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► To cite this version:

Konstantinos Stouraitis. Teachers' decisions and the transformation of teaching activity. CERME 10, Feb 2017, Dublin, Ireland. <hal-01949085>

HAL Id: hal-01949085

<https://hal.science/hal-01949085v1>

Submitted on 9 Dec 2018

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Teachers' decisions and the transformation of teaching activity

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In this paper I study teachers' decisions as a response to emerged contradictions in the context of enacting a new set of curriculum materials. The way these decisions are framed and the potentials they have to transform the teaching activity are analysed. Our data come from discussions in teachers' group meetings through one year. I use activity theory to capture social and systemic aspects of decision making and to interpret teachers' decisions. Future-oriented envisioning of the deliberate outcomes of teaching and action-based decisions about the actions to be undertaken are two different aspects of decision making. Both are traced in the data of this study as two necessary aspects for decisions that create possibilities to broaden the horizon of teaching activity.

Keywords: Activity theory, contradiction, decision making, teachers.

Last decades, in the context of curriculum reform efforts, teachers are seen as active agents and designers, whose instructional actions are influenced by curricular materials, but also shape the enacted curriculum alongside their students (Remillard, 2005). Considering teacher at the centre of the curriculum enactment, highlights the importance of teacher's decision making. Thus, a number of studies focus more or less explicitly on teachers' decisions. For example, Lloyd (2008) follows a teacher for two years and finds that his perception of students' expectations and his own discomfort associated with using the new curriculum were key factors in his decisions. A large number of studies are focused on in-the-moment decisions made by teachers. ZDM special issue 48(1–2) on teachers' perception, interpretation, and decision making, is indicative. Schoenfeld (2011) uses the notions of resources, goals and orientations to "offer a theoretical account of the decisions that teachers make amid the extraordinary complexity of classroom interactions" (p. 3).

The studies examining in-the-moment teacher decisions, focus on the classroom context and emphasize the individual dimension of deciding. Nevertheless, the broader social, temporal and cultural dimensions of decisions a teacher makes in his planning or in the classroom are not addressed. In this study I seek a better understanding of how decision making process develops and how is shaping the teaching activity, drawing on cultural historical activity theory. The study is conducted in two secondary schools in Greece at the time of the introduction of a newly prescribed mathematics curriculum. In Stouraitis, Potari, & Skott (2015) and Stouraitis (2016), we have analysed the contradictions emerged in this context and how teachers' decision-making is framed and develops considering social and systemic dimensions. In this paper I study how and why teachers' decisions, may or may not have a transforming effect on teaching activity. The decisions in focus are discussed in group meetings and refer to planned actions undertaken in the classroom. I examine three teachers' decisions, the different ways these decisions shape the teaching activity and I interpret these differences. Although sociocultural perspectives have been used in research about teachers' decisions in mathematics education (see for example, Skott, 2013), activity theory has not been used so far. Thus, although empirically based, the paper is methodologically oriented, giving an account about the affordances of using activity theory in studying teachers' decisions.

Theoretical considerations

Cultural historical activity theory (AT) offers a lens that tries to capture the complexity of teaching, by integrating dialectically the individual and the social/collective. The activity is driven by a motive and directed towards an object (Leont'ev, 1978). In our case, teachers (the subject) are involved in teaching activity with the motives of students' learning of mathematics and the fulfilment of other professional obligations. The unit of analysis is the activity system (Engeström, 2001a) incorporating social factors (rules, communities, division of labour) that frame the relations between the subject and the object with the mediation of tools (Figure 1). In our case, a tool with considerable influence in the teaching activity is the new curriculum.

Activity is carried out through actions which are "relatively discrete segments of behaviour oriented toward a goal" (Engeström, 2001b). I conceptualise teaching action as discrete instructional acts or clusters of acts that constitute the teaching activity, e.g. the selection or creation of a task, the enacting of a lesson plan, etc.

