitive knowledge (MK) and metacognitive monitoring and self-regulation. Many researchers also refer to the latter component as metacognitive skills (MS).

Metacognitive knowledge (MK) refers to knowledge, beliefs, ideas, and theories about people as "cognitive creatures" and about their diverse interactions with cognitive tasks and strategies [11]. MK includes three subcategories: knowledge about persons, tasks, and strategies. In the context of teaching HOT, knowledge of tasks and strategies is particularly significant. Kuhn views strategy and task knowledge as interrelated subcomponents of *metastrategic knowledge (MS)* [12]. Metastrategic knowledge, as defined by Kuhn, entails knowledge about what thinking strategies can accomplish, about when, why, and how to use these strategies, and about the goals and requirements of tasks [12, 13]. *Metacognitive skills (MS)* are the skills and processes used to guide, monitor, control, and regulate cognition and learning. For example, Schraw and Moshman [14] point out three essential skill categories: planning, monitoring, and evaluation.

Many methods for teaching HOT embrace metacognition as a crucial component of instruction (for a review see [15]). In order to understand the importance of metacognition

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in teaching HOT, let us consider a successful execution of a HOT strategy in science education, for example, variable control. When designing an experiment, students need to know that the task *requires* variable control, to understand *why* variable control should be used (e.g., that without it inferences will be invalid), and to know *how* to control variables (e.g., to change only one variable at a time while keeping the other variables constant). These are components of metacognitive knowledge regarding the when, why, and how of performing the strategy. Alternatively, using the terminology presented earlier, we can say that these components consist of MSK about variable control. However, in order to actually control variables during their experimentation, students also need to plan their actions in a careful way, to monitor their actions in order to see if things are going according to plan, and to evaluate whether they have indeed controlled variables correctly and if their inferences are valid. This evaluation may lead the students to conclude that they need to design a new and better experiment. That is, successful execution of a HOT strategy also requires MS such as planning, monitoring, evaluating, and regulating.

Both theoretical and empirical studies support the significance of metacognition for instruction of HOT [15]. The claim that increasing students' MSK enhances strategic thinking implies that it may be fruitful to try teach that knowledge rather than wait until it develops spontaneously. Addressing MSK in the classroom often amounts to helping students see the general thinking structures embedded in the "messy" domain-specific situations they are dealing with. For instance, students may not see any connection between an inquiry activity they are doing in class in the subject of seed germination and an inquiry activity they did a month earlier in the topic of force and motion. The teacher, however, can explicitly point out that both activities share the same features of the inquiry cycle and that the rule they had learned regarding the need to control variables applies in both cases. Using explicit general knowledge pertaining to MSK in teaching thinking is therefore a type of "bridging" activity that may enhance transfer [16].

Metacognitive skills (MS) also make substantial contributions to students' thinking. In order to control and regulate their thinking, learners employ MS that draw on their MK regarding cognitive processes [14]. For example, learners need to plan, in the sense that they need to choose which HOT strategy to use among several available strategies, based on task demands. Then they need to monitor and regulate the use of that strategy.

1.3. Teachers' knowledge in the context of teaching HOT and metacognition

A deep knowledge of the principles of the educational reform highlighting HOT and metacognition is necessary for successful and thoughtful enactment. Such knowledge must go beyond the acquisition of a fixed set of teaching skills [17], otherwise, teachers will revert to a "mechanical" way of teaching that may preserve external elements of the reform while ignoring its deep core. In the context of the present chapter, the main thing is that teachers need to be highly proficient with specific knowledge that pertains specifically to teaching HOT and metacognition. Like in any other field, in order to teach successfully, teachers need familiarity of whatever it is they attempt to teach as well as sound knowledge of how to teach it. In order to delineate the unique nature of HOT and metacognition, Zohar [6, 15, 18] suggested

that teachers' knowledge in this context can be addressed using the terms: "knowledge of elements of thinking and/or metacognition" and "pedagogical knowledge in the context of teaching HOT and/or metacognition." These terms highlight the fact that teachers' knowledge in this field has unique characteristics and is both domain general and domain specific (for a more detailed explanation, see [15, 18]).

