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Revisiting the concept of reflection: An empirical investigation of mathematics teachers' articulations on the teaching practice

Yael Nurick¹, Abraham Arcavi¹ and Ronnie Karsenty¹

¹Weizmann Institute of Science, Department of Science Teaching, Israel; yael.viz@gmail.com

The scientific literature points to the importance of reflection and its contribution to teachers' work. However, the reflective process involves some challenges. Definitions of reflection are abstract, and models of reflection are complicated and not always accessible to practitioners. The goal of this study was to unpack the concept of reflection into categories – actions or phases which are part of a comprehensive reflective process. For this aim, we analyzed 11 mathematics teachers' reflective expressions, collected in three different settings of professional development. Six categories of reflection were identified in the study, which suggest different actions that teacher educators can consider when designing guiding tools to support teachers through the reflective process.

Keywords: Reflection, professional development, journal writing, stimulated-recall interviews.

Introduction

Beginning with John Dewey, reflection is a central concept in many fields, among them the field of mathematics education. Reflection is a special kind of thinking, a process of looking back at experiences and learning through and from them (Finlay, 2008). Involvement in a reflective process is considered to be important and beneficial for teachers' professional development: Reflection enables teachers to be more aware of their actions and of the beliefs and assumptions that stand at the basis of these actions, so decision-making processes become more deliberate (Finlay, 2008; Karsenty & Arcavi, 2017). Reflection is linked to the mechanism of knowledge development (Clarke, 2000; Karsenty et al., 2015; Schön, 1983), and was also found to be a key aspect in processes of change regarding teaching practices (Clarke, 2000; Karsenty & Arcavi, 2017; Schwarts & Karsenty, 2020).

However, there are still some considerable challenges in understanding this concept. Specifically, there is a need to understand what it is that mathematics teachers do when they reflect on the teaching practice. In this study, we analyzed mathematics teachers' reflective expressions, with the goal shedding light on the complex concept of reflection, and to unpack the definition of reflection into categories – actions or phases which are part of a comprehensive reflective process.

Theoretical Background

Based on John Dewey's ideas, Schön (1983) related to reflective practices, where practitioners examine their actions. Schön distinguished between two types of reflection: (1) *reflection in action* – the practitioner's thinking about his/her actions while doing them; and (2) *reflection on action* – a process where the practitioner is consciously looking back at a situation and critically examining, analyzing, and evaluating it, in order to gain new insights which will improve future practice.

Dewey's and Schön's ideas led to development of various definitions for the concept of reflection, which relate to diverse kinds of categories of reflection, to aspects included in the reflective process, to the purposes of the reflective process, or to its results (Finlay, 2008; Lyons, 2010). In the field of mathematics education, Clarke (2000) distinguished between three types of reflection: the first two

are similar to Schön's – *reflection in practice* and *reflection on practice*. The third type, *reflection for practice*, refers to the development of teachers' awareness to decision-making processes. Geiger et al. (2016) offer a two-dimensional framework for looking at mathematics teachers' reflections: the level of reflection (technical, deliberate, or critical reflection) and the object on which the reflection is focused (self, practice, or students). As the basis of this study, we chose the following definition, which is concise, yet relates to diverse aspects of reflection which the literature emphasizes:

[Reflection is a] detailed, analytical, and careful observation of “what was done” in order to attempt to understand intentions, plans, actions and utterances and to consider alternative decisions and their possible implementation (Karsenty & Arcavi, 2017, p. 435).

Different models were developed in order to support teachers, and other practitioners, in the process of reflection. Two central models are Gibbs' (1988) Reflective Cycle, which offers six phases for the process, and Korthagen's (2014) ALACT model, comprised of five phases, alongside the 'core reflection' model, which highlights the aspects teachers should relate to in the reflective process. Finlay (2008) stresses that different models for reflection are discerned from each other in the phases and actions they include, the aspects that the reflection relates to and the tools and means that the model offers (guiding questions, peer discussions, writing journals, etc.).

