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Aligning teaching with current experiences of being, becoming and belonging: An identity perspective on the use of digital resources

Charlotte Krog Skott[1], Giorgos Psycharis[2], Jeppe Skott[3]

[1]University College Copenhagen, Denmark, [2]National and Kapodistrian University of Athens, Greece; [3]Linneus University, Sweden

ABSTRACT

The chapter is on how social issues influence teachers' use of digital resources in mathematics classrooms. The study is on an experienced, digitally competent, Danish teacher, Sofia, and one question is how her use of digital resources relates to her shifting professional identities. To address the question, a framework called *Patterns of Participation,* PoP, is used, one that draws on the notions of practice and figured worlds from social practice theory and of self and interaction from symbolic interactionism. Another question is whether PoP is helpful for understanding how Sofia contributes to classroom interaction when using digital resources. Sofia's case was previously analysed with another framework, *Structuring Features of Classroom Practice*, which is developed to study teachers' expertise and development in relation to digital resources. The PoP perspective supplements the previous and primarily descriptive account by providing explanations for how digital resources are used in Sofia's classrooms, including a focus on procedures and a paucity of attention to conceptual understanding and mathematical reasoning. These explanations relate to Sofia's identities, understood as her professional experiences of being, becoming and belonging. The PoP analysis, then, offers contextual interpretations and explanations of teachers' acts as related to broader social enterprises beyond classroom interactions.

INTRODUCTION

Studies of teachers' use of digital resources (DRs) in mathematics teaching adopt different frameworks (cf. Goos et al., 2010). Some frameworks are specialised and developed specifically for studying the use of DRs or other educational resources in classroom settings. Other frameworks adopt a broader perspective and use interpretations of issues beyond the classroom to understand how practices unfold within it. In this chapter, we intend to show the possible contribution of theories of the latter type for examining the role of the teacher and the influence of a range of personal, contextual and professional factors on the integration of DRs in mathematics classrooms. To do so, we analyse data that have previously been

analysed with a theoretical framework of the former type and compare the two analyses with regard to their respective benefits when attempting to understand the complexity of teaching-learning processes that involve the use of DRs in mathematics classrooms.

We previously used the framework called *Structuring Features of Classroom Practice (SFCP)* (Ruthven, Deaney, & Hennessy, 2009) to analyse teaching-learning processes in the classrooms of a Danish elementary teacher, Sofia, who is highly committed to the use of DRs (C. Skott & Psycharis, 2018). She has just participated in a professional development project, *the Innovative School (IS),* the aim of which is to support teachers in becoming more proficient with the use of DRs and with inquiry-based teaching. We analysed the emerging conflicts between Sofia's conventional instructional approaches and the inquiry processes intended by IS, focusing on an episode from the implementation of an IS unit on statistics called *Youngsters' use of digital media*.

In this chapter, we use another framework called *Patterns of Participation (PoP)* to analyse the same episode. PoP is more in line with the second group of frameworks mentioned above, favouring understandings of how broader social constellations and modes of reasoning inform action and meaning making (Skott, 2019). In our choice of framework, we have taken into account recent discussions of the relationship between DRs and instruction. These discussions indicate a need to consider the broader contexts in which teachers operate as they make decisions about what resources to use and how to use them (Trouche, 2019). PoP allows a social perspective on Sofia's professional identity, which we define as her professional experiences of being, becoming and belonging at her school, *Hillside*. As they relate to DRs, these experiences depend for instance on social practices at Hillside and of broader discourses on what it means to teach with DRs and of the societal position of teachers in general. In fact, from a PoP-perspective experiences are constituted in social interaction. Using PoP, it becomes important to investigate Sofia's engagement with a multitude of different practices beyond the ones promoted by IS and their possible significance for her professional experiences. Our research questions are:

- How does Sofia's experiences of being, becoming and belonging at Hillside influence how DRs are used in her classroom?
- What are the potentials of social practice theories for understanding teachers' contribution to classroom practices involving DRs?

We begin by recapitulating key characteristics of SFCP and the results of our SFCP analysis of the data on Sofia. Next, we outline aspects of PoP before presenting the methodology and the results of our PoP analyses. We end with a discussion and the contribution of our approach.

