

RETHINKING SUCCESS AND FAILURE IN MATHEMATICS LEARNING: THE ROLE OF PARTICIPATION[1]

Elsa Fernandes

University of Madeira and Technology Mathematics and Society Learning Research Group, Centre for Research in Education - University of Lisbon

This paper analyses and discusses the notion of participation in a community of practice and its role on the rethinking of the notion of success and failure in the learning of mathematics, taking as support for the discussion some episodes collected on a vocational school where a group of young boys wanted to become blacksmiths.

INTRODUCTION

Before starting school life children learn many things, participating with their parents and friends in important activities for their lives and for their family's lives. Learning occurs meanwhile children participate in ongoing activities of their families and the activities purpose and the reasons for learning are obvious for the children.

After starting school life children continue learning a lot of important things, out of school.

But during many years this reality had been ignored or had not aroused researchers interest that dedicated themselves quite exclusively to the understanding of learning in school contexts focusing themselves "on observable aspects of individuals or on mental representations (that are assumed as reflecting or indicating experience" (Matos, 1999, p. 3)

In 1988, Jean Lave, with her book *Cognition in Practice*, brought in changes on cognitive and transfer (of mathematical learning) theories.

In 1991, Lave and Wenger presented a 'new conception' of learning arguing that to understand learning it is important to shift "the analytic focus from individual as learner to learning as participation in the social world, and from the concept of cognitive process to the more-encompassing view of social practice." (Lave and Wenger, 1991, p. 43)

Learning central feature is legitimate peripheral participation that is, according to Lave and Wenger, (1991) "the process by which newcomers become part of a community of practice." (p. 29) To belong to a community of practice "does imply participation in an activity system about which participants share understandings concerning what they are doing and what that means in their lives and for their activities."(p. 98)

Also Wenger (1998) discusses the notion of participation: "Participation refers to a process of taking part and also to the relations with others that reflect this process." (p. 55) Participation refers not only to local events of engagement in certain activities but to surrounding processes of being active participants on the practice of

community and to processes of building identities in relation to those communities. Such participation shapes, not only what we do, but also who we are and the way we interpret what we do. It also shapes communities in which we participate; “the potential transformative goes both ways. Indeed, our ability to shape the practice of our communities is an important aspect of our experience of participation.” (p. 57)

To analyse participation in the practice of the community become important in order to discuss and understand learning as a phenomenon that emerges from participation in social practice. In this paper we will analyse the participation of a group of young boys in a community of blacksmith apprentices. Our trajectory on this paper will be to present the boys and what they had been doing to become blacksmiths. Then to characterize participation in the practice of blacksmiths apprentices’ community, discussing aspects such as: negotiating the meaning, motives to participate, ways in which practice is constituted, forms of participation and patterns of the practice. Finally we will discuss the main ideas emerged from this paper pointing out the situated character of learning in communities of practice and suggesting implications for school learning.

TO BECOME A BLACKSMITH

The vocational school ‘CAMPO’ proposed a course of blacksmith technical to the community. A group of youths, between 16 and 21 years old, had subscribed the initiative, by very different reasons.

Starting classes, life of blacksmith apprentices - all boys - gained a set of routines. They have to attend different classes (from 9h to 18h) with an interruption for lunch (from 13 to 14h). Students had usually one morning or evening with the same theoretical classes (as they call it, such as Mathematics, English, Technical Design, Computing, etc.). ‘Blacksmith practices’ was the exception. They had this subject every Friday or Saturday alternatively in a ‘real’ blacksmith's workshop.

Apprentices started to work individually, training several soldering techniques, but quickly they were doing different things with different times and methods. After learning how to sold, the blacksmith master proposed them to build a dust-pan. The second project proposed by the blacksmith master was a bench. Initially apprentices drew the object they will build on blacksmith's workshop in Technical Design classes. The dust-pan and the bench had been drawing on that class. When apprentices noticed that they could propose their own projects to the blacksmith master they quit drawing in Technical Design classes and drew it mentally. Many times apprentices drew part of the object they were building on the bench, with the aim of analysing and discussing with the blacksmith master any aspect of the work. This communication technique had been started by the blacksmith master.

Frequently blacksmith master and apprentices discussed their work communicating with support on schemes drew over the bench. These schemes usually showed one of the views of part of the object they were building. It was not a perfect drawing, but it

was always in proportion and communication between apprentices and the master was sustained by the use of these drawings. Eventually apprentices added any line to the scheme and questioned the master or explained their ideas using the draw more than oral language.

On this context it was not frequent the dialogue between apprentices, despite they were working on group. This fact is related with the machines noise, characteristic of the blacksmith's workshop that makes audition difficult. But blacksmith's workshop has its own way of communication - using as support the object scheme.