A precondition for teachers' metacognitive knowledge in this area is their familiarity with thinking strategies and processes on the cognitive level, that is, with **knowledge of elements of thinking**. In addition, previous researchers noted that in order to use metacognition successfully when teaching HOT, teachers need robust knowledge of **elements of metacognition**, that is, of the pertinent **metacognitive knowledge and skills** related to HOT [19, 20]. Moreover, the domain-specific aspects of **metastrategic knowledge (MSK)** suggest that teachers may need diverse types of MSK for the diverse thinking strategies they would address in class. Teachers obviously also need to be proficient with the **metastrategic skills (MS)** that are relevant for planning, monitoring, evaluating, and regulating thinking processes in the area of HOT. Such complex knowledge of metacognition is a precondition for sound **pedagogical knowledge** in this area. Zohar and Barzilai [15] further elaborated the component of the pedagogical knowledge noted earlier, describing several pedagogical principles, two of which are particularly significant for the present chapter: (1) deliberate attention to general thinking structures and skills, and (2) fostering explicit awareness of metacognition in the classroom.

Despite researchers' agreement about the value of teachers' knowledge about metacognition, studies show that in effect, the knowledge of most teachers in this area is slim [1, 20–27]. Teacher education programs may cultivate that knowledge using multiple means. For example, while small groups of student-teachers engage in problem-solving, one member of the group is asked to record the thinking strategies her peers have been using during that process. At a later stage of the lesson, this member of the group shares the data she recorded, thereby making the thinking strategies explicit and an object of discussion and evaluation. Other examples may consist of watching and analyzing a video of a lesson in which the teacher applied metacognitive teaching or of a task presenting a thinking-rich lesson plan, and then asking student-teacher to add metacognitive components to the lesson.

2. Method

2.1. Research questions

The present study aims to answer the following research questions:

1. How do educators who lead wide-scale programs aimed at the development of students' higher order thinking (HOT) view teachers' knowledge in the area of metacognition?
2. How do they view the impact of teachers' knowledge on the implementation of metacognition?

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2.2. Methodology

This is a qualitative study based on in-depth, semi-structured interviews with 18 instructional leaders who had prominent roles in large-scale implementation programs designed to teach HOT. Data analysis applies a pragmatic qualitative research approach that is particularly suitable for professional fields because it provides the descriptive information that can inform professional practices [28]. The research conducted within this approach is just what the name implies: research that draws upon the most sensible and practical methods available in order to answer a given research question. It aims for description of experiences and events as interpreted by the researchers, and therefore marks the meeting point of description and interpretation, in which description involves presentation of facts, feelings, and experiences in the everyday language of participants, as interpreted by the researcher. Analysis typically consists of qualitative content analysis using modifiable coding systems that correspond to the data collected. Interpretation stays close to the data [28].

2.3. Participants

Participants in this study are 18 educators, each of which had a prominent role in leading a comprehensive, large-scale change process that aims to foster students' HOT by implementing thinking-rich instruction. Eight participants are (or were until recently) National Subject Superintendents who are responsible for curriculum development and implementation, for professional development, and for assessment in a specific school subject across the whole school system. Four participants have (or had until recently) prominent roles in the development and implementation of programs in the area of teaching HOT on the national level, and three participants had a similar role on the district level. Two participants have leading pedagogical roles in a large school network, and one participant is an academic who has been deeply involved in national efforts to improve learning and instruction in a specific school subject. Because all participants are well-known educators who could easily be identified and because confidentiality was promised to the participants, all details (such as names of programs or subject domains) were omitted from the quotations used throughout this chapter.

The selection of participants applied the following criteria:

1. At least two years of experience in leading a wide-scale pedagogical change process that is closely related to instruction of HOT.
2. Intense involvement in leading the pedagogical sides of the change process (rather than leading only its administrative sides).
3. Developing students' HOT is an explicit and central goal of the change process.