SFCP AND THE SFCP INTERPRETATION OF SOFIA'S CLASSROOM

The SFCP framework synthesizes concepts from earlier studies of classrooms and teacher expertise and applies the synthesis to technology integration. SFCP, then, is a

model for analysing teacher expertise as it relates to the integration of DRs. The question that orients SFCP is "how material-cultural factors structure the functional organization of teaching expertise" (Ruthven, 2014, p. 390). SFCP intends to make it possible to analyse crucial facets of teachers' expertise as "craft", facets that are related to classroom experience rather than to formal teacher education. SFCP highlights five features that shape how teachers do or do not integrate DRs: *Working environment*: the physical surroundings, organization of people and resources, and routines enabling lessons to flow smoothly; *Resource system*: the coordinated use of tools and curriculum materials for student activity and learning; *Activity structure*: the collection of activity formats, which frame how the teacher and students act and interact in specific parts of a lesson; *Curriculum script*: a loosely ordered individual system of goals, resources and actions for teaching a mathematical topic that interweaves mathematical ideas, appropriate tasks, potential emergent issues, anticipated student responses and alternative paths of action; *Time economy*: the teacher's management of the time to convert it into "didactic time" for student learning.

Previously, we used SFCP to analyse if and how Sofia aligned her teaching with the aims of IS. In particular, we were interested in if and how Sofia incorporated new DRs into her resource system, and how their classroom use influenced her activity formats and curriculum script. We focused on Sofia's contributions to classroom interactions that involved DRs to interpret emerging conflicts between the activity structures related to her history of classroom teaching and the inquiry processes promoted by IS. Our analysis resulted in the somewhat surprising finding that Sofia tended to stick to her typical procedure-oriented activity format when DRs were involved, but to align with IS when they were not. It seemed that the integration of DRs reinforced Sofia's procedural contributions to classroom interaction that supported the students in solving closed tasks and provided them with technical support.

As part of IS, Sofia taught the unit on *Youngsters' use of digital media*. The unit exploits the affordances of different digital and non-digital resources to support students' development of conceptual understanding and a critical stance to the use of statistics. We analysed an episode, *the calculator episode*, to which we return later in this chapter. In this episode, Sofia asks a group of students to use a calculator to check if the mean of four time-periods (7 hours and 48 minutes) given in a newspaper article is correct. The group has difficulties interpreting the decimals provided by the calculator as minutes. Sofia is unsuccessful in helping them, and the episode ends with both parties being dissatisfied.

The SFCP analysis shows how Sofia's conventional activity format makes it hard for the students to engage meaningfully in the intended statistical inquiry. Regarding the resource system, Sofia chooses to use a DR familiar to the students (the calculator), bypassing DRs suggested by the unit (e.g. spreadsheets) that could promote their inquiry. When planning the implementation, Sofia draws on her existing curriculum

script, built from years of experience, which focuses on using DRs for standard procedures. Furthermore, she ignores that refinements are needed in order to use DRs to support inquiry-based learning. In effect, she blocks the students' communication and their use of DRs in statistical inquiry.

IDENTITIES AND THE POP-FRAMEWORK

Mathematics education has focused increasingly on the role of social and broader cultural and societal factors when seeking to understand instruction. This shifts the emphasis from teachers to teaching (Chazan, Herbst, & Clark, 2016; Skott, Mosvold, & Sakonidis, 2018), and explanations of teachers' acts and meaning-making tend to focus less on teacher characteristics per se, especially their knowledge and beliefs, and more on how institutional contexts and other social factors are reflexively related to and co-determiners of instructional decisions and classroom practice.

PoP is in line with this development. It was initially developed in response to the conceptual and methodological problems of research on teachers' beliefs and to develop a more social perspective on affective issues in mathematics education (e.g. Skott, 2015a, 2015b). It has later been used in studies of teacher identity (Skott, 2019). Like a range of other studies of teacher identity (e.g. Buchanan, 2015; Kang & Battey, 2017), PoP draws on the notions of practice and figured worlds in social practice theory. In this line of thinking the term practice "connotes doing [but] doing in a social and historical context that gives structure and meaning to what we do […] practice is always social practice" (Wenger, 1998, p. 47). Figured worlds are "socially and culturally constructed realm[s] of interpretation, in which particular characters and actors are recognised, significance is assigned to certain acts, and particular outcomes are valued over others" (Holland, Skinner, Lachicotte Jr, & Cain, 1998, p. 52). Holland et al. mention caste systems in Nepal and romance at a university campus as examples of figured worlds.