Blacksmith master circulated between apprentices and observed them attentively all the time, but only interfered if one of the apprentices posed a question or if he saw them using the machines in a dangerous way. In this situation he showed how to do it correctly.

Mathematics class was a traditional one.[2]

PARTICIPATION IN A BLACKSMITH APPRENTICES COMMUNITY

To characterize participation in this practice, informed by situated learning theories, we had been analysing some aspects of it, such as negotiation of the meaning, motives to participate in different activities[3] of practice, ways in which practice in constituted, forms of participation and patterns of the practice.

To Participate in Different Spaces of the Practice

When apprentices started blacksmith practices they had a particular space to work, inside the blacksmith's workshop. It was a corner on the 2nd floor limited by a balcony. Sometimes, they need to use some machines that were out of this space and timidly they frequented that space that does not belong to them. It was the space where professional blacksmiths worked. It was common to see apprentices observing professional blacksmith working and vice-versa.

In a beautiful Saturday ('The Special Saturday') the blacksmith owner asked apprentices to help professional blacksmith to finish a work whose time of delivery will not be accomplished without apprentices help. In other words, apprentices were not only explicitly authorized to frequent all the space of the blacksmith's workshop but also to participate in blacksmith practice for a task that corresponds to a need of the workshop. From this moment apprentices did not leave this space. The boundary crossing and the entrance in the space of professional blacksmith practice not only give apprentices autonomy in relation to the space, but also favoured, in a natural way, the interactions between apprentices and professional blacksmith, that started to comment apprentices work.

The situation above related was, for the workshop owner, only a way to solve his own time of delivery problem, for apprentices was a crucial moment of that activity. It was the moment in which they secured all space of the blacksmith workshop, but this corresponds to another conquest equally (or maybe more) important - to see

themselves and to be seen as able to performance a more all-embracing task and more responsibility, in interaction with professional blacksmiths of that workshop. It was also, from this Saturday that, on Abreu's initiative - one of the most active apprentices - apprentices started to propose, to Mr. António, the execution of their own projects.

The Negotiation of the Meaning in Different Practices

Since the beginning of apprentices' blacksmith practice they were in the presence of two different practices on the same physical space. These practices were well demarked by physical boundaries, behaviours, ways of talking, by identity features evidenced in interactions, on mutual dependencies, on implicit comprehensions in moments where the dialogue seems not to exist. More than to ask if they were in presence of two communities of practice (Lave and Wenger, 1991) it is important to characterise the way students/apprentices create the continuity between both practices - support to talk about participation in different (although with overlapped elements) communities of practice. In spite of apprentices had a clearly peripheral position in relation to the professional blacksmith practice, the authority of the workshop owner legitimated their participation on the blacksmith community. This aspect give them access to a set of relations, ways of being, acting, doing, dialoguing that apprentices will not have access if those 'Special Saturday' did not happen. Apprentices were explicitly and intentionally authorized to participate in an organized practice in patterns and vocational terms, 'larger' when we think in its positioning on life trajectories of apprentices, opening possibilities and potentialities of apprentices engagement on the blacksmith professional practice.

Another element that had contributed, in a decisive manner, for the blacksmith school practice integration in the blacksmith professional practice was the fact that Abreu brought some pieces of an old griller and asked the master if he could rebuild it in spite of building the window proposed by the master. From this phase of implicit negotiation between the blacksmith master and Abreu (by initiative of the second), all the group became aware that they could bring their own projects to the workshop and that they did not need to wait for the master proposals. Despite the negotiation was between two elements of the community, all others assumed that negotiation as being their own negotiation.

“The engagement in practice has patterns, but it is the production of such patterns anew that gives rise an experience of meaning” (Wenger, 1998, p. 52). In blacksmith activity one of the aspects of extreme importance is visualization, but master António did not make it explicit to apprentices. When master António communicated with them about what they were building, he had drawn a scheme of the object. Apprentices started timidly drawing some more lines on the scheme and using these schemes to explain, with few words, why they adopted certain process instead of another. Few weeks later, apprentices used this process commonly to communicate with master and with the all the members of the community. In other words, it was

through repetition of a certain pattern that apprentices negotiated the meaning of visualization on that practice.

“Negotiation of the meaning is a process that is shaped by multiple elements and affects these elements. As a result, this negotiation, constantly changes the situation to which it gives meaning and affects all the participants.” (Wenger, 1998, p. 54)

In fact, below examples ‘Special Saturday’ and ‘the griller brought by Abreu’ show that nothing was left as it was before. In the first case, apprentices had access to the work and comments of professional blacksmiths working on the workshop. And this had changed the dynamic of that space. The second case also showed that negotiation of a meaning affected all the participants and had completely changed the situation. In both cases, apprentices gained power with the negotiation of the meaning.

