Introduction to 'Producing the sociocultural research in mathematics education'

Núria Planas, Universitat Autònoma de Barcelona (España)

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1. The sociocultural concept in our area of research

Some time ago, a doctoral student asked me what was the point of the sociocultural research in mathematics education that I was talking about, if conducting research meant simplifying. The question surprised me, and my spontaneous reply was that sociocultural research in mathematics education tries not to simplify too much, not to over-simplify. This reply was tricky in the sense that the term "sociocultural" is in itself a simplification of the relationship between culture and society. The student went on to complete an excellent thesis based on the detection of learners' behaviours when resolving mathematical tasks in class. He decided that the behaviours could be documented with relative ease, while the cultures of mathematical participation and the forms of interaction between learners and with the teacher were difficult to interpret with any guarantee of objectivity. It is certain that behaviours are visible and the influence exerted on them by the culture and by the social structure is sometimes not.

This monograph deals with the construction of the domain of sociocultural research in mathematics education and with the challenges of communicating its meaning clearly. The domain is observed through eight studies by authors in Costa Rica, the United States, New Zealand, Malta, Lebanon, Mexico and Spain. It is an incomplete, schematic collection, mediated by the journal editor's background (see, for example, Planas, 2010), my network of collaborations as a researcher and my academic conversations with colleagues and associate editors. Having said that, however, and given the monograph's aims, it is a sufficient collection. It seeks to illustrate the diversity of approaches that intermingle within the domain and, at the same time, offer a space for discussion on the sociocultural concept. Taken together, the articles indicate that the sociocultural concept is compatible with –and is being forged within– a variety of theoretical approaches in mathematics education, some of which are relatively isolated from others, or scarcely in communication. More generally, the monograph is intended to help foster understanding and reflection on singular aspects of sociocultural research in mathematics education.

The notion that mathematics learning and teaching are mainly social processes has been on the mathematics education research map for decades and has become more and more prominent in recent years. Lerman (2000) wrote about the "social turn" in reference to the reactions to positivist and rationalist research in our area, often based on Piagetian epistemologies. Today, these reactions are still being formulated in response to diagnoses of a crisis in the representation of the problems of mathematics education that our academic community prioritises for research. Quite a number of authors within the area who describe their recent research as sociocultural, some of whom place themselves in the epistemology of critical mathematics education (Skovsmose, 1994), have a background in the positivist tradition, showing the social turn to be a collective, as well as an individual, phenomenon. Even founders of qualitative research in the social sciences like the US North American sociologist

Barney Galland Glaser, often known for grounded theory, aspired to objectivity and generalisation in their early contributions. Not until Glaser (2001), was the maxim "all is data" applied to participants' subjectivity in a study, including the researchers'.

The sociocultural turn in research in mathematics education deconstructs researchers' subjectivity and places their history and individuality in indivisible interaction with the contexts and the participants they are studying. This subjectivity is not a bias or an intrusion, but rather the instrument that makes it possible to collect and interpret data from which to produce and share findings. The analysis is not oblivious, for example, to the fact that the researcher studying the Zapoteca women who read, write and calculate in order to take part in the local and family economy is a teacher to these women's children; or the fact that the researcher studying the arrival and distribution of collectivist cultures and forms of activity in mathematics classes in New Zealand is of Pāsifika origin; or even the fact that the researcher examining patterns in the multilingual teaching of algebra in Lebanese schools is a speaker of the learners' languages and does not need the mediation of interpreters or facilitators. Understanding how the researcher's subjectivity must be made explicit and why in the course of a study has generated, and continues to generate differing approaches within the domain. In any case, these approaches do not treat human subjectivity as a threat to scientific credibility, nor as a lack of objectivity or a problem to be addressed. Human subjectivity (which includes our beliefs, with their contradictions and convergences, in the sense adopted by one of the articles in this monograph) is one more mediator between the phenomena we wish to understand and the knowledge that we generate, and this subjectivity is, in turn, mediated by participation in cultures and social structures.

2. What are we simplifying/abbreviating behind "sociocultural"?

Uniting what is cultural and what is social in the abbreviation "sociocultural", to define the scope of sociocultural research in mathematics education, signals above all the inseparability of culture and social structure. Culture and social structure co-constitute each other, just like individuals and society. This is the psychology-based point of departure with Vygotsky (1978) –although Vygotsky hardly ever used the term sociocultural in his work– and the philosophy-based one with Merleau-Ponty (1964), among other disciplines and authors. Neither learners nor teachers of mathematics, nor their minds, are ahistorical entities floating in the air, free of culture and social structures, which is also of use to those who research into mathematics learners and teachers.

From a broad perspective that brings together various sociocultural approaches, culture is a historical set of situated standards that are learnt and must be known in order to recognise the expectations of others and appropriate ways of interacting (Goodenough, 1971). We can thus talk about vegan cultures, agrarian cultures, workplace cultures, mathematics classroom cultures, mathematical cultures, algebra teaching cultures, learner assessment cultures, etc. In sociocultural research into mathematics education, however, the concept of culture is to be further defined through the prism of specific concepts in mathematics education, such as mathematics, learning, education, teaching, or curriculum. The meaning of "culture" is then generic and not definitive in the domain until the theories underpinning other, more specific, concepts are explained. The same applies to the meaning of "social structure" and, accordingly, that of the relationship between culture and society. Within the domain of sociocultural research in mathematics education, these meanings are pinpointed when

they are placed in the framework of theories that signify specific concepts in mathematics education.