However, identity studies with PoP differ from other studies of professional identity that draw on the same or similar social perspectives on human functioning (cf. Skott, 2018). This is so in the sense that we do not focus on how teachers move towards more comprehensive participation in one particular, pre-established practice (e.g. a PD programme) or figured world (e.g. the reform). Instead we recentre the individual and seek to understand what and how other previous and present practices and figured worlds play a role for the teacher's contributions to classroom interaction, and how the character of and relationships among these practices and figured worlds change over time. To do so we draw on the notions of self and interaction in symbolic interactionism (Blumer, 1969; Mead, 1934). The notion of self has two aspects or phases that evolve in interactions, an I and a me. When the I acts, the actor instantaneously sees herself through the eyes of others, interprets their actual or envisaged reactions to her own act, be it physical or verbal, and adjusts the act in the process. In the terms of symbolic interactionism, the acting person takes the attitude to herself of others and becomes a me.

Consider for example a teacher, who in the process of explaining a solution to a student interprets the student's increasing physical uneasiness as an indication of mental and emotional withdrawal. Taking the student's attitude to herself, the teacher may react emotionally and adjust the explanation for instance by leaving out conceptual difficulties and focusing on the procedure to avoid difficulties that may further threaten the student's involvement and her own relationship to the student. In this case, "the other" is the student. However, one may also take the attitude to oneself of generalized others, that is, of a social group or community. In PoP we interpret practices and figured worlds as possible generalized others. In a study of the professional identities of a novice teacher, Anna, for example, the focus was on how Anna's professional experiences developed over the first few years of her career (Skott, 2019). The character and importance of some significant others changed, (e.g. the team of colleagues she worked with and the reform discourse), and she began to take the attitude to herself of other ones (e.g. the school leadership). As the dominant others changed her professional experiences were transformed, including her relationships with the students, her position at the school, and the ways in which she engaged her students in mathematics.

In the case of Sofia at Hillside, we also use PoP for identity purposes. As in other studies, we define identity as Sofia's experiences of being, becoming and belonging as they relate to the profession. This may include experiences of being (in)competent or challenged; of becoming better (or worse) for instance at mathematics, at using DRs, or at establishing productive relationships with her students; and of belonging by being recognized as a good colleague or as a good teacher by the students, the parents and the leadership. Identity is not seen as a stable personality trait, but as dynamic and affectively laden. When Sofia is with her students, for instance, her experiences of assuming professional responsibility and of being recognized as a competent professional may change, if she at the instant sees herself from the perspective of a recent professional development (PD) initiative, or a dominant discourse among her colleagues on what it means to teach. Each of these and many other practices or figured worlds may influence Sofia's shifting experiences of assuming – or not assuming – her professional responsibilities. We use PoP to analyse how Sofia engages with other individual and generalized others, including practices and figured worlds, as she interacts with the students and the contents. For our present purposes, we are particularly interested in if and how the use of DRs is incorporated into and transforms the dominant practices and figured worlds that orient Sofia's contributions to her interactions with the students.

METHODOLOGY

Sofia at Hillside

Sofia graduated from college in 2000. She had studied to become a teacher of mathematics, physical education, science and domestic science. However, she experienced college mathematics as similar to mathematics in high school, as it –

according to her – focused on reproductions of theorems and proofs, not on educational matters such as classroom use of DRs. Upon her graduation, Sofia took up teaching at the small, rural elementary school, Hillside, that has one class at each grade level from 1 to 6. Sofia still works at Hillside and teaches the aforementioned four subjects in grades 4-6.

In 2013, Hillside merged with two other schools in the municipality and became one of three departments of a large elementary and lower secondary school. It is a top priority of the new school's leadership to develop teaching with DRs. This is in line with the educational strategy of the municipality that has invested heavily in digital equipment for all its schools. In 2013, the leadership at Hillside applied for the school's participation in IS in order to build teachers' capacity to teach with DRs.