2.4. Interview

The semi-structured interview protocol consisted of 13 core questions and numerous examples of follow-up questions to be asked according to need, for deeper probing into participants' initial responses to the core questions. The core questions addressed the following

issues: a general description of the program, the strategies used for wide-scale implementation, main barriers and challenges, professional development, the development of learning materials, assessment, the suitability of the program to diverse learners, and whether the program involved metacognition.

2.5. Data collection

Data collection took place between January and October 2015. The interviews were between 90 and 120 min.

2.6. Data analysis

Both researchers read the full interview transcripts (referring to all 13 questions) numerous times and wrote down initial codes for each segment. Data reduction took place by creating a file ("the metacognition file") that consisted of the full responses to the metacognitive question (#10) and all the segments from responses to other questions that belonged to the "metacognition" code.

Then both researchers read the metacognition file numerous times and coded it to create thematic sub-files that were then analyzed using a narrative approach.

3. Findings

Our findings show that 15 of the leaders we have interviewed recognized the value of metacognitive teaching in learning and instruction:

> *We really really want to be there [i.e., to engage in metacognitive thinking]. We are aiming at it. We want very much to be there.* (#7).

> *I wish, I wish it [i.e., metacognition] would have been implemented in all schools.* (#17).

> *Metacognitive processes are really important… Because at the moment you are engaging in a metacognitive process you secure the strategy and you make it possible to transfer it to another domain…/ You need it [the metacognitive process] in order to acquire a thinking skill and to transfer it from one domain to another.* (#2).

Yet, although the majority of the participants recognized that metacognition is indeed valuable for their program, only four of them reported that their programs currently apply metacognitive teaching in classroom learning and instruction. A number of participants reported that metacognition is part of their PD. Participants reported that the major reason for the unsatisfactory implementation of metacognition was teachers' fragile knowledge.

3.1. Teachers' fragile metacognitive knowledge

In total, 15 interviewees noted weaknesses in teachers' knowledge regarding metacognition, referring to two different elements: knowledge of metacognition and pedagogical knowledge

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concerning how to teach metacognition. Participant #4 noted that teachers are ill-informed in this area and don't know how to apply metacognition in the classroom *(teachers did not understand it at all).* He continued by explaining that:

> *This whole idea of metacognition is something you really need to understand. That students actually need to think about what they are doing, before, while and after [engaging in a thinking task]. This whole thing… It is something that [teachers] first need to study, to understand from a theoretical point of view, and then to connect it to whatever they do….*

In her response to a question about metacognition, participant #14 noted that:

> *Earlier this year I gave a talk in a professional development workshop for "X" teachers ["X" stands for a particular school subject]. I was shocked to discover that although it appears in the textbook [for students], some teachers don't know anything about it.*

Participants also addressed the type of knowledge teachers need in order to apply metacognition in class. Although they did not use the concept "pedagogical knowledge in the context of metacognition," they had in effect referred to the meaning of this concept and to its relationship to metacognitive knowledge, expressing the idea that teachers must first gain metacognitive knowledge before they can start teaching it:

> *….The teacher needs to understand the process before she starts teaching it….* (18).

> *I think teachers did not feel confident in this area… They did not… and even those who did try to…/ It was not based on comprehension…/ You cannot engage in metacognitive thinking on a process that you do not really and truly understand… or that you are fully clear about… And that you are deeply involved with and you know what it entails… What it means from an instructional point of view….* (#15).

> *They don't teach metacognition in the relatively simple way metacognition appears in the teaching unit…. Teachers themselves don't know how to use it….* (#14).

Participants therefore see teachers' fragile knowledge of metacognition as an inhibiting factor in their ability to teach metacognition, even when they are using learning materials that were specifically designed to teach metacognition and even when such learning materials are rather simple.

