**Chapter 4**

**Teachers’ Knowledge: The Central Link in Substantive Pedagogy Change Processes**

**Teachers’ Knowledge**

As mentioned in the first chapter of this book, the most striking aspect of successful programs for the implementation of advanced pedagogies relates to teachers' knowledge. In order to transition to new methods of working in schools, it is essential to develop teachers’ relevant professional capabilities and to support them in the schools. The type of educational policies focused on in this book, namely policies with the goal of advancing students’ understanding and thinking, presents teachers with special challenges. The preparation required to develop their professional knowledge is complex. This chapter examines the issue of teachers’ knowledge in system-wide implementation of programs for teaching higher-order thinking. In particular, it deals with the questions of what can be learned by considering teachers’ knowledge in the field of higher-order thinking, and how development of this knowledge impacts the implementation of such programs.

Throughout this chapter, I use the term ‘teachers’ to describe both those who are being trained to work as teachers and those who are actively engaged in teaching. When I refer to only one of the two groups, I will make this explicit.

**Teachers' Knowledge in the Context of Teaching Higher-order Thinking**

The first step towards answering the questions posed above is to understand what teachers need to know in order to teach their students how to think. Like other pedagogic reforms, teaching higher-order thinking requires teachers to extend the limits of their knowledge and skills (Fishman et al., 2003). In order to respond to the unexpected events that characterize lessons on higher-order thinking, teachers must be able to apply flexible, intelligent, and creative methods. Prepared instructional materials and technical guidelines with set schedules for instruction cannot possibly include the full range of educational methods required to teach higher-order thinking (Carpenter et al., 2004). For implementation processes to be successful, teachers must have in-depth knowledge of the principles of teaching good thinking skills (Loef-Frank et al., 1998). When teachers fail to grasp the intentions embedded in educational and evaluative materials created for a particular reform, there is a clear danger that the substance of that reform will be lost in the implementation process (Spillane, Reiser, & Reimer, 2002). Thus, teaching higher-order thinking in traditional classrooms requires far more than the adoption of new instructional content. It involves a substantive pedagogic change that includes at least four elements of teacher knowledge:

1. **Knowledge of higher-order thinking**. Many studies have shown that a necessary precondition for effective teaching is familiarity with the subject being taught. In the professional literature, this is often referred to as ‘content knowledge’ (Cocharn & Jones, 1998; Shulman, 1986, 1987; Wilson, Shulman, & Richert, 1987). However, this term may be confusing when referring to the distinctive field of teaching thinking strategies, rather than transmitting facts and concepts. To avoid confusion, I suggest substituting the term ‘knowledge of high-order thinking’. This type of knowledge includes the ability to reflect while leading learning activities and applying cognitive processes (such as those described in the explanation of higher-order thinking and thinking strategies presented in the first chapter). It is intuitively clear that it is not possible to teach higher-order thinking without such knowledge. Additionally, teachers need knowledge of other essential aspects of higher-order thinking, such as thinking dispositions and the characteristics of a culture of thinking (Newton, 2015; Perkins, Jay, & Tishman, 1993; Swartz et al., 2008).
2. **Knowledge of metacognition**. A second component of relevant teacher knowledge concerns metacognition. Multiple studies have shown that use of metacognition in class improves learning in general (Veenman, 2015) and higher-order thinking in specific (Zohar & Barzilai, 2015). Metacognitive skills (i.e., planning, monitoring, and reasoning) and metacognitive knowledge are essential to achieving this goal. The most significant component of metacognitive knowledge in this context is meta-strategic knowledge (MSK). This consists of general information about thinking strategies: what the strategy is, as well as when, why, and how to use it. Teachers need MSK to improve their own thinking and to teach higher-order thinking. This point will be clarified in the next section.
3. **Pedagogical knowledge in the context of teaching higher-order thinking**. A third important component of teachers’ knowledge relates to the pedagogy of teaching higher-order thinking. In the literature, knowledge about how to teach a particular subject is termed ‘pedagogical content knowledge’ (PCK). However, I suggest avoiding this term in discussions of teaching higher-order thinking, due to difficulty in understanding the term ‘content’ in this context. Additionally, the literature on the pedagogy of teaching higher-order thinking does not make a clear conceptual distinction between PCK and general pedagogic knowledge (Zohar, 2004, 2008b). This lack of clarity stems, in part, from a debate among researchers about whether thinking strategies are general or content-dependent. An integrated approach to teaching higher-order thinking – that is, an approach that combines higher-order thinking and specific content, such as segments of a curriculum – is based on the assumption that thinking strategies have both general and content-dependent components (Abrami et al., 2008, 2015; Perkins & Salomon, 1989; Swartz et al., 2008). Such an approach does not enable us to relate to teachers’ pedagogic knowledge about teaching higher-order thinking as either pedagogic content knowledge (which tends to be subsumed under specific content areas) or as general pedagogic knowledge (which tends to be independent of specific content areas). Therefore, the term PCK is not appropriate in this context, and I suggest adopting the term "pedagogic knowledge in the context of teaching higher-order thinking". This term covers knowledge of a large number of instructional practices, some of which are general, some of which are content-specific, and some of which are both (e.g., Swartz et al., 2008; Tishman et al., 1995).

Pedagogic knowledge for teaching higher-order thinking includes, among other things: knowledge of appropriate instructional strategies; awareness of students' thinking abilities at the outset of classroom learning process; and common difficulties experienced by students engaged in learning tasks that require higher-order thinking. It also necessitates having unbiased opinions regarding the appropriateness of teaching higher-order thinking to the entire student population, regardless of their level of academic achievement (Resnick, 2010; Zohar et al., 2001). In addition, this knowledge includes ways of developing students' thinking dispositions and creating a culture of thinking in the classroom (Perkins, Tishman, & Jay, 1993; Swartz et al., 2008).