To be a blacksmith is required a specific way of looking to the objects they have to build. The ability to interpret the object building in blacksmith workshop reflects the relation that blacksmith and the object has in practice. Apprentices contribute for the negotiation of the meaning because they are members of the community and because they transport with them stories of participation on that practice. In a similar way, objects built contribute for this process reflecting aspects of the practice that had been ‘frozen’ in themselves and had been fixed on their forms. Blacksmith apprentices, as community members, incorporate a long process that Wenger (1998) called participation. Similarly, the objects as artefacts of a certain practice incorporate a long process that Wenger (1998) called reification. It is on the convergence of these two processes that negotiation of the meaning occurs.

As a pair, participation and reification, refers to the fundamental duality for the negotiation of the meaning (Wenger, 1998). Participation and reification are not mutually exclusive. They are intrinsic and complementary elements in the negotiation of the meaning. On blacksmith workshop, it is participating that apprentices build objects that, by its turn, are reifications of that practice. The negotiation of the meaning occurs on this process. On their practice apprentices expressed their way of belonging and their identities as members of the community of blacksmith apprentices but progressively manifesting their belonging to the blacksmith community (in which they want to become). For instance, when they started blacksmith activity they always used overall, maybe because they did not feel such as blacksmiths and the needed something that identified them (for themselves and for others) as blacksmiths. In summer, almost in the end of the course, some of them did not use the overall completely dressed. This fact can mean that these apprentices did not need anymore clothes to see themselves and to be seen as blacksmiths.

In mathematics classes it happened several moments of negotiation of the meaning, namely in relation to the kind of communication that was possible on that context, to the kind of attitudes acceptable on that activity and also to the institution expectations, namely in relation to the kind of student that was expected they were. It was through the repetition of several moments of communication that students had

becoming aware of the kind of answers that teacher approves. For instance, when a student answered teacher and he ignored the answer, student did know that that answer was not correct or that it was not appropriated to that context.

In relation to mathematical contents there was little visibility of eventual negotiation of meaning. When we had been on the mathematics classroom we had not observed any discussion, between teacher and students or between students, concerning a certain mathematical content. Therefore opportunities to the negotiation of the meaning were reduced.

Mathematical contents were presented by teacher to students in a reified way and this difficult the negotiation of mathematical meaning. “An excessive emphasis on formalism without corresponding levels of participation or conversely a neglect of explanation and formal structure can easily result in an experience of meaninglessness.” (Wenger, 1998, p. 67)

Motives to Participate

To become a blacksmith had been a common motive, to participate, for all blacksmith apprentices and this motive was decisive in the way how students had participated in both the activities of practice analysed in this work. Nevertheless, there are other nature motives, in the different apprentices and that we grouped as follows: (1) the present – all apprentices approached to a moment in their lives that they felt necessity to wrap themselves in a transition; (2) the future imagination. Here we can distinguish three groups – the larger group that sees in the profession a social and professional identity that will allow them to reach ways of life that they desire. The minority group, that sees in profession an intermediate step to a ‘more elevated’ professional life project. And another minority group that seems to be not quite sure of the professional identity that desires.

How the Practice is Constituted and What are Forms of Participation?

On the blacksmith activity dynamic we can identify three different phases of participation. The first one – the beginning – that is characterized by the existence of two distinct practices – the real practice and the blacksmith pedagogical practice. Blacksmith apprentices’ participation in the real practice is characterized by non-participation[4]. But non-participation had fundamental importance on the learning of ways of participation on blacksmith learning activity. Apprentices had a peripheral participation in relation to blacksmith real practice. The second phase – the appropriation of physical space. On this phase there was only one practice – blacksmith practice. Apprentices had had a legitimate peripheral participation on the real blacksmith practice. The third phase – full participation – where there was only a practice and blacksmith apprentices had a legitimate participation towards full participation. It has been important that apprentices learned to participate, but for that is has been necessary that they had access to participation cause this access is a

fundamental condition to the practice. There was an ‘evolution’ on apprentices’ identity. They left seeing themselves as students to seeing themselves as blacksmiths.

Students have learned to participate in mathematical activity when they engaged on it. They have learned what type of answers to give to the teacher, how to show (to the teacher) that they are interested in (looking for or pretending looking for on the copy-book a similar task), there is, they have learned to be students of that mathematics class. All students had, on that activity, a full participation, seeing that all of them saw themselves and were seen as ‘from within’ that activity. Nevertheless, existed students with a bigger or smaller degree of legitimacy in agreement with they had better learned the kind of participation to have on that class.