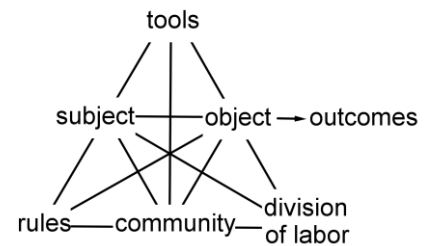


Figure 1: The activity system
(adapted from Engeström, 2001a)

Every activity system is characterised by contradictions which are the driving forces for the development of every dynamic system (Ilyenkov, 2009). They may create learning opportunities for the subject and may broaden the activity, for example leading to reconsideration of the actions and goals (Engeström, 2001a; Potari, 2013). In our study, the introduction and enactment of the new curriculum produced or revealed contradictions in teaching that emerged in group discussions (Stouraitis, Potari, & Skott, 2015).

Dealing with contradictions involves decisions about the goals and the actions to be undertaken. Of particular importance are decisions related to the "discrete individual violations and innovations" (Cole & Engeström, 1993), that is the search for novel solutions as the first, individual response to the emerged contradictions. Thus, although teachers' decisions are part of the teaching activity, they may have a transformational effect on this activity. Engeström (2001b) identifies four dimensions of decision making: social, temporal, moral and systemic. The systemic dimension is particularly concerned with the way "this [decision] shape the future of our activity?" (Engeström, 2001b, p. 281). This dimension is connected to expansive learning, the activity theoretical notion in which the learners are creating new ways to carry out the activity, reconceptualising its object.

Engeström, Engeström, & Kerosuo (2003) make a distinction between action-based decisions about the actions to be undertaken, and future-oriented envisioning, which is the imagination of the deliberate situation of the object as outcome of the activity. Drawing from their interventional study in health sector, they argue that intertwining these two aspects is necessary in any attempt to transform the activity stating that "history is made in future oriented situated actions" (p. 287).

Methodology

A new set of reform-oriented curricular materials was introduced and piloted in a small number of schools in Greece in 2011-12 and 2012-13. The new materials emphasize students' mathematical reasoning and argumentation, connections within and outside mathematics, communication through

the use of tools, and students' metacognitive awareness. It also attributes a central role to the teacher in designing instruction. In 2012-13 I collaborated with teachers in three of the lower secondary schools that piloted the new materials. The collaboration took place in group meetings at the respective schools, where the teachers discussed about their lesson planning and reflected on their experiences from teaching some modules of the designed curriculum. I participated in these meetings, providing explanations about the rationale of the materials, as I was a member of the team that developed the curriculum. I was also discussing their reflections provoking their explanations about the rationale of their choices. In this paper, I refer to two reflection groups, one of five teachers working in school A and one of two teachers working in school B.

School A is an experimental school with an innovative spirit. Our focus here is on the teaching decisions of two teachers, Marina and Linda. They both have more than 25 years of teaching experience and additional qualifications beyond their teacher certification, as Marina has a masters' degree in mathematics and Linda has one in mathematics education. They both have experiences with innovative teaching approaches and both have strong views about their instructional choices and a critical stance on teaching innovations and materials introduced by various agents.

School B is a normal school with a culture open to innovations. Peter, the teacher in focus, is teaching in public schools about 15 years. Before this, he was teaching in private education preparing students for examinations. Peter is assistant principal of the school, he attends master studies in education and he is educator preparing teachers to use digital tools in teaching mathematics. He is open to the new curriculum, but he bases his teaching on the old textbooks. In the year of the study Peter is questioning the teaching practices he was involved for many years.