However, although reflection is a keyword in the field of education for many decades now, the literature shows that it is not easy to be involved in a reflective process (Finlay, 2008; Korthagen, 2014; Lyons, 2010). The definitions for reflection are somewhat abstract, and models for reflection include many components. It is difficult for teachers, as well as for teacher educators, to understand what the process of reflection should look like in actuality (Brown & Coles, 2012; Finlay, 2008; Korthagen, 2014; Lyons, 2010). Since the guiding lines for reflection are not clear, teachers tend to reflect on their teaching in technical, superficial, or inefficient ways, which do not necessarily support their teaching (e.g., Korthagen, 2014).

Rationale and Research Question

As we aim to support mathematics teachers as they are involved in reflective processes, the overarching goal of our study is to bridge the gap between the theoretical knowledge that exists on reflection on the one hand, and the way it is implemented and practiced by teachers, on the other hand. In our study, we analyzed mathematics teachers' articulations, in which they reflected on the teaching practice in three different settings of professional development (details follow). When we tried to analyze these articulations with the definition of Karsenty & Arcavi (2017), we found this definition does not capture all the actions that teachers perform when they reflect on their practice. Other existing definitions were not operational either. Therefore, the first step of the study, reported in this paper, was aimed at unpacking the definition of reflection into operational categories which relate to actions that mathematics teachers perform when they reflect on their teaching practices. Accordingly, the research question was: *What categories of reflection can be identified in mathematics teachers' reflective articulations, within different settings, and how do these categories relate to, correspond, or add to the existing literature?*

Methodology

Study participants

70 secondary mathematics teachers took part in one of seven VIDEO-LM PD courses held in Israel in 2015-2016. Out of the 70 teachers, 11 teachers were chosen to participate in this study. The 11 teachers were selected to represent various characteristics of the 70 teachers, such as teaching record, gender, academic education, and teaching experience (high/middle school; low/advanced track, etc.).

Data collection

For each teacher, data was collected from the following sources, which refer to three different settings of professional development that allow teachers to reflect on their mathematics teaching practices:

- (1) **VIDEO-LM PD meetings:** The participating teachers all took part in one of seven VIDEO-LM PD courses' meetings held in Israel in the academic year 2015-2016. The VIDEO-LM project (**V**iewing, **I**nvestigating and **D**iscussing **E**nvironments of **L**earning **M**athematics) is a project aimed at enhancing mathematics teachers' reflection skills and mathematical knowledge for teaching. A typical VIDEO-LM course is composed of 7-10 meetings, 30 hours in total. In each meeting, teachers watch a videotaped mathematics lesson and discuss it, while using the "six-lens framework" – an analytic framework focused on aspects of mathematics teaching (see Karsenty & Arcavi, 2017). All meetings in the seven PD courses were videotaped. From these meetings, all excerpts in which the participating teachers spoke were transcribed. The number and length of excerpts vary between the teachers.
- (2) **Weekly journals:** The 11 teachers wrote personal journals on a weekly basis, for five months. In these journals, the teachers were asked to write about the most significant event that happened to them during the past week, either while preparing for class or during a mathematics lesson. They were also asked to explain why it was significant for them. There were no additional guiding questions, and the teachers wrote the journals independently and without feedback. Each teacher wrote between 10 to 19 journals (15 in average). The average journal's length was 165 words.
- (3) **Stimulated-recall interviews (SRI), based on a videotaped lesson:** One lesson of each of the participating teachers was videotaped. The teachers chose which lesson will be videotaped, with no limitations regarding the class, level of group or the subject/setting of the lesson. A while afterwards, an individual interview was held with each of the teachers, where the first author watched their videotaped lesson together with them. The teachers were asked to stop the video whenever they saw a "issue of interest" which they wanted to talk about. The conversation was held in an open manner, with no specific instructions, with requests for clarifications as needed. The interviews lasted some 60-90 minutes. The teachers stopped their videos about 10 times in average, and in most cases the conversation continued after the video watching has ended. All the interviews were videotaped and transcribed.