Patterns of Practice

Patterns that have emerged from the analyses of apprentices’ participation on that practice can be characterized in order to three aspects: discourse, ways of working and knowledge. Discourse between apprentices and between apprentice and the master on blacksmith activity can be characterized by the use of few words. Apprentices were not used to translate verbally their work, neither to talk explicitly about it in detail. This kind of discourse did not belong to that activity of practice. On mathematics class the discourse between students is to joke or to ‘blow’ the answer to a colleague. Discourse between teacher and students had several styles according to the moment: if the moment was naturalness, the discourse was informal, when they were solving tasks discourse was characterized by question/answer. When teacher wanted to maintain order on the class he talked in a loud voice.

According to Lave and Wenger (1991) discourse is a resource where visibility and invisibility are in constant interaction. Discourse must be invisible so that the problem to be solved can be engaged, that is, can become visible. The challenge is to make the discourse invisible. In many mathematics classes, discourse is invisible for some (few) students but visible for others (the great majority). If we want that discourse becomes invisible it is important to create opportunities for the negotiation of the meaning.

Students were able to recognize the context and specificities of mathematics (for instance, through teacher discourse) but they didn’t have access to the realization rules (Bernstein, 2000) seeing that they do not realize it. To participate in one activity that somebody described is not only to translate the description to an incorporated experience, but to renegotiate its meaning in a new context (Wenger, 1998), there is, students in mathematics class should renegotiate the meaning of learning mathematics, the meaning of look for solutions for the problems they have to solve, the mathematical meaning of contents they were using, and, in fact, they didn’t have space to that renegotiation. To be able to say and to be able to do are not equivalent things. To know a mathematical formula (a concept or mathematical idea reification) can make us believe that we have completely understood the process that it describes.

But exploring ideas only intuitively, without moments of reification, can make things too much disconnected and that will lead to a meaninglessness experience.

In relation to ways of working in blacksmith activity apprentices worked most of the time on pairs. On mathematics activity, most of the time students and teacher worked in a big group. It was unusual to see students solving problems on pairs or individually.

In relation to the knowledge, on blacksmith activity, we had identified some patterns such as: visualization (we have discussed before on this paper), measurement unit (that is millimetre), the tolerance margin of error (one millimetre) and mathematical proceedings (as we will see below).

The Dustcart

Vasco and Abreu were building a dustcart. They had over the bench where they were working, a piece of aluminium, a ruler, a set-square, a scribe, a piece of iron (used to trace out straight lines and a tape measure.

Vasco was drawing several lines on the piece of aluminium as we can see on the figure 1.

Researcher: Why did you trace out these lines (pointing to the trapezium diagonals)

Vasco: To find the middle of these one (pointing to the parallel sides of the trapezium).

Researcher: The middle?

Vasco: Yes (and he drew a perpendicular line to the parallel sides of the trapezium through meeting point of diagonals).

Researcher: How do you know that this point is the middle point of parallels sides?

Abreu takes a tape measure and measures the bigger side (of parallel lines) of the trapezium. After that he measures the distance between one of the vertexes of the trapezium and the 'middle point' defined by the perpendicular line that Vasco drew on the bigger side. He didn't talk. He only looked for me.

Researcher: Yes. But... why?

Vasco: Because we always do like that. All of us do it like that (referring to the old-timers of the community).

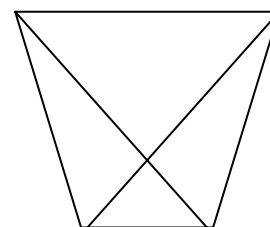


Figure 1

The above episode shows the use of an important geometrical property (the meeting-point of the diagonals of a parallelogram or of an isosceles trapezium belongs also to the mediatrix of opposite sides or of parallel sides respectively) that apprentices did not know theoretically.

This property is not valid to other kind of quadrilateral, but in fact, I have not seen apprentices neither blacksmiths (old-timers) working with it. For the type of things they do on blacksmith practice, this 'rule' always works. Apprentices used it because they learned it with 'insiders' of the community that it worked. Mediator tools (such as blacksmith tools, mathematics, etc) invisibility allowed apprentices to focus on and to learn on in the visibility of their aim – the building of the dustcart.

CONCLUSION

In blacksmith apprentices community of practice, apprentices had strong motives to participate on several activities of practice that composed the practice of that community. Those motives, namely the motive 'to want to become something' was determinant in the way students participated, namely, in activities with a more scholar logic, such as mathematics. What motives have students to participate in the different activities that constitute the scholar practice of Public School? In which they want to become? Which communities they want to belong?