Pedagogic knowledge related to teaching metacognition is also relevant. Meta-strategic knowledge enables teachers to think clearly about the strategies of thinking embedded in their lessons, especially when they address rich and complex content subjects (Zohar & Barzilai, 2015). Awareness of MSK and metacognitive skills contributes to teachers’ ability to teach higher-order thinking in a deliberate and planned way, rather relying on intuition. In addition, teachers need a wide range of relevant teaching practices, such as:

* use of metacognitive cues
* modeling thinking strategies for a variety of subjects
* providing students with opportunities to verbalize the thinking strategies they apply while learning
* assimilating the "language of thinking" into classroom discourse
* planning and teaching educational activities with explicit reference to the goals of thinking
* metacognitive discussions
* reflective writing exercises
* long-term and systematic planning to extensively integrate the teaching of higher-order thinking into the curriculum

1. **Epistemic knowledge.** Personal epistemology investigates how people think about knowledge and knowledge acquisition (Hofer & Benedixen, 2012; Hofer & Pintrich, 1997; Kuhn, 2001). Models of personal epistemology have metacognitive components (Barzilai & Zohar, 2014; Bromme, Pieschl, & Stahl, 2010; Kuhn, 2001). Personal epistemology has a great influence on thought processes in general (Hofer & Pintrich, 1997; Kuhn, 1999) and specific areas such as argumentation (Duschl, 2007; Mason & Scirica, 2006; Nussbaum, Sinatra, & Poliquin, 2008; Tabak & Weinstock, 2011), critical thinking, and inquiry-based learning (Kuhn, 1999; Siegel, 1988; Stoddard, 2010; Ten Dam & Volman, 2004).

Studies of epistemic thinking among teachers generally make one of the following claims:

1. Teachers tend to unaware of their own personal epistemology (Shulman, 1987)
2. Teachers do not have a unified epistemic perception (Ryder, Leach, & Driver, 1999; Stoddard, 2010)
3. Teachers’ personal epistemology is shaped by the learning processes they experienced during their own education and professional development (Luft & Roehrig, 2007)

Research clearly shows that teachers' epistemic beliefs influence the decisions they make while instructing and interacting with students (Brickhouse, 1990; Hofer & Pintrich, 1997; Richardson, 1996). Teachers’ personal epistemology is related to their own critical thinking skills and their pedagogic goals regarding their students’ critical thinking (Stoddard, 2010). In the realm of inquiry-based teaching, teachers' personal epistemology affects the level at which they integrate inquiry and research into their lessons (Wallace & Kang, 2004), the nature of the inquiry they choose to teach (Chinn & Malhotra, 2002), and the higher-order thinking skills they introduce into the classroom and encourage their students to use in their processes of inquiry and research (Maor & Taylor, 1995).

The way teachers interact with and relate to knowledge and knowledge-acquisition processes serves as a model for their students (Hofer & Pintrich, 1997). Students who observe their teacher contemplating multiple possible answers to an open question and reflecting on processes of knowledge construction may develop a different epistemology than that of students whose teacher arrives at one ‘correct’ answer and presents authoritative perceptions of knowledge. It has also been found that teachers’ explicit and implicit epistemic beliefs dictate how they assess their students’ learning (Tabak & Weinstock, 2011). All these factors affect how students utilize higher-order thinking strategies (Maor & Taylor, 1995). Therefore, epistemic knowledge is an essential element in the teaching of higher-order thinking.

**Figure 4.1: Teachers' knowledge required for teaching higher-order thinking**

**General pedagogy of knowledge-building:** When teaching concepts in the field of knowledge, a pedagogy based on simple transfer of information can encourage memorization and passive acquisition of meaningless facts. Studies examining the knowledge and beliefs held by teachers of higher-order thinking show that those whose view of education is based on a pedagogy of information transfer generally believe that teaching higher-order thinking means providing students with rules of thought and problem-solving algorithms. They see giving students problems that require independent thought as an inappropriate method, since it may confuse or frustrate students. Even when such teachers use learning activities designed to make students think, the way they conduct lessons actually prevents their students from actively engaging in thinking. On the other hand, teachers who view the teaching of higher-order thinking from a knowledge-building perspective tend to preserve the high level of cognitive demands embedded in learning tasks (Zohar, 2004). Thus, pedagogic knowledge in the context of teaching higher-order thinking is closely related to teachers' implicit theories of instruction and learning in general. Therefore, professional development programs in this field cannot ignore general theories of pedagogy. They should be addressed along with the other components of teacher knowledge mentioned previously. One theoretical model of the types of teacher knowledge necessary for teaching higher-order thinking is presented in Figure 4.1.

It has already been clearly demonstrated in this chapter teaching higher-order thinking requires complex and multi-faceted knowledge. Therefore, the most pressing question in the current discussion is: to what extent can teachers participating in large-scale, system-wide implementation of processes for teaching higher-order thinking be expected to possess this knowledge? The subsequent sections address this question and present empirical evidence from three areas of research. The first area relates to teachers’ relevant knowledge on an intuitive level, and its development in small-scale interventions. The second area concerns whether professional development programs that are part of large-scale implementations address all, or at least most, of the knowledge that teachers need in this context. The third area is based on interviews with pedagogic leaders, in which they describe the challenges pertaining to teachers’ professional development in large-scale implementations of change processes.