3.2. Teachers' fragile metastrategic knowledge

The present study discusses metacognition in the context of teaching HOT. It is important to note that the data are based on participants' testimonies and statements rather than on direct observations. Under these circumstances, participants explicitly addressed teachers' lack of knowledge concerning MSK of thinking strategies. Participant #1 explained that the matriculation exam in the subject she is responsible for includes HOT items. These items ask students to use thinking strategies (on the cognitive level) and then to reflect on how they have solved the HOT items by noting (1) **which** thinking strategy(ies) they have been using to solve the HOT items and (2) by explaining **why** they chose to use precisely this particular thinking strategy. This reflective part of the item corresponds to MSK. Students receive a list of thinking strategies, so that in order to answer section (1) of the question all they needed to do is to choose the name of the appropriate strategy from the list. Yet, interviewee #1 reported that **teachers** who

participated in a PD course initially found this task (taken from the matriculation exam, and thus originally written for students) too difficult, indicating a weakness in their MSK:

> *There is a list. They don't need to remember by heart [the names of the thinking strategies]. [They need] to answer the question and then to explain, to justify how this thinking strategy helps…* ***and it drove teachers crazy because they could not answer this question… they didn't know and it drove them mad****. [original emphasis by interviewee].*

Participant # 13 also reported that the PD workshops revealed deficiencies in teachers' MSK. For example, when a workshop engaged teachers in making comparisons, they immediately noted specific differences and commonalities between the objects they compared, that is, they had no difficulties using the HOT strategy of making comparisons on the cognitive/strategic level. They lacked, however, the knowledge of discussing comparisons on the general, meta-level that MSK consists of. Participant #13 asserts in an explicit way that during the PD workshops, there is a need to work with teachers on the construction of the MSK that the program addresses. This assertion indicates that teachers were not proficient in using MSK prior to their formal learning in this area. The next citation supports this conclusion:

> *We teach the teachers how to carry out a comparison, or a sorting task. If teachers don't know that- how will they know how to teach? You tell me. If the meta-strategic knowledge does not really sit well in their minds (1)? … They are not familiar with the thinking maps, or they are only partially familiar with them. Now, if a teacher is not familiar with the thinking map, it will also be very difficult for her to construct a teaching strategy because teaching strategies go together with the thinking map (2)….* (#13).

In this citation, participant #13 discusses teachers' missing MSK (1) in an explicit way. Her program uses "thinking maps" as graphic representations for MSK. She explains that teachers are unfamiliar with the MSK represented in the thinking maps (either completely, or only partially). Notably, she also established an explicit connection between teachers' MSK and their pedagogical knowledge for teaching HOT, explaining that the former is a condition for the latter (2). In other words, if teachers are not proficient with MSK, they will not be able to teach thinking effectively. Participant # 3 also expressed the same connection between the two components of teachers' knowledge:

> *It is important to me that the teacher himself will have the conceptualization of whatever it is [he is teaching]… It is very important to me that when a teacher enters the classroom and teaches he will be able to say to himself: Ahaa, what I did just now was to ask them to make a generalization.*

The conceptualization of the type of thinking (in this case a generalization) a teacher engages with in class, including the ability to use the "language of thinking" in terms of being able to name the strategy, is in effect MSK. In this citation, participant #3 therefore also addresses the connection between teachers' MSK and instruction, stating her belief that teachers' MSK is significant for instruction.

3.3. Mechanical knowledge

Six participants noted that because teachers lack the deep knowledge required for teaching metacognition in a meaningful way, they might adopt a "mechanical approach" in their

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teaching. In Hebrew, the term "mechanical knowledge" is used to designate knowledge that is superficial and meaningless, allowing the knower to "hit" the right answer by carrying out routines that do not require thinking. These participants imply that in such cases, teaching thinking in general and metacognition in particular may cause more damage than benefit. It seems that by using the term "mechanical approach", the participants meant that teachers engage in superficial rather than deep facets of metacognition:

> *Teachers did not understand what it is all about. How they are meant to do it… And some of those who did [teach metacognition], did it in a very mechanical way.* (#4).