When Hillside's application is accepted, Sofia is the only mathematics teacher, who is asked by the leadership to take part in both rounds of IS, and consequently she teaches the unit (15 lessons) *Youngsters' use of digital media* twice, both times in grade 6. She is also asked to be the local leader of ten colleagues, who teach this unit and another unit taught in grade 3. As the IS-initiative finishes in 2015, the leadership of the school and the educational leadership of the municipality agree that the school has benefitted tremendously from its participation. The leaders therefore decide to continue the teaching of all the five IS-units. Again, Sofia is asked to lead her colleagues' teaching of the two units. Today, the teachers still teach these units, and the school continues to emphasise the significance of IS. This is so to the extent that the school's participation in the project is mentioned at the top of its homepage.

Sofia considers herself digitally competent and she is recognised as such at Hillside. She has participated in many other development projects on the use of DRs in mathematics and, as indicated above, Hillside supports her in doing so. This means that the case of Sofia at Hillside may be seen as a critical case (Flyvbjerg, 2011), as it allows a generic interpretation: if the potentials of IS do not materialise in this case, they may be unlikely to do so also under less favourable circumstances. In combination with PoP, the study of Sofia at Hillside becomes instrumental (Stake, 2000), as it sheds light on the more general issue of how teachers' professional experiences are co-constituted by practices and figured worlds in and beyond the school and the classroom.

Data generation

We used field notes and video to observe Sofia's classrooms and to identify differences and similarities between her normal approach to teaching and the ones she took when teaching *Youngsters' use of digital media*. We observed 15 lessons before and after Sofia's teaching of the unit, and 16 lessons from the unit itself, mainly from the second round in which we assumed that Sofia was more familiar with it. We transcribed 15 hours of our recordings. To understand what other practices and figured worlds may influence Sofia's use of DRs, we conducted six semi-structured, one-hour interviews. Four of them were with Sofia, three during IS

and one five months later; two were focus-group interviews, one with Sofia and two of her colleagues, and one with the school leadership. The two latter interviews focused on IS, especially on how Sofia and her colleague engaged in it. We transcribed all six interviews.

Data analysis

We conducted two analyses. The first was to identify practices and figured worlds that may play prominently in Sofia's use of DRs when teaching. Inspired by grounded theory (Charmaz, 2014), we analysed the four individual interviews with Sofia line by line and constructed initial codes such as "differentiating teaching is easier with DR" and "supervising rather than teaching". Based on these, we constructed focused codes for example "using DR to meet general pedagogic concerns", which we assembled into distinct practices and figured worlds. In this way, we identified two characters from practices and figured worlds related to the teaching of mathematics, *a modern teacher* and *a digital spearhead*, and a contrasting figured world that Sofia still refers to, *the traditions of mathematics teaching*. In what follows, we refer to these three as identity markers. We confirmed and consolidated these markers by comparing with extracts from the two other interviews and from classroom observations.

The second analysis was to investigate if and how the three identity markers played significant roles as generalized others for Sofia when teaching. In order to make it possible to compare our SFCP analysis with the PoP analysis, we chose the calculator episode referred to earlier. We also analysed other classroom episodes to consolidate and refine our findings.

PROMINENT IDENTITY MARKERS

We now present the three identity markers identified in our first analysis and show how they play significant, but different roles for Sofia's use of DRs.

Being a modern teacher

A significant character for Sofia is that of a progressive and modern teacher. There are two aspects to this: the use of DRs and elements of the reform agenda.

As for the first aspect, Sofia is particularly concerned with introducing new and technologically advanced DRs (e.g. multimedia applets). She focuses on whether they allow the students to engage in different activities and to have fun and allow her to differentiate activities so as to engage all students particularly the weaker ones. Another rationale is to ease her obligations, for instance correcting tasks and controlling student work. In her own account, the use of DRs has not transformed her approach to teaching, but it has made certain things easier.

As for the second aspect, Sofia is inspired by constructivism, which has two implications for her. The first implication is that the students should be active with the content and responsible for their own learning. The second implication is that

Sofia is reluctant to present mathematics to the whole class and to engage in whole class discussions. She considers "that old-school teaching" (second interview) a waste of time as most of her students can or will not follow. Rather, she sees her main responsibility as being a supervisor organising students' independent learning.