**Teachers’ knowledge of higher-order thinking: Intuitive and resulting from professional development**

How extensive is teachers’ initial, intuitive knowledge about teaching higher-order thinking? What is their base of knowledge prior to participating in formal learning processes on this subject? According to previous research, many teachers’ intuitive knowledge of this subject is limited and insufficient for them to offer instruction in this field (Bransky et al., 1992; Jungwirth, 1994). For example, teachers have varying degrees of knowledge about different areas of scientific thought (Zohar, 2004). Additionally, teachers are rarely able to clearly explain what critical thinking is, key concepts related to thinking (such as assumption, reasoning, or argument), or which critical thinking strategies are most important to help students develop (Paul et al., 1997). Further, teachers have limited intuitive knowledge regarding the types of thinking related to research processes (Crawford, 2014).

Since the research on teachers’ intuitive knowledge and professional development in the field of higher-order thinking is too broad to comprehensively review here, I focus on the subject of argumentation in science education. I made this choice due to the central role argumentation had played in recent policy documents regarding inquiry-based learning. Additionally, there is a relatively large body of recent research on teachers’ knowledge regarding teaching argumentation.

Research examining teachers' knowledge of the components of argumentation reveal a complex picture. In one study, four participants in a teacher-training program consistently succeeded in offering support for their claims, but their arguments were limited by over-simplification, inappropriate sampling methods, hasty conclusions, over-generalizations, and severe misunderstandings of what constitutes evidence (Zembal-Saul et al., 2002). Similarly, in a case study by Beyer and Davis (2008), one observed teacher demonstrated inaccurate understanding of scientific explanations and the role of evidence. This teacher’s self-reports about teaching argumentation to elementary school students indicate that she instructed students to support their claims by describing a variety of details rather than using research-based data. Similarly, Sampson and Blanchard (2012) interviewed 20 teachers and found they struggled with issues related to argumentation. In assessing the validity of a claim, they relied primarily on their previous knowledge of the subject, rather than on data presented to them. Most of the interviewed teachers formulated arguments that provided explanations but were not supported by evidence. In Crippen’s (2012) study, the surveyed teachers used evidence to support their claims, but seldom explicated why the evidence supported these claims. They even demonstrated a lack of understanding of the very idea of justification. The teachers who participated in Sadler’s (2006) research were generally proficient in the construction and analysis of arguments, but found it difficult to distinguish between data and justifications. Another study found that elementary school science teachers tend to base their claims on prior assumptions rather than on data collected through observation or from other reliable sources (Ozdem et al., 2013).

Overall, these studies point to teachers’ inconsistent knowledge of the components of argumentation. Teachers are able to construct simple arguments, but often encounter difficulties in constructing and analyzing complex ones. These studies reveal that the greatest weakness in teachers’ thinking is their limited understanding of the nature of evidence and justification.

Multiple studies on teachers’ knowledge in the context of argumentation indicate that the primary barrier to the routine application of reasoning in science education is teachers' lack of awareness of pedagogic strategies that support students' reasoning abilities (Driver et al., 2000; Zeidler, 1997; Zembal-Saul et al., 2002). Simon, Erduran and Osborne (2006) assert that most science teachers lack the pedagogic knowledge necessary to plan lessons for developing students' reasoning skills, and have limited resources to assist them in teaching argumentation. Additional findings related to limitations in teachers’ pedagogic knowledge in the context of argumentation are found in Byer and Davis (2008) and Sampson and Blanchard (2012).

Other studies examine whether targeted interventions improve teachers' knowledge of the components of an argument and their pedagogic knowledge pertaining to argumentation, and if so in what ways (Crippen, 2012; Dawson & Venville, 2013; McNeill & Knight, 2013; Osana & Seymour, 2004; Venville & Dawson, 2010). For example, a year-long series of workshops conducted with 12 post-elementary teachers offered concrete strategies designed to help them improve students’ written and oral argumentation skills (Simon, Erduran, & Osborne, 2006). Their findings indicate that the teachers' argumentation improved during the year, but this was inconsistent because the patterns of argumentation used and the nature of the change process were unique to each individual teacher. In addition, not all teachers used metacognitive argumentation in their classes.

Another study assesses the impact an intervention program regarding teachers’ knowledge had on students’ thinking. The students in the experimental group (n = 133) improved their reasoning skills, ability to use informal rational thinking, and understanding of the content matter (genetics). However, few demonstrated sophisticated forms of argumentation (Dawson & Venville, 2013; Venville & Dawson, 2010). Clearly, the teachers' knowledge that was developed within the framework of this intervention was not sufficient to enable them to improve complex argumentative thinking among their students. Other studies on developing the relevant knowledge for teaching argumentation among in teachers-in-training show a certain level of improvement, but the teachers continue to demonstrate limits in the relevant knowledge and considerable difficulties in applying this knowledge during classroom instruction (Sadler, 2006; Zembal-Saul, 2009).

Cumulatively, these studies indicate that small-scale pilot programs for professional development can improve some elements of teachers’ knowledge and pedagogy regarding the teaching of argumentation. At the same time, knowledge development varied among individual teachers, and many important components were still absent at the conclusion of the intervention.

At this point, it is important to note that my emphasis on the need for more extensive training of teachers is not intended to show any disrespect to teachers. On the contrary; the conclusion that teachers cannot be expected to engage in a type of teaching for which they were not properly trained reflects great respect for the profession of teaching and the professional integrity of the teachers.

Returning now to a more general discussion of instruction for higher-order thinking, it should be remembered that argumentation is only one of many aspects. Calls for development of students’ higher-order thinking, therefore, requires the expansion of teachers' knowledge in multiple areas. Such an expansion necessitates teachers' participation in professional development on a significantly larger scale than that described in the studies reviewed here. It is difficult enough to achieve the desired results in professional development in the field of argumentation. It becomes that much more difficult when addressing the body of knowledge necessary to teach a wide range of aspects of thinking.