Participant #3 was apprehensive about a mechanical and shallow use of metacognition and more specifically of MSK. In the following citation, she expresses her aversion toward teachers and students who discuss what thinking skills they have been using in class and why it is important to apply particular thinking strategies when they do not really understand the concepts they are using:

> *I don't want it to turn into a mechanical language of students who will start to talk using slogans…/ This is why I really dislike that teachers bring into the classroom words that they don't really understand. You start saying [here the interviewee mimics a formal, pompous voice] - "Please pay attention. What we did now was to engage in strategies that teach the importance of argumentation", or that "what you just did is a generalization". If the teacher doesn't understand what he is talking about, it is preferable that he would not use that language. I don't want him to bring into the classroom words that he doesn't really know how to use.*

Participant #15 also addresses the association between mechanical use of a thinking strategy and lack of metacognition. She talks about a thinking activity in which students are presented with a picture and asked to ask questions about it:

> *…But if you are doing it mechanically… [moving to in a scornful voice] "OK, I was told I must look at this picture and ask questions" … [moving back to her normal voice] So where is the metacognition?*

Participant #18 also said explicitly several times that throughout the system HOT is used in a "mechanical" way on both the cognitive and the metacognitive level.

In summary, several participants brought up the idea of "mechanical knowledge" of metacognition, implying that in such cases, it may be better to overlook metacognitive teaching altogether than to engage with it in a meaningless and superficial way that may be harmful. It should be noted that additional participants (not cited here) also expressed apprehension from shallow knowledge without using the term "mechanical knowledge."

3.4. Professional development in the area of metacognition

3.4.1. Knowledge components addressed in PD

In total, 16 participants addressed the issue of metacognition in the context of PD processes. A few of these participants described in detail what goes on in PD workshops. The description informs us how teachers' learning processes handle metacognition in the context of teaching thinking. The interviews indicate that the PD workshops address all three knowledge components that are relevant for teaching metacognition:

1. **knowledge of thinking strategies**, that is, the workshop helps teachers in constructing their own knowledge about how to reason by using thinking strategies (on the cognitive or strategic level);
2. **knowledge of metacognition**, including both metacognitive knowledge and metacognitive skills; and
3. **pedagogical knowledge**, that is necessary in order to teach the components mentioned in (1) and (2).

For example, participant #4 describes the construction of MSK during PD but then proceeds to explain how teachers' MSK forms the foundation for supporting the development of pedagogical knowledge. Emerging from a concrete example embedded in the content of the lesson, she talks about the nature and role of criteria in a comparison (i.e., MSK). Then she says:

> *Which criteria would you put forward here so that the comparison would be worthy? (1) Would you present the criteria to the kids or would you ask* **them** *to propose which criteria they should use? (2) Because if the kids are on a higher level it is better if they choose the criteria by themselves (3)…/ What I am saying is that when you do something and you conceptualize it, you understand what you are doing. You can do it in a better way.*

Participant #3 addresses three pedagogical issues: (1) the teacher's need to choose wisely among the many possible criteria for comparing and contrasting precisely which criteria would it be best to bring up in class; (2) the degree of guidance the teacher needs to provide with respect to the thinking strategy: whether to let students discover the criteria by independent thinking, or to guide them how to construct the criteria?; and (3) the need to accommodate the degree of teachers' guidance to students' level. This is based on the (implicit) assumption that when students are on a lower level it is advisable to provide more guidance (and to present them with the criteria for the comparison), but when the students are on a higher level, it is advisable to let them discover the criteria on their own.

Additional interviewees repeated similar ideas.

3.4.2. Principles of addressing metacognition in teachers' workshops

Participants described several principles for working with teachers on the development of metacognition in the workshops. One recurrent theme was the significance of teachers' active learning.

More specifically, because the assumption is that most teachers are not experienced metacognitive thinkers, teachers' active learning makes it necessary that the workshops will provide opportunities for teachers to experience metacognitive thinking "as learners":

> *[Working on a thinking skill in the workshop] is not simply to come and lecture them about the skill. It's not about lecturing. Teachers themselves must experience it as if they were students, to go through the experience with all the metacognitive processes.* (# 13).