These two aspects merge for Sofia into imaginings of a modern teacher, who uses DRs effectively within a reform agenda. We describe two ways in which she relates to *being modern*. Each of them points to ways in which she disclaims responsibilities often attributed to teachers.

Firstly, acting as a *modern teacher* Sofia refers to the reform agenda by implying that students need to engage actively with DRs. She even expects them to learn to work with new DRs by themselves, "That is what I expect of them. When we were to learn to use GeoGebra [I told them] 'You have to learn it by yourselves'" (first interview).

Secondly, and because of leaving the responsibility for the students' learning to themselves, Sofia does not need to know everything about the DRs used in the classroom. She happily asks students about the potentials of new DRs and about how to solve tasks with them. This makes it possible for her to introduce new and technologically advanced DRs without having the responsibility to familiarise herself with them in advance. It also means that she does not need to solve the tasks the students are to work with beforehand, irrespective of whether they require new or complicated uses of DRs. She is not worried that she is sometimes unable to help the students, "That is how it is to be a teacher" (second interview).

To summarise, Sofia's experiences of *being a modern teacher* relates to her use of new and technologically advanced DRs that frees her from responsibilities that teachers traditionally assume. By *being modern*, she distances herself from most of her colleagues and positions herself as different. At the same time and paradoxically, she claims to gain a prominent and valued position among them.

Relating to the traditions of mathematics teaching

Sofia also draws on approaches to school mathematics that are more traditional. This is so in two ways. First, Sofia emphasises students' mastery of skills and tools (e.g. multiplying fractions, using a protractor) and does not acknowledge the significance of mathematical processes. She focuses on "all the basic knowledge … all the content parts of mathematics" (first interview). Though Sofia is aware of a new emphasis on processes in the national syllabus, she rejects it and trusts her own professionalism, "[it is] too fluffy in relation to how concrete the subject really is" (second interview). Student command over basic skills is an aim in its own right that requires practice, "It is important to make a lot of the same type of tasks because then you get good at it" (first interview). However, Sofia also refers to the assumption that drill-and-practice leads to conceptual understanding.

Second, Sofia's choice of a particular DR concerns whether it allows students to solve their normal tasks quickly and easily. It is not based on whether the DR

provides students with opportunities for learning concepts and procedures more profoundly or for engaging students differently in mathematical processes. Spreadsheets, for instance, involve too many choices and do not help the students produce answers quickly. Therefore, Sofia does not use spreadsheets although the national syllabus requires her to do so.

These two issues suggest that mathematical proficiency is a matter of solving routine tasks quickly and point to efficiency as a key concern for Sofia's choice and use of DRs. Some DRs introduce efficient methods for dealing with for instance geometric problems. This includes GeoGebra, as it helps students to reflect and translate geometric figures more easily than when drawing on paper. Others are digital platforms offering instantaneous feedback when practising skills, "[they] are fantastic for drill and practice tasks compared with providing students with notebooks" (second interview).

To summarise, Sofia focuses on traditional mathematical virtues and on DRs that provide students with efficient ways of learning and working with the related routines. Her experiences of being valued by her colleagues and students and of being aligned with what is generally required in the profession are based on the extent to which she manages to establish teaching-learning situations that allow the students quick and easy access to the routines. Being valued and competent with regard to DRs is then a matter of the procedural efficiency of the resource, not of learning the specific content differently or more profoundly.

Being modern merges with the traditions of mathematics teaching

Being modern merges sometimes for Sofia with the *traditions of mathematics teaching*. One example is when Sofia designs her lessons. When doing this, she relates primarily to the *traditions* by basing most of her decisions about the content on a textbook matching her emphasis on routines, and using its tasks (i.e. closed questions with right answers) and what is referred to as 'workshops' (i.e. repetitions of skills in new contexts). Normally, she begins a lesson by telling students which tasks to do and providing organisational details. After that the students work for some time individually on routine tasks on a digital platform, and later they work in groups with the textbook tasks or workshops. As a *modern* teacher Sofia supervises groups of students and rarely presents specific content to or leads discussions with the whole class. Hence, Sofia promotes a reform agenda regarding student's autonomous learning at the surface level, while she engages them in routine tasks and guides them on procedural and technical matters when she interacts with them.