The data material consists of transcriptions of audiotaped group discussions and interviews conducted with each teacher in the beginning of the study and six months after the end of the group meetings. The transcriptions were analysed with methods inspired by grounded theory (Charmaz, 2006). The initial open coding resulted in the identification of the discussion themes for each meeting and the corresponding contradictions that emerged in the context of enacting the curriculum. Seeking an understanding of these emerging contradictions I used AT which provided me a lens to study them and a language to discuss about their dialectical nature, integrating social, cultural and historical aspects. Analysing the ways teachers decide to deal with contradictions, I traced shifts in teachers' discourse across different meetings and interviews and I used AT and the relevant literature to interpret these decisions and the factors influencing them. In this paper I focus on the part of my analysis concerning the relations between the action based decision making and the future oriented envisioning, and the potential of transforming the teaching activity.

Results

Below I present two examples selected as illustrative cases for the relations of action based decisions and future oriented envisioning. In the first one, Marina and Linda make contrasting decisions, both addressing their perspectives about their students' learning. In the second one, Peter makes action based decisions without a clear articulation of his envisioning about his students' learning.

First example: teaching congruence involving geometrical transformations

Geometrical transformations are introduced as a distinct topic in the new curriculum with the rationale of supporting students' development of spatial sense and of using transformations when tackling issues of congruence and similarity. The use of transformations as a proving tool is an alternative to the Euclidean perspective in school geometry: the intuitive use of the moving figure is seen as incompatible with the rigorous deductive rationale of Euclidean geometry. This contradiction between the two proving tools is a manifestation of the dialectical opposition between intuition and logic. In Stouraitis (2016) I discuss in details the two contrasting ways Marina and Linda deal with this contradiction in the discussions in school A. Below, I briefly describe their decisions to highlight the different future-oriented envisioning they hold for the object of activity.

In the fourth meeting (A4), Marina discusses her thoughts to use geometrical transformations in teaching triangle congruence in grade 9. She considers using tasks with geometrical transformations in parallel to or in combination with criteria of triangle congruence. She describes her goal saying "I want them [the students] to understand that when we compare angles or segments, we have two tools. One is transformations and the other is the criteria of triangle congruence". On the other hand, although Linda appreciates Marina's approach as a "nice idea", she prefers not to intertwine the two topics. She refers to "the purpose [students] to learn how to write [a justification], to observe the shape, to distinguish the given data from the required claims, to make conclusions, and to prove", implying that these goals can be achieved through teaching congruence with a Euclidean perspective, without involving transformations. Although Marina's response is that the same goals are relevant in every geometrical topic, Linda states that in teaching congruence she wants to focus on Euclidean geometry and not transformations.

In next meetings (A5, A6) Marina describes how her students work with both geometrical transformations and congruence of triangles, discussing also emerging epistemological issues. She explains her decision as creating an "opportunity to change the framework [of proving] in grade 9" and to "get away from Euclidean geometry". Linda contributes to the discussion with her opinion and ideas, but she does not change her decisions. In other meetings, Marina mentions a seminar on transformations she attended three years ago in the university and her experimental teaching of transformations in a school she was previously working.

Analyzing Marina's and Linda's decisions across Engeström's (2001b) four dimensions, I conclude (Stouraitis, 2016) that, although Linda and Marina share similar experiences and perspectives and participate in the same school community and in the same reflection group, there are significant differences between the goals they set, the decisions they make and, consequently, the actions they undertake. Marina appears more fluent with the mathematics of geometrical transformations to use them as a proving tool alternative to Euclidean geometry, and this may possibly and in part be explained by her involvement in past activities like the seminar on transformations and her experimental teachings. Linda has not such experiences. Moreover, her goals are based on the affordances of the Euclidean perspective.

Focusing on the possibilities their decisions have to shape the future of teaching activity, I look at the way the teachers envision the future of their students learning. All the aforementioned extracts of Marina's discourse reveal a future-oriented envisioning of the object of the activity she is

engaged in: she imagines her students working fluently with both approaches and consciously about the differences between them and she notes their development in this direction. In the interview conducted in the next year, Marina says that she uses the same approach, with more elaborated tasks for her students. Like Marina's envisioning, Linda is showing her motive in the relevant extract: she imagines her students in the future to work having developed understandings and proving abilities based on Euclidean perspective in school geometry.