The three settings differ in many features, like the manner of expression (written or oral); the object in the basis of reflection (the teacher's own experiences, or another teacher's lesson); and the level of guidance in the settings (high level of guidance in the VIDEO-LM meetings compared to minimal

guidance in the weekly journals and in the SRIs). These differences influence the manner of reflective process, and so can highlight different aspects in teachers' reflections.

Data analysis

The data analysis process consisted of moving back and forth between two processes: (1) The teachers' reflections in the different settings were analyzed in an inductive approach, in order to identify actions that teachers perform in actuality when they reflect on their teaching (i.e., analyzing the situation, referring to intentions/plans or considering alternative decisions). (2) Examination of definitions and models of reflection offered by the literature, both inside and outside mathematics education. While the result of the inductive process was in a list of coded categories of reflection, the comparison to the literature enabled us to refine these categories.

Results

The analysis resulted in the identification of six main categories of reflection (some have sub-categories): (1) analysis of the situation; (2) consideration of alternatives, doubts, or dilemmas; (3) re-orientation; (4) consideration of beliefs; (5) addressing the emotions that a situation evokes; and (6) addressing challenges of teaching. Below we describe and demonstrate each of these categories.

Category (1): Analysis of the situation

A central part of a reflective process is to look back at a situation and analyze it. In different models of reflection, such as the 'Reflective Circle' (Gibbs,1988), this is the first phase of the process. However, the literature is not clear on what is included in such an analysis. Therefore, we decompose this category into four subcategories: (a) Observation of 'what was going on' and thinking about reasons for what has happened; (b) Consideration of goals that stand at the basis of the teacher's decisions and actions; (c) Attendance to broad assumptions and contexts, such as social, political, affective, or institutional assumptions; and (d) Evaluation of the situation and of teachers' actions (e.g., practices, assignments, or interactions). In order to exemplify these subcategories, we will describe a section from Diana's SRI, where she watched her own videotaped calculus lesson:

After watching a part of the lesson where she phrased some conclusions to her students, Diana stopped the video and talked. She began with an evaluation of her action: "Horrible! I remember that while I phrased the conclusion, I felt I wasn't phrasing it in a good way. And now when I watch it, I wonder if it is even worthwhile to write down this conclusion". Diana then related to the reason for her action: "I did it because I always think about the weak student that learns in the advance track, and there are many here". Then, Diana explained that "We used to have only 12 students, in average, in the advanced level class [...] and now we have 40 students. It is clear to us, the mathematics teachers, that not all of them are in the same level, and they need our help". This explanation referred to the political context of the situation: due to the Israeli Ministry of Education' reform, which aims at increasing the number of students in the advanced track classes, Diana' class became larger and more heterogenous. Diana continued and deliberated her reasons, while considering her goals:

Diana: When I phrase rules and conclusions, I always think about these students, that must have this reminder when they do their homework. It is a good goal, right? But now I think that these things must be well prepared, in advance. If a weak student gets home and reading his notebook – does he understand what is written there?

The first two subcategories were prominent in all the three settings, while the subcategory *evaluation of the situation and of teachers' actions* was identified mainly in the weekly journals and in the SRIs. The subcategory *attendance to broad assumptions and contexts* appeared sometimes in an implicit manner in the teachers' articulations. We will also mention that the subcategories are connected to each other and the distinction between them can be delicate, as can be seen in the example above.