Becoming a digital spearhead

As mentioned previously, using DRs is to Sofia one part of *being a modern teacher*. Gradually she also begins to see herself as a *digital spearhead*. There are two interrelated aspects to this. One is her experience of being digitally committed and competent; the other is how she positions herself and is positioned as proficient with DRs at the school and elsewhere. As for the first, her major motivation for using DRs

is her personal commitment, which has taken her beyond what could be expected of a teacher "I have invested interest in this … To me, this is not just a job … If it was really just a job, I wouldn't do it!" (first interview). One indication of her commitment is that she has participated in many PD activities related to DRs in order to keep on top of recent developments. Also, she refers to discussions with her husband, who teaches mathematics at another school, about how best to use DRs.

In part, the second aspect also concerns Sofia's participation in PD, including IS. Her participation has not made her think of herself as part of a community of highly qualified and committed DR users. On the contrary, she consistently refers to her disappointment both with the other participants, who know much less than she does, and with the PD initiatives, as they do not support her in becoming better at using DRs. She always expects that "[t]here must be somebody, who knows more [than me] … who can inspire me, but there never is" (first interview). Considering herself more digitally competent than her colleagues at Hillside and beyond, Sofia distances herself from them and positions herself as a digital spearhead. This is affirmed by how she is positioned by the school leadership as key to successful integration of DRs among her colleagues. She is highly valued for her digital competence, and asked to participate in and be in charge of various activities such as being the digital coach for all the schools' mathematics teachers. In the interview with the leadership, they readily acknowledge her significance for the school's integration of DRs.

In summary, Sofia consistently experiences herself as being highly digitally competent, and she positions herself and is positioned as such. Her sense of *becoming a digital spearhead* coevolves with her distancing herself from other teachers. Thus, as a *digital spearhead* she experiences belonging to an imagined elite of teachers, who are experts on the use of DRs in mathematics teaching.

THE CALCULATOR EPISODE

We now return to the episode described earlier in which Sofia asked a group of students to use a calculator to find the mean of four time-periods. Our analysis aims to document if and how the three identity markers described in the previous section play a role as generalised others for Sofia when she interacts with the students.

The activity

In the second round of IS, Sofia teaches *Youngsters' use of digital media* to a small grade 6 class with 13 students. Sofia considers these students mathematically weaker than the class she taught in the first round. The unit's first lessons are based on a newspaper article that uses inappropriate statistical methods to justify and argue that youngsters spend too much time on the media. It is a main goal that the students develop a critical stance to the use of statistics by examining the article. The students are to use spreadsheets to work on open questions, for instance on how the journalist has presented the data and used them to calculate the mean of previously found averages of media-time, and how to interpret this mean (7 hours and 48 minutes).

The incident

The incident lasts 12 minutes and involves interactions between Sofia and a group of three girls, who according to Sofia are among the mathematically strongest in the class. Even before the girls have read the questions, Sofia asks them to use a calculator to check the mean of the four averages, thus omitting the critical and difficult part of the questions. She also tells them how to transform time to minutes. Following Sofia's instructions, the girls transform each average, add the numbers and divide the sum by 4. Sofia intervenes asking them also to divide by 60 without further explanations. The next 5 minutes they and Sofia struggle to get the calculations right. Finally, the calculator returns 7.7333, and the girls utter "It was close … But not right". Unsure how to interpret the result, one girl asks Sofia, but Sofia replies that she must find out herself. Instead, Sofia begins to explain how to change 0.7333 hours to minutes "If you multiply by 60 then you get that part of an hour". However, the girls do not understand her explanation, and one girl complains "You confuse me more than I was before". In the end, both parties seem disappointed. Sofia comments that the students do not develop understandings from the procedures "But you do not understand; only know how to do it".

ANALYSIS AND RESULTS

In what follows we use the three identity markers to analyse Sofia's instructional choices when planning the activity and her interactions with the students as she implements it. This allows us to develop an understanding of the role of each marker and of their shifting mutual relationships. This leads to an identity-interpretation of why the calculator episode develops as it does.