Second example: the use of modelling in teaching algebra

The new curriculum materials recommend mathematical modelling as an important aspect in students meaning making in algebra. Generating algebraic expressions and equations to represent realistic situations and problems is introduced in grades 7th, 8th and 9th. In group discussions about teaching polynomials in grade 9, a common contradiction was about introducing polynomials and operations in a formal, abstract way or involving realistic situations and modelling procedures. This contradiction is a manifestation of the dialectical opposition between the abstract and the concrete. Below I describe Peter's dealing with this contradiction as appeared in group discussions of school B with Manolis (Peter's colleague) and the researcher.

In the 3rd meeting (B3) Peter describes his introductory lesson of monomials using only definitions, examples and counterexamples. He says "we begin with the algebraic expression, they [the students] read the definition, and I give them examples to discuss ... then to monomials [with the same way]". After researcher's and Manolis' questioning about the "why" of teaching polynomials, Peter refers to a similar student's question. He is reflecting that "he begins with the definitions", but "we must pay more attention ... to the practical use of monomials". Again in the discussion with Manolis and the researcher about modelling, Peter starts thinking the potentials of it. After some turns, he says that he likes the word "modelling" because "it shows exactly what we are doing: we transform real situations to mathematics, verbal expressions to mathematical ones". With modelling "you give [the students] a motive, a goal. Ok, you must first pose the problem to create questions"

Although Peter finds modelling a useful idea, he is involved in a discourse emphasizing the role of mathematics and his own teaching but not the deliberate students' development. For example, he describes what "he did" and what he "usually does", and that modelling is what "we do in mathematics". In this discourse, no explicit or implicit longitudinal objective appears related to the way his students should deal with modelling. This can be interpreted as absence of any clear articulation of his future-oriented envisioning that could lead his decisions.

In another meeting (B7), Peter refers to classroom discussions about functions where students and teacher modelled realistic situations and phenomena (mostly from physics) leading to linear and quadratic functions. He says that his goal is "[the students] to understand that a function shows a relation between two interdependent things. And that everything is a potential function". These formulations reveal Peter's future-oriented envisioning about students understanding of functions and connecting them to realistic situations and also physics. But again, there is not any similar envisioning about students' work on modelling per se. The modelling processes Peter involved in classroom discussions were limited at the level of actions subordinated to his teaching of functions.

In the interview conducted in the next year, the researcher asked Peter if he uses modelling in teaching polynomials this year. Peter responded that although he thinks it is useful and keeps it in

mind, he “hasn’t the time to do all this”. This response shows that there is not any movement in the way Peter carries out the teaching activity about modelling.

Peter's adoption of the idea of modeling in teaching polynomials and functions can be interpreted as adoption of elements introduced by the new curriculum, based on Peter's reflection about teaching and on the group discussions with Manolis and the researcher. But this adoption did not give rise to actions involving students in modeling procedures, especially in teaching polynomials. Peter's previous involvement in practices, like preparing students for examinations in the private education, seem to have strong influence on his decisions. Moreover, his decision about modelling had not any systemic influence on the teaching activity, since it was not connected with future oriented actions.

Discussion and conclusion

The introduction of the new curriculum created or revealed contradictions that provide opportunities for teachers to engage differently in mathematics teaching and learning. The analysis exemplifies these opportunities and the teachers' decisions to make or not shifts in their teaching.

In both provided examples, all three teachers seem to be aware of a contradiction of the introduction of the new curriculum. Marina and Linda appear to be more consciously aware of its epistemological and dialectical nature. Peter also shows an understanding of some aspects of the relevant contradiction. Teachers' awareness of the contradiction is the necessary but insufficient driving force for the development of the teaching activity. From this point, teachers' decisions can lead to one or the other direction.