The sociocultural research in mathematics education that, for example, conceptualises learning as cultural objectification of knowledge (Radford, 2002) narrows down a notion of mathematics classroom culture to a configuration of historically produced objects which offer learners and teachers ways to intuit phenomena of reality. This complex of objects configures the classroom culture in the same way as the complex of individual cells configures the body of a living being by incorporating a historical memory that is genetic, if I may be allowed to draw a metaphor from the biology realm. In the article in the monograph that deals with the language for teaching the relationship between area and volume, the implicit notion of culture does not refer to the historical production of the mathematics classroom and the processes by which collective memory is updated; the focus is rather on pedagogical cultures with future teachers and curricular cultures of mathematics education in teacher training at university and those of primary schooling, in line with particular standards analysed from the view of their sociolinguistic construction. Also different is the notion of culture underlying the anthropological theory of the didactic (Chevallard, 1990), and other theories like ethnomethodology and funds of knowledge guiding studies in the issue. Looking at the articles as a whole, we see in brief that the term "sociocultural" is another simplification to represent a family of terms which encompass the historical-cultural, the socio-historical, the sociolinguistic, the anthropological-cultural…

For both concepts –culture and social structure– the different articles arrive at meanings within theories for investigating particular phenomena in mathematics education. From that point, there opens up a continuous stream of interpretations based on our understanding of other concepts in mathematics education, on our conception of the basic relationship between culture and society, and on where we put our emphasis. On the one hand, emphasis on the social side highlights participation in cultures of mathematical practice due to living in society and occupying a place in a network of social structures. On the other hand, emphasis on the cultural side stresses that such participation is organised on the basis of rules laid down by culture, which can be changed in exceptional circumstances. These two emphases do not compete with, but rather complement each other, like the two sides of a coin, if I may use another metaphor. With either of the two emphases, the conclusion is that of a greater chance of unquestioningly accepting a school mathematics –with its rules– and a project of mathematics education –with its rules too. But the school mathematics and the mathematics education project that are not questioned are far from being natural phenomena like climate or the water cycle: they are historical products, standardised and therefore artificial –created in the relationship between culture and society. There are more types of additive structures that could be worked on in early schooling, more types of linear geometries that could be included in curricula and which could take into account that straight roads are not common in all parts of the world. Sociocultural research in mathematics education critically asks why there are cultures whose rules are considered rational, logical and universal, as we are reminded in the article that provides data on Costa Rica and its mountainous regions with hardly any straight roads, or in the article with data from the United States on how hard it is to shake beliefs about compensatory school curricula for children who are learning English.

In the article discussing democratic mathematics classroom rules and practices, it becomes clear that adapting and adhering to these rules and practices is a criterion for

identifying the "expert" learner: the one who knows well and accepts the rules of the classroom culture and of school mathematics. Such learners, along with any others, have an active, but complicated, role in their mathematics learning. They recreate rules and practices and, when this recreation is not appropriate, the teacher has the responsibility of making this clear without, paradoxically, giving a detailed explanation of the corresponding rule or practice. "Non-expert" learners can start interesting conversations when they ask questions like "What's wrong with my way of working?" "Why do I have to do it a different way?" "Why do I have to use algebra if I can solve the problem with numbers?" "Why do I have to use Pythagoras theorem if I can find out the area of the square that is formed?" The answers will be logical or rational within the rules system of the cultures being considered. It is a situation similar to that of the learner driver who asks why he has to pay the motorway toll. There are rules and consequences. The situation is different in the case of the learner driver who asks why he has to stop the car at a stop sign; here the answer has more to do with avoiding an accident and staying alive than with keeping to the rules. If we want mathematics learners to understand and practise Pythagoras theorem, perhaps it would be reasonable to ask them to use it in tasks that they can accomplish without resorting to the theorem. However, the rule that forces a learner to complete a task by applying the theorem is not a drama-free one and could even be counterproductive to mathematics learning.

The article discussing mathematics activity in relation to play in an early childhood education class in Malta uses the sociocultural concept based on the Vygotskian distinction between scientific language or culture and everyday language or culture. Here, the didactically designed classroom-play situations allow the generation of a hybrid culture in which both scientific and everyday elements have value as mediating tools in the learner mathematical learning. A comparison of the key words and concepts of this article with those of other articles in this monograph highlights the flexibility of meanings of the term "sociocultural" within research in mathematics education. While some papers focus on analysing anthropological, sociological and philosophical aspects of culture and social structure, others study psychological aspects of human action and development to recount mathematics learning experiences and teaching processes. In the latter, the social structure is that of interaction and the culture is that of the immediate context in which the interaction takes place, with its artefacts or mediating tools: whether material (such as beads, or the task) or immaterial (such as the teacher voice, or the school tradition). The article that explores mathematical language for teaching the relationship between area and volume, with student teachers, considers the participants' individual development in the sociocultural context arising from interaction with the mathematics tasks in the questionnaire and with a school culture in which meanings attached to the term "area" in the early ages are restricted to plane geometry.