Identity markers when designing the activity

At the level of design, we emphasise three of Sofia's choices that relate to the identity markers, sometimes in contradictory ways. First, Sofia does not generally deal with the inquiry-based character of IS-activities, and in particular, she aligns herself with the *traditions of mathematics teaching* by turning the open questions of the activity into tasks for practising procedures. This choice, however, may also relate to the students being relatively weak, prompting Sofia to draw on her obligations as a *modern teacher* and simplify the task to make it accessible to all students. In this case, elements of the first and second identity markers seem to merge.

Second, Sofia rejects the use of spreadsheets and decides to use a calculator, a tool that in this activity does not promote student inquiry. This choice relates to all three identity markers. After narrowing the open questions, a calculator is more efficient for finding the right answer and in this sense Sofia's choice aligns with the *traditions*. *Being modern* Sofia normally choses a new or technologically advanced DR and not a calculator. She compensates for this in this case by using it in combination with a multiplicity of other DRs. Also, and still as a part of *being modern*, Sofia's choice of the calculator can be seen as guided by a general concern for the weaker students,

who are less challenged by a well-known DR. Finally, Sofia's decision relates to how she sees herself as more digitally competent than others. Being the only participant in IS to question its suggestion of DRs, she draws on her digital commitment and confidence, that is, her becoming a *digital spearhead*, to challenge the project recommendation.

Third, and in line with *being modern*, Sofia has not prepared herself by working with the activity beforehand or considering how to facilitate her students' learning. According to her, the students are to learn by engaging with the content and the calculator themselves, and her role is one of framing and guiding their work.

Summarizing, Sofia makes three choices oriented by the identity markers when preparing the activity. *Being modern* plays the most dominant role.

Identity markers when implementing the activity

Although all of the three identity markers are at play in the incident, the balance among them changes. The interactions relate mainly to *being modern* and *the traditions*, while *becoming a digital spearhead* coexists in the background. We divide the analysis into three parts.

First, it is notable that Sofia narrows the questions to such an extent that even the most mathematically strong students cannot approach them in other ways. This indicates that making questions more skill-focused relate more to Sofia's emphasis on *traditions* than to a *modern* concern for the weaker students.

Second, Sofia expects the girls to engage actively with the content and the calculator. In line with *the traditions*, she provides explicit support on procedures, but aligns with *being modern* when the girls request a meaningful interpretation of the mean and she requires them to discuss it among themselves. Her rejection to engage in conceptual discussions can also be seen as rooted in *the traditions*, as her assumption is that conceptual understanding develops when students work with procedures.

Third, Sofia is not prepared for the conflict that emerges with the students. The girls' unproductive struggle with the calculator and their growing frustration suggest that at least the part of *being modern* related to differentiating instruction and allowing students to have fun are challenged. As the calculator does not provide a meaningful context for the students, Sofia increasingly draws on her well-established *traditional* orientations, thus re-engaging in practices of supporting student skill-mastery. This tension between the group's emotional responses to not understanding and Sofia's increased procedural instructions create a communicative gap suggesting a conflict among Sofia's identity markers. That is, featured choices such as the *modern* prompt to let students work autonomously finding their own ways to solve tasks with DRs, the *traditional* priority given to students' skill-mastery and to providing procedural instructions, and the *digital-spearhead* decision to do away with the recommended DRs and use a calculator instead, short-circuit her interactions with the girls.

This conflict may influence Sofia's professional experiences and orient her future ways of contributing to interactions with students. We wonder whether the episode will reduce Sofia's engagement with *the traditions of mathematics teaching* or – more likely – will lead her to blame IS and the unit for the conflicting communication.

DISCUSSION AND CONCLUSION

Our previous analysis based on the SFCP framework provided a rich descriptive account of conflicts between Sofia's dominant activity format and the innovative ones targeted by IS. For instance, it prevented students from engaging meaningfully in the intended statistical inquiry, when DRs were involved.