It is also significant that all the studies cited above were conducted under the optimal conditions that characterize small-scale interventions. The results of large-scale interventions in this field are likely to be more limited, due to the “ripple effect” (Fullan, 2007). Dede (2004, 2006) describes this phenomenon as throwing the components of change “out the window” and claims this is typical of system-wide implementation efforts.

This assertion is confirmed by Simon, Erduran, and Osborne (2006), who developed professional development methods proven to be effective on a small scale. In a follow-up study, these researchers (Osborne et al., 2013) examine a large-scale implementation, assuming that the conditions for this were less than optimal. They investigate whether it is possible to successfully integrate the use of argumentation into the daily work of science teachers if the investment of resources supporting this process is limited. In this follow-up study, a relatively small number of hours had been dedicated to professional development, as compared with the first study (which demonstrated the effectiveness of the small-scale intervention). Additionally, all the teachers who participated in the first study were volunteers, and therefore represented a self-selected population likely to have a positive attitude to the subject, whereas in the subsequent study, the population consisted of the entire school staff. Thus, the second study examines the program's impact under the prevailing conditions common to system-wide implementation of educational programs, rather than under the optimal conditions typical of small projects. The results of the second study indicate that the educational intervention carried out under these conditions had no effect. That is, the same principles underlying the successful small-scale intervention were unsuccessful when the program was conducted under the conditions of the real educational world.

These findings raise a crucial question: how likely is it to expect that sufficient resources will be dedicated to the professional development of teachers, so they will receive the complex knowledge necessary for the implementation of a large-scale program of teaching higher-order thinking? This question is explored in the following sections.

**Do large-scale implementations adequately address the knowledge necessary to teach higher-order thinking?**

Researchers disagree as to whether teachers' professional development programs affect student learning, even when it takes place under the optimal conditions of small-scale interventions. The issue is even more controversial in the case of system-wide implementation. This is particularly true when considering a subject such as higher-order thinking, which requires teachers to have complex knowledge (Grigg et al., 2012; Lotter, Harwood, & Bonner, 2007).

Research on large-scale professional development programs in the field of teaching higher-order thinking is quite limited. One example of such a study, conducted among teachers in 15 European countries, is described in a report on the status of teaching argumentation (Jimenez-Alexandre et al., 2010). According to this report, the subject of argumentation has recently been integrated into professional development programs for teachers-in-training and practicing teachers in numerous European countries, but few hours are dedicated to it. For example, in the teacher-training programs, argumentation is rarely discussed for more than six hours. The depth of discussion addressing this subject was found to vary widely. In some countries, discussion of argumentation is an explicit goal of the training program, while others deal with it only implicitly, and it is subsumed under subjects such as teaching inquiry-based learning.

Research from other parts of the world also find teachers' knowledge of higher-order thinking is limited, both in scope and in terms of outcomes. Since there has been no systemic study specifically addressing teaching higher-order thinking, this conclusion is based on studies of professional development programs in various fields. The data indicate the number of hours dedicated to professional development is severely limited, and the programs have a low level of effectiveness. For example, in a study by Tallis (2013), the vast majority of teachers (about 88%) reported participating in some form of professional development during the 12 months preceding the survey. About 75% of these teachers said their professional development dealt with capabilities related to teaching content. (Teaching content was the survey category most relevant to the current discussion, although it covers many topics unrelated to the development of higher-order thinking). Only 20% of these teachers said they felt the training had a major impact on their teaching (OECD, 2014).

According to the 2012 US National Science and Mathematics Education Survey, over 80% of secondary school teachers and over 50% of primary school teachers participated in professional development on content areas relevant to their teaching during the three years preceding the study. Only about 30% of the secondary school teachers and 4% of the primary school teachers received more than 35 hours of professional development during this period (Banilower et al., 2013). Similarly, in Israel, the "New Horizon" agreement between the Ministry of Education and the national teachers' union limits the number of paid hours a teacher can receive for professional development to 30 hours annually. Since this pertains to professional development on a variety of subjects, it can be concluded that the number of hours devoted specifically to teaching higher-order thinking in the educational system is far lower.

In summary, research verifies the claim that teachers’ professional development in large-scale implementations in the field of teaching higher-order thinking is severely limited in educational systems around the world.

**Interviews with Pedagogic Leaders**

The conclusion stated above is also supported by a study based on interviews with eight (or 12?) pedagogic leaders in Israel. Each of these leaders played an active role in system-wide change processes related to the instruction of higher-order thinking. The interviewees were senior officials, including supervisors in the national education system, leaders of pedagogic change at the level of the local authority, heads of major teacher-training centers, and leaders of educational programs in school networks. The semi-structured interviews were conducted in person. Each lasted between one hour and two-and-a-half hours.

One goal of the interviews was to describe planned changes in the field of developing higher-order thinking. Another was to identify the challenges to change processes regarding professional development, assessment, and development of learning materials (Zohar, 2013; Zohar & Lustov, 2018). The interviews were analyzed using the pragmatic approach to qualitative data analysis (Savin-Baden & Howell-Major, 2013). Of the many topics that emerged from the interviews, two are relevant to this chapter. The first pertains to the gap between the breadth and complexity of the knowledge teachers need to teach higher-order thinking and the duration of professional development programs included in large-scale change processes. The second related to the lack of skilled instructors to lead high-quality programs for teachers’ professional development.

The following sections provide excerpts from the interviews that illustrate how the theoretical issues discussed in the previous sections are reflected in the real-world conditions that characterize implementation of system-wide change processes in the Israeli educational system. In order to preserve the anonymity of the interviewees, no personal details identifying their roles are presented.