All these boys already had failure in school mathematics and in general in school. Suddenly, with a traditional class, very similar to the kind of class they had in public school, all the students had success on mathematics. Why was this change? The motivation for the success in mathematics comes from the fact that they want to become blacksmiths and for that they have to be approved in all subjects of the course. Probably, till then, most of these students had the label of 'incompetent' in mathematics. To change the emphasis from 'ability' to 'to belong' or 'to become' suggests a redefinition in the way of looking to 'success' and 'failure' in mathematics class (Boaler, William and Zevenbergen, 2000).

These boys are the kind of students that Skovsmose (2003) called 'disposable[5]'. Mathematics Education, in a certain sense, prepares some groups to be the 'disposable'. It's important to understand how failure in mathematics can be part of the process of nomination of people as 'disposable' and also understand that the one who are considered 'disposable' in public school can not be 'disposable' in another situation, also scholar, but with stronger motivations than those that public school allows themselves to develop.

Non-participation on blacksmith activity reveals itself fundamental in the learning of forms of participation. Non-participation in public school is, usually, punished. It's important that non-participation be decriminalised on mathematics class, seeing that it is a crucial element on the learning of forms of participation.

To have success on the learning through participation on activities of a community includes the development of an identity on that community and that development is related with and depends of the identity of the person in another activities of the community and in other communities to which the person belongs.

Success or failure cannot be understood, only in terms of knowledge and skills brought by the student to the situation. This individual attributes have to be considered in relation with social arrangements and resources in which individuals interact (Greeno, Eckert, Stucky, Sachs and Wenger, 1999).

NOTES

1. This paper was prepared within the activities of Project LEARN: Technology, Mathematics and Society (funded by Fundação Ciência e Tecnologia (FCT), contract no. PTDC/CED/65800/2006 and Project PARTICIPAR (funded by Centre for Research in Education of the University of Lisbon). The research reported is based on a larger study developed for a PhD dissertation (Fernandes, 2004).

2. When you read this sentence you have imagined a traditional mathematics class. What I have been observing was quite similar to your imagination. The only difference is that tables are arranged in a U form.

3. The different activities that constitute the practice of that community take in from two activity systems with enough different logics. Some of those activities are strongly related with production logic ('Blacksmith Practice' and 'Traineeship' subjects) in spite of being integrated in the curriculum of a vocational school. Other activities have school logic (Applied Mathematics, Technical Drawing, English, etc, subjects).

4. On Wenger (1998) sense.

5. Skovsmose (2003) comments about groups of people that can be enfolded in or affected by mathematics education. These groups are: constructors, operators, consumers and disposables. On this perspective disposable are the one who are not 'necessary' to the informative economie.

REFERENCES

Bernstein, B. (2000). *Pedagogy, Symbolic Control and Identity: Theory Research Critique*. Revised Edition. London: Taylor and Francis.

Boaler, J. Wiliam, D. e Zevenbergen, R. (2000). The construction of identity in secondary Mathematics Education in J. F. Matos e M. Santos (Eds.), *Proceedings of the Mathematics Education and Society Conference*, pp. 192-202, Montechoro, Portugal: Centro de Investigação em Educação da Faculdade de Ciências de Lisboa.

Fernandes, E. (2004) *Aprender Matemática para Viver e Trabalhar no Nosso Mundo*. [Learning Mathematics to Live and Work in Our World]. PhD Thesis. Universidade de Lisboa

Greeno, J. G., Eckert, P. Stucky, S. U., Sachs, P. e Wenger, E. (1999). Learning in and for participation in work and society. *How Adults Learn*.

<http://www.ed.gov/pubs/HowAdultsLearn/Greeno.html>

- Lave, J. (1988). *Cognition in Practice: Mind, mathematics and culture in everyday life*. Cambridge. Cambridge University Press.
- Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press.
- Matos, J. F. (1999). Aprendizagem e Prática Social: Contributos para a Construção de Ferramentas de Análise da Aprendizagem Matemática Escolar. *Actas da II Escola de Verão*. Sessão de Educação Matemática da Sociedade Portuguesa de Ciências da Educação. Santarém.
- Skovsmose, O. (2003). Ghettoising and globalisation: A challenge for mathematics education. Conferência Paralela apresentada na *XI Conferência Interamericana de Educação Matemática (XI CIAEM) – Educação Matemática & Desafios e Perspectivas*
- Wenger, E. (1998). *Communities of Practice: Learning, Meaning and Identity*. Cambridge, UK: Cambridge University Press.