In this chapter, we adopt a more explanatory approach. We revisit the data and use PoP to relate the emerging classroom practices to significant aspects of Sofia's experiences of being, becoming and belonging as a teacher at her school, that is, of her professional identities. Our interactive interpretation of these experiences, points to the significance of social practices in and beyond the classrooms and suggests an analytical potential of a social perspective on identity for understanding teachers' contribution to classroom practices with DRs.

We identify three practices, characters, and figured worlds that orient Sofia's experiences at Hillside. These identity markers are *being a modern teacher*, *relating to the traditions of mathematics teaching* and *becoming a digital spearhead*.

At the level of design, we see that all identity markers merge in Sofia's decision to use a calculator, and not a spreadsheet. *Being modern*, however, dominates at this level as Sofia disclaims responsibilities often attributed to teachers such as to investigate the learning potentials of the activity and to address students' difficulties with conceptual issues in advance. This is so even when Sofia as a *digital spearhead* decides to use a different DR than that suggested by IS. When teaching, Sofia acts as a *modern* teacher by disclaiming responsibilities for setting up whole-class sessions, which combines well with *the traditions*, but poorly with IS. Thus, although Sofia claims to follow a reform agenda, as does IS, she only does it on a surface level expecting students to work autonomously, but with tasks that she has transformed into closed ones targeting skill mastery and with DRs that she has not prepared herself to use. In our interpretation her affiliation with these dominant figured worlds prevents her from attempting to engage in the parts of IS that concern DRs as resources to promote students' statistical understandings and engagement in processes of inquiry and reasoning. This constellation of identity markers including the recognition of her as digitally competent from the school leadership makes Sofia very confident in her ways of using DRs.

The analysis of the incident indicates a pattern in Sofia's contributions to classroom interactions. PoP allows us to analyse this pattern and highlight how and to what extent it is oriented by the three prominent identity markers. The analysis brings to

the fore how Sofia's identity fluctuates as she engages with her students while her experience of assuming professional responsibility and of being recognized by her school and beyond as a competent teacher working efficiently with DRs evolves. Initially Sofia draws mainly on *being modern* assuming that the students would solve the tasks by themselves. As the incident evolves, Sofia insists on providing 'efficient' explanations in line with *the traditions* but fails to support the learning of her better performing students and to align with IS's inquiry-based aims. This experience may and may not at the instant challenge her sense of herself as being a competent teacher. In the subsequent interview, however, she explains the students' reactions with reference to the poor design of the unit, keeping intact her experience of herself as a *digital spearhead.* This may be seen as an answer to our previous question about whether Sofia will reduce her engagement with traditional mathematics or blame IS.

In this sense, the PoP analysis offers a set of explanations for the descriptive account of Sofia's use of DRs in our previous SFCP analysis. In particular, the analysis can explain Sofia's dominant focus on procedures at the level of design and in classroom interactions when DRs are involved. More generally, PoP offers an identity perspective on teachers' roles in technology-based learning environments and on how figured worlds, characters and practices beyond the classroom may influence the integration of DRs in different ways. PoP allows a perspective on significant identity markers as they relate to different aspects of teachers' professional lives. While the SFCP analysis is useful in providing descriptive accounts of aspects of Sofia's instructional approaches, PoP offers more social explanations of the development of these aspects. This takes the analysis further and allows contextual interpretations and explanations of Sofia's agency, that is, of her acts as related to broader social enterprises beyond the immediate interaction.

The insight provided by the above findings is not limited to a single teacher. The generic case of Sofia indicates the complexity of how teachers' engagement in different practices and social worlds (in and out of the classroom) interrelates with their professional experiences as regards the integration of DRs in teaching. We expect that different, similar or other identity markers, patterns of classroom interaction and respective explanations will emerge in other less promising cases of teachers who attempt to use DRs in their mathematics classrooms.

At the level of theory, the two frameworks help us highlight different facets of Sofia's experiences with using DRs in her classroom: while SFCP provides an account of her organisation of the lesson and her structure of interactions with the students, PoP offers an identity lens to analyse if, how and why the use of DRs influences the practices and figured worlds orienting her contribution to the classroom interactions. In conclusion, the present study indicates that different frameworks and theoretical approaches – including networking and double analyses – are needed to develop balanced understandings of the integration of DRs in mathematics classrooms that acknowledge the significance of teachers' professional identities.

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