1. **Gap between the knowledge necessary to teach higher-order thinking and professional development in large-scale change processes**.

The interviewees describe the knowledge teachers need to teach higher-order thinking as highly complex. One interviewee led a process to integrate inquiry-based learning and higher-order thinking as central subjects in all schools in Israel. He emphasizes that the degree of complexity involved in integrating thinking and inquiry into instruction and learning processes is far more complex than simply changing the list of topics in the curriculum.

*"The change itself is a highly complex task. It's not that instead of teaching about ancient times, we will teach about the Middle Ages ... in that case, there is a topic that we did not teach before and now we have to teach it. Here, the change itself is extremely complex at the level of the skills required of the teacher."*

This interviewee elaborates precisely what new knowledge and skills teachers need to be able to support this change process. He covers a considerable portion of the components of teachers' knowledge that were mentioned in the previous sections of this chapter and in Figure 4.1. For example, he speaks about the shift from a teacher-centered pedagogy to a student-centered pedagogy, and the thinking strategies teachers must learn in order to make this shift.

Another interviewee, who spent many years leading system-wide professional development programs for teachers, also notes the need to develop teachers' knowledge related to the components mentioned previously: thinking strategies, meta-strategic knowledge, and pedagogic knowledge. She explains the difficulty in adequately addressing this necessary and highly complex pedagogic knowledge within the limited time allotted for professional development. According to her, restricting teachers to 30 hours per year of ongoing professional education, as stipulated in the "New Horizon" agreement, impairs their professional development in general and specifically in the area of teaching higher-order thinking:

*“There has been some damage to teachers' professional development. For example, science teachers receive 30 hours of training. In those 30 hours, according to the requirements set by their subject-coordinator, they must study astronomy, because this year astronomy is included in the schools' official assessment*. *The teachers do not know enough about astronomy, because they don't teach astronomy in teachers' colleges. So, what can we do? They have to study astronomy. Thirty hours represents seven or eight meetings, tops. It is impossible to expect any significant process to take place within 30 hours in terms of building knowledge or in terms of building thinking skills.”*

Instruction of teachers is, for all intents and purposes, instruction. Therefore, it is possible to discuss here the various levels of pedagogy described previously in this book. At the level of structural pedagogy, the interviewee notes a significant gap between the goals of the professional training and the number of hours offered. In 30 hours, distributed across seven or eight learning sessions, it is not possible to cover, in any significant way, the content knowledge in a given field (in this case, astronomy) and also to teach thinking skills. Later, the interviewee focuses on aspects of substantive pedagogy. She explains how this gap becomes more acute when one looks at deep change processes within teacher education:

*“Teaching skills does not mean delivering a lecture about skills. Teachers must model these skills. They must first experience these skills themselves, as learners, with all the metacognitive processes involved. Two types of knowledge must be built…* *First, the knowledge of the skill itself, which they do not know,* *then the meta-strategic knowledge of teaching it…the pedagogy…* [pause] *I often ask the teachers simple questions: How do we compare? Let's make a comparison between A and B.* [pause] *They jump straight to the level of thinking about what is similar and what is different. They ignore the previous stages, such as: what is the purpose of comparison? According to what criteria will I make the comparison? What is the conclusion drawn from the comparison? The thought-maps we are talking about* [i.e., meta-strategic knowledge about the skills] *…* *they do not know these, or don't know them well…* *If a teacher doesn't know the meta-strategic knowledge of a thinking map, it will be very difficult for him to develop a teaching strategy, because the teaching strategy goes with the thinking map.”*

These remarks address substantive processes of teacher education. They focus on the interrelationship between the educational goals of the course, methods of instruction and learning to be used in the course, teachers' knowledge prior to and after the course, and typical difficulties related thinking that they face prior to and after the course. In order to achieve meaningful learning, it is not adequate to deliver information. Rather, the course must work with teachers on approaches to knowledge-building that include active learning experiences, as these are essential for structuring the cognitive and experiential aspects of teaching higher-order thinking.

Three kinds of knowledge need to be addressed for each thinking strategy: knowledge of the strategy (or 'skill'); the thinking map, which is a means of representing MSK; and pedagogic knowledge. The interviewee's example of teaching how to make a comparison demonstrates the gap between teachers' initial knowledge and the knowledge they will need in the classroom. She explains that a teacher who lacks the MSK of general aspects of a thinking strategy will not be able to successfully teach that strategy. In other words, the pedagogic knowledge necessary for teaching purposes will be lacking.

This interviewee's description illustrates that the level of substantive pedagogy cannot be addressed within the 30-hour limit established in the New Horizon agreement. This limit was determined in an agreement between the Ministry of Education and the teachers' union, not as a result of discussions about the pedagogic needs inherent in the proposed reform. The gap between the desired and the actual, in terms of time resources dedicated to professional development, is exacerbated by the multiplicity of goals. This gap stems, inter alia, from the Ministry of Education’s frequently-changing policies:

*"We do not have enough time. ... In 30 hours, we cannot do it. Because each time, there is some new policy. This year, the supervisor made the announcement about doing research. But along with doing research, there is the issue of health, so they must leave the course with scientific knowledge about health. It is impossible to do everything ... In many seminars this year we have been working with teachers on how to conduct an entire research process from start to finish. In other words, from first encountering a given phenomenon, to framing the questions [...] is a very, very difficult process ... In 30 hours, it is impossible to do this. Because every time, there is a new policy ... They come to the seminars and they learn, but I do not know exactly what they absorb from it. The fact that they smile at me and say how wonderful it was, I don't know ... What exactly did they get from it? There is a large gap here."*

The interviewee then expands upon the difficulties of implementation. She explains that in order to make the transition to a classroom in which higher-order thinking is applied, teachers must not only teach thinking strategies, but also make a comprehensive change in the classroom culture. Therefore, the content of the teachers' professional development courses must be expanded.