On the contrary of "traditional views [that] locate decision making in the heads of individuals at a given point of time in a particular place" (Engeström, 2001b, p. 282), searching, under an activity theoretical view, what makes teachers to set goals and what creates the horizon for possible actions, contributes to our understanding of teachers' decisions. Although activity is collective and the object is socially formulated, different teachers can have "different positions and histories and thus different angles or perspectives on their shared general object" (Engeström, 2001b, p. 286). In the first example provided in this paper, Marina and Linda make different decisions about the same contradiction. The difference may in part be explained by their different histories, including Marina's attending of the seminar and her experimental teachings. In the second example, Peter's decision seems to be influenced by his previous activities in the private education sector.

In the two provided examples three possibilities appear for teachers' decisions and the way these decisions may or may not influence the future of the activity. Marina's decision to combine geometrical transformations with Euclidean geometry is an attempt to overcome the contradiction synthesizing dialectically the opposing poles. On the other hand, Linda decides to keep the two opposing poles separated, pursuing the affordances of Euclidean geometry. Somehow in the middle, Peter decides to deal with the contradictions using aspects of modelling in teaching functions, but not to use modelling as meaning-making introductory activity in polynomials.

Marina's decision has the potential to transform the teaching activity, broadening the horizon of the possible modes this activity is carried out. The dialectical overcoming of the contradiction is a discrete individual innovation, although its evolvement is not already known. Linda's approach does not transform the activity, but clarifies and strengthens some objectives of teaching Euclidean

geometry. Linda's decision reinforces aspects of the existing way activity is carried out, showing that every learning is not necessarily expansive (Engeström, Engeström, & Kerosuo, 2003). Peter's decisions have not any shifting effect to the way the activity is carried out, neither reinforce any existing practice. Somehow this decision seems to have not the power to affect the activity.

What is the difference between Marina's and Linda's decisions on the one hand, and Peter's decision on the other, that provide the different power on them? The difference could not be the attempt to overcome or not the contradiction, since Marina's and Linda's decisions differ at this point although both are strong enough to have an effect on the teaching activity. The difference is grounded on the connections made between action-based decisions and future-oriented envisioning of the object. Marina and Linda underpin their decisions about the actions they undertake with a strong future-oriented projection of their students' understanding. This adds fluency in deciding among the possible actions realizing the relevant goals. At the same time it generates decisions with the potential to be stabilized, even if initially the stabilization refers only to individual modes of carrying out the activity. On the other hand, Peter's decisions seem to be restricted to action level, without a grounding on future envisioning of the object, namely the deliberate modelling processes his students should be able to involve as outcome of the sequential actions undertaken. The absence of future-orientation restricts the horizon of possible actions and reduces the potentiality of stabilizing them. Our conclusions appear in line with Engeström, Engeström, & Kerosuo (2003) who, researching developmental work in the health sector, write that "professionals make history in future-oriented discursive actions" (p. 286) and "to overcome the gap between action and imagination in history-making, it may be necessary to bring them closer to one another" (p. 305).

Summing up, one can argue that for decisions to affect the activity the following elements seem to be necessary: the emergence of a contradiction and some degree of awareness about it, a willingness to deal with it and a future-oriented envisioning about the outcomes of the activity. If there is to have a transformation of the activity, the decision must aim to a dialectical overcoming of the contradiction by searching new solutions. Although schematic and perhaps simplistic, this sequence may represent some crucial aspects of decision making, especially the relations between action-based decisions and the future of the activity.

Our developmental intervention was not designed on an AT basis. However, based on AT, our analysis traces aspects of the path leading from the contradiction to the transformation of the teaching activity. In this analysis, AT seems to offer two particularly important aspects. Firstly, the four dimensions capture social and historical aspects of teachers' decisions, which is critical in our interpretations. Secondly, the distinction between action-based decisions and future oriented envisioning, provides a lens to interpret the possible power of teachers' decisions. The not-predetermined nature of the intervention might be seen to provide the analysis with a potential to interpret more naturally some snapshots of the trajectory of transforming the teaching activity. More research could be useful for a more holistic, but also detailed view of this trajectory.

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