> *In principle, I think that the way we have been working most often with teachers is by some sort of mirroring movement… Teachers are going through processes that later on they will go through with their students.* (# 6)

Another (related) principle is not to begin talking about metacognition in an abstract and theoretical way but to anchor discussions about metacognition in examples taken from specific topics teachers have been teaching. Participant #3 noted that she is apprehensive of starting to discuss the metacognitive aspects of thinking strategies in an abstract, theoretical way, because she feels that teachers find it menacing and alienating. She believes that metacognitive conceptualization must always begin with a concrete example. In other words, she prefers inductive to deductive discussion of metacognitive knowledge:

> *I always want it [i.e., metacognitive knowledge] to develop from an example that they will conceptualize. I mean my idea is that when you actually do something and then you conceptualize it – you understand what you are doing. You will do it better. Rather than- I will present you with a theory and we shall see how it can connect to reality. Because this approach does not work with teachers.* (#3).

3.4.3. Reasons for not implementing metacognition in classrooms

The scarcity of metacognitive learning in classrooms is not surprising when we look at the data concerning teachers' fragile knowledge. Most participants talked about the deficiencies in teachers' knowledge as the most prominent reason for not implementing metacognition in classrooms. The previous sections support this statement with ample evidence. Many of the excerpts cited in previous sections of this chapter imply the participants' belief that teachers' metacognitive knowledge and pedagogical knowledge in the context of metacognition is a necessary condition for metacognitive teaching and that in general, the pertinent knowledge of many teachers is too fragile to support such teaching. In addition, participants talked about their apprehension from shallow and "mechanical" teaching. That is, they believed teachers' superficial knowledge could only allow them to teach using slogans and fixed algorithms rather than flexible scaffolding of students' metacognitive thinking. Because they wanted to refrain from such shallow implementation of metacognition, they preferred to avoid metacognitive teaching altogether.

4. Summary, discussion, and implications

The findings confirm the findings of previous researchers [24, 26, 22] regarding a prevalent theory-practice gap in the area of teaching metacognition. As noted earlier, the data are based on participants' testimonies and statements rather than on direct observations. Yet, our findings show that educators who led wide-scale programs aimed at the development of students' HOT viewed teachers' knowledge in the area of metacognition as valuable for their program. Yet, only four of them reported that classroom instruction in their programs currently addresses metacognition. Participants reported that the major reason for the unsatisfactory implementation of metacognition was teachers' fragile knowledge of metacognition. Our analysis shows lack of teachers' general metacognitive knowledge, lack of the more specific MSK regarding individual thinking strategies, and lack of the pedagogical knowledge required for teaching metacognition. Some participants thought that the knowledge teachers had could have enabled them to teach metacognition only in a shallow or "mechanical" way. Such knowledge can facilitate routine teaching according to given scripts or fixed learning

materials but does not support the ability to respond to the unexpected events characterizing the teaching of HOT and metacognition in a flexible way. Many of the participants shared the apprehension of previous scholars who believe that without teachers' deep understanding of the intentions embedded in new curriculum materials, there is a danger of clinging to an innovation's external characteristics, while the essence of the reform might be lost in the adaptation process [17, 29, 30]. Because they saw this potential risk as a serious menace, many participants thought it was better to avoid any metacognitive teaching altogether than to engage with it in a distorting "mechanical" way.

Participants also described several principles for working with teachers during PD. One recurrent theme was the significance of teachers' active learning, including a need that the workshops will provide opportunities for teachers to experience metacognitive thinking "as learners." Another (related) principle is to anchor discussions about metacognition in examples taken from specific topics teachers have been teaching rather than to discuss metacognition in an abstract and theoretical way. The data thus show that it is possible to address metacognition in large-scale implementation processes, but unfortunately, it does not happen frequently. Teaching metacognition is not common in wide-scale efforts to implement HOT and thus remains an unresolved challenge in the implementation of most programs.

The main implication of this study is an emphasis on the need to develop practical and user-friendly, yet not "mechanical," ways to foster the knowledge teachers need in order to teach metacognition in programs designed to teach HOT. Teachers PD in programs that foster students' HOT need to cater to both theoretical knowledge pertaining to metacognition and to the pedagogical knowledge required for teaching it.

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Author details

Anat Zohar* and Elina Lustov

*Address all correspondence to: anat.zohar1@mail.huji.ac.il

The Seymour Fox School of Education, The Hebrew University, Jerusalem, Israel

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