*“We need a paradigm shift.* [In addition to developing thinking strategies] *... the issue is the culture of teaching, and thinking as a part of the culture of teaching. We encounter this in everything. This ... culture of thinking, the language of thinking, discourse in class... integrating a culture of thinking means working on thinking habits and thinking dispositions, so that they become part of the classroom culture. This is essential.”*

Other interviewees raised similar issues related to the limit of 30 annual hours of professional training, and the number of goals competing for these hours. For example:

*“This is a problem [...] The training course is 30 hours long. Very few things can be achieved. And there is so much you have to impart to be able to do this process ... I'll say it again: it's never enough.”*

The insufficiency of the professional training is also evident in the words of an interviewee who was responsible for implementing a nationwide reform pertaining to a subject that is a core area in the Israeli educational system. She clearly understands the tension between 'depth' and 'breadth' in professional development. She notes the difference between a change process at the organizational level and a change in consciousness; that is, a change in teachers' level of knowledge. She explicitly states that the learning processes in which teachers must participate are highly complex, and therefore take time. She explains that in order to bring about a profound change in teachers' knowledge, it is not enough for teachers to take part in professional development courses. According to her, a profound change is possible only through work at the micro-level, which includes precise feedback to teachers, down to the level of the wording of questions to be asked in the classroom. She expresses concern that the current conditions, which include brief training and lack of support for classroom instruction, will inevitably lead to a situation in which teaching higher-order thinking is a purely technical activity, and therefore not worth undertaking.

*“Changing a teacher's mind is extremely difficult, even if he really wants to make the change. And I am talking about people who seriously want this. The ability to make a deep change is very, very slow. It's not just an organizational matter, it's a matter of awareness…First of all, awareness, and second a matter of support. Teachers should be provided with mentors. It is not enough for a teacher to listen to an excellent lecture and take a wonderful workshop about teaching thinking. If no one observes him in class and says, ‘You asked this question; how could you ask it differently?’ then it is hard to believe that we will succeed in reaching that teacher... I'm afraid the teacher will only half-understand, and then will teach it in a technical way. And to teach thinking in a technical way…it is preferable not to teach thinking at all. Don't say you are teaching thinking if it becomes* [here the interviewee drops her strong, clear voice and imitates a tired teacher repeating a memorized text in a nasal voice] *'Now wait a minute, I am supposed to ask you a thought-provoking question. Open your notebooks, here comes a thought-provoking question.' It's terrible! And it happens all the time in this system, whenever you try to introduce new ideas."*

1. **Lack of Skilled Instructors to Lead Professional Development Programs**

The interviews with the pedagogic leaders reveal a second limitation to addressing the level of substantive pedagogy or the organizational aspects of implementation of a reform, especially in terms of professional development. This pertains to having instructors and teachers who can lead such a change process. Instructors are an important link in the chain of reliably transferring professional knowledge from policy documents that define a reform to the teachers who will carry it out. The interviewees describe a wide variety of roles carried out by instructors in reform processes: teaching professional development seminars; participating in teams that develop educational and assessment materials; and visits to schools to meet teachers, observe lessons, and provide teachers with constructive feedback. Thus, the quality of instructors' knowledge about teaching higher-order thinking is essential for the reliability of the implementation process (Spillane, 2000).

The interviewees note that some programs are led by teachers who have prior experience leading change processes within their school staff. The interviewees see these instructors as an important link in the system-wide implementation process, but note that this raises distinct challenges. One of these challenges concerns training the instructors. For example, one interviewee strongly believes in using instructors in the implementation of educational programs for teaching higher-order thinking, but stresses that they must undergo an intensive course of professional development. Instructors and teachers who serve as change leaders also tend to be outstanding teachers, chosen on the basis of their strong pedagogic capabilities. Often, they are the "stars". Nevertheless, their training requires considerable resources and usually takes several years:

*“In order to implement this policy document* [on teaching higher-order thinking] *in the field, we must first train instructors. We had a series of training sessions ... We trained a whole group of instructors to teach higher-order thinking.”*

Another interviewee further elaborates this point:

*“Some groups of instructors met regularly for six or seven years, other groups met for three or four years ... We also had a number of courses for teachers who were change leaders. We saw positive development. It is not true that you can't help teachers progress in this area. But we have come to the conclusion that it is very difficult to do this on a large scale.”*

Many interviewees note that the programs they lead face a severe shortage of instructors with sufficient relevant knowledge. As seen in the quotes regarding teachers, the interviewees repeatedly emphasized the depth and complexity of knowledge that instructors need in order to be able to work with teachers on the issue of education for higher-order thinking:

*“We do not have enough people who are experts in pedagogy, who do not only talk on the level of slogans and catchphrases, but can follow this path down to the level of questions to be asked* [in the classroom] *and who can analyze, critique, improve the work, and make it reflect higher-order thinking in the best possible way. We don't have these people."*

Another interviewee says there is a lack of instructors with sufficient pedagogic expertise in the Israeli educational system as a whole. The problem, in her opinion, is that the role of instructor requires extensive experience in the field, in addition to theoretical knowledge. Too often, instructors without such experience speak theoretically about instruction for higher-order thinking, but are unable to move past the discursive level:

*“You should understand that there are not enough pedagogues in the Ministry* [of Education] *... They talk about something, but it doesn't happen, nothing comes of it ... I think there is a sort of rush towards external issues in the Ministry these days. And these external issues look wonderful ... For example, the Ministry is promoting the issue of research. But how many teachers know how to guide their students in properly framing a research question? [...] What is the question that should be asked?”*