Category (2): Consideration of alternatives, doubts, or dilemmas

This category includes expressions where the teachers discussed alternative actions, practices or perspectives, with correspondence to the second part of the definition of Karsenty & Arcavi (2017). This category also includes expressions where the teachers referred to dilemmas or deliberated some issues, which quite often were accompanied with consideration of alternative actions. The following excerpt exemplifies this category, when in her second VIDEO-LM PD meeting, Mila related to a situation she identified in a videotaped probability lesson in an 11th grade class:

Mila: It seems like the [videotaped] teacher believes she should present many solutions, and so she went along with the student's idea [...]. It is a dilemma, to choose whose idea to hear, because some students can make things complicated. For instance, I sometimes choose to hear someone's idea personally, so he will not confuse the other students. I have this dilemma, but I didn't feel this teacher has it. On the contrary, it seems like she encourages the most problematic students, goes along with them: 'show me your way'.

According to Dewey, a situation of dilemma or doubt is the basis for reflective process. Consideration of alternative actions can be found also in models for reflection. For instance, Korthagen's (2014) ALACT model, creating alternative methods of action is the fourth stage, before a new trail. In the data, this category was more prominent in the VIDEO-LM PD meetings than in the other two settings.

Category (3): re-orientation

This category refers to gaining new insights or adjustments, and includes two subcategories:

(a) "looking forward": Expressions where teachers refer to possible future actions, as a result of their analysis. There is a subtle difference between this subcategory and the category of considering alternatives. Expressions were identified as "looking forward" when teachers referred to new insights they gained from their analysis which *could* be used in future actions. However, expressions were identified as considering alternatives when teachers explicitly referred to "what would I have done differently". The following excerpt, taken from Ivan's 8th weekly Journal, exemplifies this category:

Ivan: A concluding lesson in the subject of 'scale', in a low-track 8th grade class. I asked the students to draw a sketch of the class's tables. Then, after a short discussion, the students drew objects they chose. The lesson was more free than usual. During the lesson I felt uncomfortable, like there's no real learning. But in the end of the lesson, I was pleasantly surprised [by the students' cooperation and outcomes]. I plan to combine more activities of this kind in my teaching. I believe I should "let go" more often, to give the students opportunities to learn and to make mistakes.

(b) A change in perspective: Expressions in which a change could be identified in teachers' beliefs, attitudes, or perceptions regarding the teaching practice or the students. The change was either articulated explicitly, for example when teachers used expressions like: "I learned", "I realized" or "I noticed", or it was implied, for instance by a change in the teacher's tone (e.g., decisiveness vs.

hesitancy), or when a teacher expressed openness to new ideas. The following excerpt, taken from Nora's 4th weekly Journal, exemplifies this category:

Nora: This student's case helped me realize that students can go through a real change, and I should not stop believing this can happen (although, unfortunately, sometimes it happens to me).

Re-orientation is emphasized in the literature (Clarke, 2000; Finaly, 2008; Schön, 1983), since gaining new insights and tools for future practice is, in a way, the purpose of a reflective process. In the data, however, this category was identified only in some of the teachers' expressions, and it seems like teachers need more guidance in order to implement it.

Category (4): consideration of beliefs

Expressions where teachers explicitly referred to their beliefs, orientations and attitudes towards mathematics and mathematics teaching and learning – considered, wondered about, or doubted these beliefs. The following excerpt exemplifies this category when Sam, in his 4th VIDEO-LM PD meeting, watched an analytic geometry videotaped lesson and related to the teacher's choice:

Sam: How mathematics should be learned – is a question. In my opinion, this subject gets pretty heavy later, so [the videotaped teacher] tried to soften it in the beginning, when he connected it to worlds which were relevant to the students. I liked it. I teach both stronger classes, where the students are more active, and harder classes, where the students are less confident, less engaged, they don't even try to understand. But we should think about how to connect them [to the mathematics].

Beliefs influence teacher's actions and decisions (Karsenty & Arcavi, 2017), and awareness to teachers' beliefs is mentioned as one of the reflective process' goals (Finlay, 2008; Korthagen, 2014). This category was prominent in the data, in all the three settings and within all teachers' expressions.