Our collective memory as members of the scientific community of mathematics education researchers shows that, historically, the emphases on social factors (e.g. the interaction between learners and with the teacher) and on cultural factors (e.g. the artefacts that shape the context of the interaction) have taken effect separately from the emphases on individual factors (e.g. the learner thinking processes, or the teacher's beliefs). This introduction to the monograph is a good place to reflect on the benefits of not disregarding the knowledge produced at these different levels. Of particular significance are the studies that draw on the cognitive theories of human learning to integrate the influence of the cultural context and that of social interaction in the

development of semiotic systems for interpreting situations in mathematics teaching and learning. These studies prove that the domain of sociocultural research in mathematics education is also being constructed, as expected, at the intersection with other domains within the area. Some articles in the monograph, for example, adopt elements of situated cognition and explore communication through the body in transcript analyses as a means of access to participants' minds, thoughts and beliefs. There is no explicit reference to the corporeal dimension of meanings, but this dimension does seem to be taken into account in the light of the interpretations of certain speech turns in which literal verbal and non-verbal elements are selected, with ellipsis points for omissions (...), and are added, with square brackets for additions [ ]. The sequences of verbal and non-verbal actions in the interaction, with transcripts recreated by the researcher, blur the boundaries between the individual (the body) and the cultural and social (the world).

This reference to the interpretation of transcript data points to the topic of analytical methods and to the question of whether there are methods that can be called and recognised as sociocultural. This is not a trivial question. We could easily agree that psychometric analyses move us away from the sociocultural concept while field ethnography moves us closer. It would be more difficult to agree about other methods. Qualitative content analysis methods, for example, are epistemologically diverse; they can be guided by the sociocultural concept, depending on whether or not we take contents –units of analysis– relating to specific elements in contexts of culture and social interaction. Content analysis applied to curricular documents can examine the presence of certain mathematical truisms in a situated way with regard to the historical and spatial placement of these documents (e.g. linear geometry of straight roads in contemporary school mathematics in Costa Rica). In order to distinguish sociocultural methods, we should pay attention to what is prioritised in the comprehension process. The data can refer to direct or encapsulated products of culture (e.g. textbooks versus a learner written or spoken answers to a book task, or student teacher's responses to an item in a questionnaire-interview), but if we do not turn to the specificity of the context in the process of understanding data (e.g. if the text in the book is not put in con-text), the sociocultural concept is unlikely to guide the analysis. Different analytical methods can be regarded as sociocultural if, in the process of interpreting data, they are firmly situated in contexts of culture and social structure. The transcribed data from a clinical interview with a future mathematics teacher in her final undergraduate year can be analysed by considering the student's language as a representation of her thinking and of the cultures of mathematical pedagogy in which she has participated across mathematics education courses in her university curriculum. It is this way that these cultures turn into data.

Still continuing with reflections on the determination of sociocultural methods, the article with data from Arizona and New Zealand is another example of processes for interpreting transcripts that are based on situating data in their context. The transcripts of interactions in the mathematics workshops of Arizona and in the New Zealand school classrooms shed light on the mathematical knowledge of young people, mothers, learners, etc. produced within communities of practice, which provide knowledge to their participants that can differ from the content specified in official education systems. Here, in order to understand the data, the methods for analysing the discourse in the transcripts and in the researchers' observations focus on the local context –physical and in a specific timeframe– of the workshop and school lesson being conducted, as well as the broader historical context of the culture, the social

structure and the rules of the communities involved. The group of methods known as discourse analysis can thus include sociocultural methods, depending on the function ascribed to the context of culture and social structure in the interpretation of primary data and in the generation of new data sources. At the risk of stating the obvious, it is worth pointing out yet again that if certain content analysis methods (from ethnomethodology, ethnography, content analysis, grounded theory, narrative semiotics, discourse analysis, or various combinations) are sociocultural, it is because they focus on the sociocultural concept. This is because methods are always theoretical and epistemological.

And, since an introduction should not go on for too long, I will end here. I am sure the articles in this monograph will generate many more topics for debate, reflection and critique, or directly for critical reflective debate. At any point in the history of research into mathematics education, texts are needed that help us understand the construction of specific domains and so enable us to keep on constructing them. It is not possible to reach a definition that encompasses all instances of the sociocultural concept and its applications in mathematics education research (nor, as far as I know, in other areas, like science education research), nor would it make sense to formulate a definition that hardly explains anything or over-simplifies. Nonetheless, the more appearances and applications of the sociocultural concept we study, the more deeply we will understand the concept, the domain and the area. Given the variety of "bridging" meanings, the following articles will hopefully add to a greater understanding of sociocultural research in mathematics education and its complex, diversified role in our area.

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