In other words, the instructors and teachers serving as change leaders can repeat slogans or discuss certain aspects related to research and thinking, but when they need move beyond making simple declarations towards a deeper level of pedagogy, it becomes clear that their knowledge is insufficient. Here, too, there is a connection to substantive pedagogy. The problem, in this interviewee's opinion, is that teachers often lack the knowledge at the micro-level of the teaching process to guide their students through the details of the thinking process, such as framing a proper research question. Thus, the teaching of how to conduct research becomes merely technical. The interviewees questions how it is possible to lead a meaningful process of inquiry-based learning if teachers do not know what a proper research question is, or how to guide their students in framing one? She cynically recounts a time when, due to a chronic shortage of instructors with adequate pedagogic knowledge, the Ministry of Education suddenly increased the budget for recruiting instructors in the field of teaching higher-order thinking. Instead of rejoicing, she calls this "a minor tragedy," referring to her frustration at not being able to find personnel with the necessary pedagogic knowledge.

*“Last summer they announced ... the Meaningful Learning reform. They freed up days for training. Usually when they provide training days, it is a minor tragedy. It is a great joy, but also a minor tragedy ... that there is no one to send to them.”*

Another interviewee serves as the pedagogic director of an initiative to develop the teaching of inquiry-based learning and higher-order thinking in one region of the Israeli educational system. She sees a serious shortage of qualified instructors capable of carrying out the deep and profound work that needs to be done with teachers. In her opinion, this shortage is particularly severe in her region, which is in Israel’s social and geographic periphery. After describing the positive work being done with teachers via the regional teacher-training center, she adds:

*“It is dressed as pedagogy, but I can tell you there is a serious lack of pedagogic instructors. If we had more experts who understand what we mean when we talk about higher-order thinking and how to train for it, things would be much easier for us. There is a real lack, especially here, because we are in the periphery. Because we are considered peripheral. Something I see as really problematic is that most experts on this subject don't live in our region. Inviting them to a single event is not what we are looking for. That might be nice, but it's not what we need… First of all, we must have enough people who can do the training…people whose academic specialization deals with the development of higher-order thinking.*

*Until we have people with strong pedagogical abilities within our region, we can never really make the changes we are talking about. These are issues that constantly change and must be updated. You always have to be there. There is a need to create a high-profile pedagogic forum that will create concentric circles of impact, gradually reaching further out into the field. We started to create these circles, with the pedagogic ‘dressing’ I mentioned, but they need to be led by a strong core of seven or eight people. We don't have them. We only have two or three…I am well aware of this lack…I look at teachers' tasks that relate to higher-order thinking, and I see how few of the teachers can really undertake such a task and analyze it in depth… Until I have a broad forum of people who know how to do this, it won't be possible to raise this whole issue to a higher level…That will always be our glass ceiling.”*

This interviewee is speaking on the level of substantive pedagogy. She notes the lack of people qualified to work at this level as a primary reason for the inability to break through the glass ceiling and achieve system-wide implementation of teaching higher-order thinking. She recognizes the need for a minimum number of people with adequate knowledge to lead an implementation process and to impart this knowledge to expanding circles of educators. The absence of such people hinders system-wide implementation.

It is important to note that interviewees from Israel's central region mention similar difficulties. The lack of high-quality instructors is not unique to the periphery. An interviewee who leads a reform pertaining to a compulsory subject in the Israeli educational system expresses similar feelings. She uses the terms 'bottleneck' to explain how this shortage impairs the implementation of the program for which she is responsible:

*“This is exactly the issue ... and in this way, I feel that... there is a bottleneck. There is a desire and a need in the field, but no one to send to them.”*

The quotes presented in this section illustrate how various aspects of substantive pedagogy are integrated into the viewpoints of pedagogic leaders. One primary issue is the lack of skilled instructors, which was similarly highlighted in previous research (Zohar, 2013). First, the Israeli Ministry of Education's frequent policy shifts affect the nature of the tasks assigned to instructors. Thus, after considerable investment in developing instructors' knowledge about teaching higher-order thinking, the instructors were then often assigned other tasks, such as working with teachers on the integration of digital technology, or implementing various content-related goals.

Second, there is rapid turnover among instructors. They tend to leave their positions after a short time, mainly due to significant difficulties in working with teachers and poor financial compensation. These findings demonstrate how administrative and organizational problems interfere with implementation in the context of personnel training. Such problems inhibit the flow of information and knowledge that is expected to reach the teachers.

It should be noted that Israel's State Comptroller also sharply criticized the Ministry of Education on the issue of training personnel and its potential damage to implementation of the Meaningful Learning reform. The comptroller cites a 2016 evaluation report issued by the Planning and Strategy Division of the Ministry of Education, according to which the lack of training and professional guidance for schools is one of the main obstacles to implementing this reform. The report also notes the difficulty in recruiting qualified instructors and the rapid turnover among instructors, which interferes with continuity. It reports these difficulties are also apparent in the central Tel Aviv district, where a particularly thorough evaluation was conducted. The State Comptroller's Office informed the Ministry of Education that implementation of the Meaningful Learning reform is complex and therefore requires effective training that addresses the needs of schools' educational staff working with all age levels, in all subject areas, and in all sectors of the population. In the first year of implementation of this reform, the Ministry of Education did increase the resources for training subject-coordinators, but in subsequent years, these are gradually reduced until they return to their original level prior to the launching of the reform. This is despite the fact that, according to the work schedule presented by the Ministry's planning units, preparations for implementing the Meaningful Learning reform are still in the early stages and far from conclusion. These findings verify the conclusions of this current study regarding the importance of instructors in processes of system-wide implementation, as well as the challenges involved in strengthening this crucial link.