Category (5): Addressing the emotions a situation evokes

Expressions where the teachers addressed emotions that certain situations evoked in them. This was realized explicitly ("I was glad to see", "it is hard for me"), but was also realized implicitly: For example, in a change of tone, in gestures, or in use of exclamation marks. The following excerpt, taken from Michelle's 2nd weekly Journal, exemplifies this category:

Michelle: A student does not respond to any of my questions, and not for the first time. For 10 minutes (during the lesson) I tried to get her to say something – but not even one word!! After the lesson – again, nothing! I was very angry about this situation. In similar cases before I was told that this student is "weird". This time I was very disappointed and could not tolerate such behavior. I turned to all the concerned parties and asked for their help [...] I'm racking my head, how to deal with her.

This category was identified in some of the weekly journals and SRIs, but its frequency was relatively low. However, we decided to include it since the literature emphasizes the importance of connecting between a situation and the emotions it raises (Gibbs, 1988; Korthagen, 2014; Schön, 1983).

Category (6): addressing challenges of teaching

Expressions where the teachers addressed challenges and difficulties they experienced during their work, and analyzed them: the source of the challenge, its implications on their decision, etc. The teachers addressed various challenges: mathematical-pedagogical challenges (e.g., how to present

mathematical subjects); challenges in classroom management; addressing students' pedagogical, personal, or emotional difficulties; challenges the teachers experience as part of their belonging to the institutional system. The following excerpt, taken from Leo's SRI, exemplifies this category:

Leo: Often, when I give assignments, many students have questions. And I still don't know how to, let's say, 'split myself' between them. Many times, I give a direction [to one student] 'do this in the meantime' and then go to another student. And then they tell me 'Stay, don't go!'. They don't understand that they are not alone, that while they do something I can help other students as well. This is something I still didn't figure out how to handle.

This category appeared sometimes with proximity to consideration of doubts or dilemmas. However, we chose to include this category separately since it was prominent in the teachers' expressions, especially in the weekly journals and in the SRIs settings.

Discussion

In this study, we analyzed the concept of reflection in a process that went back and forth between reading the scientific literature and gaining insights from the data. This process resulted in the unpacking of the concept of reflection into six main categories. The identified categories offer actions that extend the categorizations found in the literature. Furthermore, they relate to different aspects of a mathematics teacher's practice and require the teacher to address various factors, some of which are not emphasized in the domain of mathematics education. Observing different teachers through the three different settings simultaneously, resulted in a broad perspective on the concept of reflection. Such perspective might not have been possible from an analysis of only one setting. Connecting between the empirical analysis to the literature suggests validation of different aspects of reflection, in the sense that the categories are congruent with definitions and models offered by the literature.

The study suggests practical implications teacher educators can consider when designing guiding tools to support teachers through the reflective process. Following Brown & Cole's (2012) question "how do we do reflection?", the categories offer actions from which guiding questions for reflection can be derived, such as: What are the goals, assumptions or beliefs that influence your actions and goals? What alternative actions/practices could have been taken, and what are the advantages or disadvantages of each one of them? What emotions does the situation induce? What challenges can be identified in the situation? What can be done differently in a similar situation in the future? This study also offers theoretical contributions: The categories can be used as a theoretical framework for analyzing reflective expressions of teachers. Said framework was implemented in a continuance study, where we looked at opportunities for reflection teachers have in different PD settings.

The literature relates to issues and challenges of involvement in the reflective processes, such as a struggle to deeply analyze the teaching practice, to consider emotions situations evoke or to connect situations to broader contexts (Finlay, 2008). As the categories of reflection were identified in the data, the study indicates that teachers are **able** to perform such actions. However, the variety of categories stresses that reflection is indeed a complex concept, and teachers should have an adequate guidance and tools in order to be involved in a beneficial reflective process. Furthermore, teachers should experience reflective processes in different PD settings, as the results indicate that teachers' actions are influenced upon different settings and contexts in which the reflection takes place.

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