**Summary and Conclusions**

As we have seen, educational researchers agree on the importance of thorough and meticulous development of the capabilities of people involved in change processes in fields of instruction and learning (Elmore, 2004; Fullan, 2007; Levin, 2008). Nevertheless, educators are still struggling with the question of how to develop such capabilities, especially on a system-wide scale. Luft and Hewson (2014) assert that while the idea of scaling-up is tempting and sounds promising, it is not clear how to realize it, or if it is even possible. They posit that due to the nature of teacher training, expanding the scale of the implementation process may be an elusive structure or concept (Luft & Hewson, 2014, p. 18). They conclude there will never be simple solutions to this complex problem.

This chapter focuses on the learning process undergone by teachers. By analyzing teacher training in the context of teaching higher-order thinking, I emphasize the need for intensive work with both teachers and instructors on all types of teachers' knowledge, as described in Figure 4.1. When expanding the scale an implementation processes, it is essential to construct a pedagogic toolbox that includes tactics for addressing all the details of substantive pedagogy. This includes tools such as: how to teach students to construct and analyze complex arguments based on reliable evidence; how to guide students in constructing a fruitful research question; and how to help teachers develop criteria for analyzing and evaluating thinking tasks so that they can reflect upon and improve them.

The interviews with change leaders indicate that essential components of expanding the scale of an implementation process take place at the micro-level, such as addressing specific details of classroom discourse and the development of appropriate educational materials and evaluation tools. Without this, any implementation will be technical and superficial. The literature review and the interviews with change leaders both indicate that the implementation process may succeed or fail based on the quality of training for teachers and instructors, especially at the level of substantive pedagogy.

This indicates the close correlation between administrative pedagogy and substantive pedagogy in the context of teachers' professional development. Even when an organizational structure enables and provides budget for professional development and training for teachers, the training may prove useless if it does not address substantive pedagogy at a detailed, practical level. The interviews note a bottleneck in teacher training due to the lack of instructors in the educational system who have the deep pedagogic knowledge necessary to put theory into practice. There is a need for more instructors who can work at the micro-level and address the details of teaching higher-order thinking in the classroom. Spillane (2000) notes that this knowledge is essential in order to convey reliably the fundamental purpose of a system-wide reform, and not dilute the message during the transition between organizational levels. Training change leaders on this issue poses a difficult problem. A combination of theoretical and practical knowledge is required, and the training process must be ongoing.

If this professional knowledge is absent in an educational system, any organizational infrastructure designed to implement a pedagogic reform may become devoid of content. That may be the case despite significant investment in planning, budgeting, and building an organizational structure that includes recruiting instructors, new frameworks for advanced studies, and professional development courses for teachers. An organizational structure cannot bring about a desired change without explicit planning at the level of substantive pedagogy when developing courses to improve professional capabilities and the knowledge being imparted to teachers and change leaders. Neumarsky (2012) also indicates to the need for closer coordination between various levels of pedagogic leadership in the system. He claims this lack limits the ability to utilize pedagogic leadership resources in a system in order to improve instruction and learning.

The analysis presented in this chapter provides insights on teachers' knowledge and its impact on strategic planning for scaling up to a system-wide implementation. The history of education is full of cases of failures when the implementation of progressive pedagogic reforms becomes larger in scale. Although there is still no solution to the "elusive problem" described by Luft and Hewson (2014), many current policy papers, curricula, and standards around the world strongly affirm the importance of teaching higher-order thinking to the entire student population, across all age groups and for all subjects of study. This recognition of the scope of the challenge involved in meaningful implementation in this field as it pertains to the development of teachers' knowledge raises an important question: do policy documents often set goals that require educators to do too much too quickly? In this concluding section, I address this question and focus on the implications of teachers' knowledge and training in system-wide implementations of programs for teaching higher-order thinking.

One of the most widely quoted remarks in the field of education comes from the McKinsey report: "The quality of an education system cannot exceed the quality of its teachers" (Barber & Mourshed, 2007). The findings presented in this chapter are a kind of extended paraphrase of this statement. If we are indeed interested in making a fundamental change in the field of teaching higher-order thinking, the depth of this change cannot exceed the depth of the knowledge provided to teachers via professional development processes. Therefore, the main conclusion of this chapter is that if we want to avoid making only a superficial and technical change, when deciding on the scope of an educational reform presented in a policy paper or curricula, we must seriously consider the issue of teachers' knowledge and consider it a central factor in the planning process. A realistic assessment of the knowledge that teachers will need to support a meaningful change, along with a critical assessment of the professional development courses to be offered, may indicate a need to compromise on the scope of the planned change. The implication of this conclusion for the field of teaching higher-order thinking is that the sweeping and broad statements that appear in policy documents and curriculum documents should be viewed with some suspicion. Often such statements are too ambitious to be applied in a meaningful way, given the limitations of teachers' knowledge, especially when they intend to expand the scope of pedagogic programs within a short timeframe. Often, politicians’ intentions stem, in part, from their desire to make their mark quickly, during their brief terms in office. One of the problems (at least in Israel, site of this study) is that there is a lag between rapid political changes and the slow schedule demanded to enact deep pedagogical changes. This difference in schedule exacerbates the problem described above. In order to avoid superficial and technical assimilation, policymakers and politicians should be encouraged to rephrase their statements in a modest manner that reflects teachers’ baseline knowledge and the scope of the professional development processes that can be reasonably expected. With regard to politicians in particular, the public should be wary and critical of such statements, and discourage them from making false promises. At the same time, it is possible to retain an ambitious vision as a long-term final goal, but to maintain a strategic plan with clear goals that differentiates between this “big” long-term dream and short-term realistic goals and actions.