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The professional identity of teacher-researchers in mathematics

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We are interested in the professional identity of teacher-researchers and in particular the influence of their discipline on their teaching practices. In this article, we present a multidisciplinary research based on this issue and report on its results for teacher-researchers in mathematics. First, we introduce the concept of professional identity in order to clarify our research problem. Then, we present our methodology and illustrate our results with excerpts from interviews with teacher-researchers from various institutions in France and Belgium. We compare these results with those obtained with teacher-researchers in physics and suggest some perspectives.

Keywords: teachers' and students' practices at university level, preparation and training of university mathematics teachers, teacher-researchers, professional identity.

INTRODUCTION

Many French universities have created professional development structures for higher-education teachers with a perspective of “pedagogical transformation” in order to respond, in particular, to the diversity of the student population (Endrizzi, 2011). While research has focused primarily on the pedagogy of teaching practices (Annoot & Fave-Bonnet, 2004), this issue has seldom been addressed through an approach based on the discipline of teacher-researchers (Henkel, 2004; Neumann, 2001), even though several authors stress the need for it (Becher, 1994). In this context, we have conducted a research based on three academic disciplines (Mathematics, Physics, Chemistry) (Bridoux et al., 2019): in this contribution, we report on the results of this research for teacher-researchers (TRs) in mathematics. Our objective is to better know this community of teacher-researchers by highlighting several aspects of their professional identity, be it transversal aspects or aspects related to mathematics.

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This could be a first step for building teacher training courses that take into account the values and qualities they emphasize and specific elements of knowledge they enhance. By this approach, we hope to encourage the transformation of teaching practices and to understand teacher-researchers' expectations about students or the secondary-tertiary transition.

THEORICAL FRAMEWORK AND RESEARCH QUESTIONS

The concept of professional identity is complex and appears in the literature under different approaches. From the standpoint of pedagogical practices, the higher-education teacher is a researcher before being a teacher (Fave-Bonnet, 1999; Musselin, 2008; van Lankveld, Schoonenboom, Volman, Croiset, & Beishuizen, 2017). In mathematics education, the concept of identity of mathematics' teachers is defined in various ways and has been extensively studied (Graven & Heyd-Metzuyanim, 2019). From the point of view of sociology of work, professional identity is defined as "a set of specific elements of professional representations, specifically activated according to the interaction situation and to respond to an aim of identification/differentiation with societal or professional groups" (Blin, 1997). This relation with the community is found in Cattonar (2001) who defines the professional identity as "the characteristics that identify him as a teacher and that the teacher shares with other teachers, which he shares in common with other teachers because he belongs to the same professional group". In this context, de Hosson, Décamp, Morand and Robert (2015) have retained several dimensions of professional identity understood as "the way in which an individual teacher is defined in relation to his or her professional teaching practice" and have highlighted tensions among TRs in physics. The dimensions retained in this work are related to the profession: norms, qualities and skills required, values (Dubar, 1996). Other studies show that teachers identify strongly with their research disciplines (Henkel, 2004). In the latter case, tensions appear, with TRs valuing the research. Drucker-Godard, Fouque, Gollety and Le Flanchec (2013) have shown that French TRs feel "a conflict between values they initially approve (freedom, independence, autonomy, public service) and new values emerging from recent reforms of the university system (scientific productivity, effectiveness, efficiency, individualization of the career, fairness and unequal treatment and esteem" (p. 19). The perception of this conflict seems to be common to many TRs, regardless of their research and teaching disciplines. It is reinforced by the results of de Hosson et al. (2015) who find that the professional identity of the physics TRs [...] interviewed appears to be strongly marked by tensions [...] that sometimes appear under the form *I know that this should be done and yet I do the opposite*. However, we may wonder if there is a discipline imprint on values, and thus on these tensions, whether at the level of public values – the epistemology of each discipline leads to potentially different beliefs and

organizations –, or at the level of individual values that can influence each TR in the choice of his/her discipline.

Van Lankveld et al. (2017) also mention that teacher training is perceived as positive in terms of teaching capacity through peer-to-peer exchanges, making them more credible in their institution. This socialization effect is all the more pronounced among teachers who have not received initial teacher education (Goodson & Cole, 1994). However, professional identity can be negatively affected when teacher education is perceived as a supervisory mechanism (van Lankveld et al., 2017).

The aim of our research is to study the following research question for TRs in mathematics: what is the discipline's imprint on teaching practices at the university? We have two main motivations for conducting this study. On the one hand, we would like to understand the way in which the interviewed TRs perceive training courses in “university pedagogy”. On the other hand, we would like to know their expectations towards students in terms of difficulties they mention. These motivations are thus taken into account in both the design of the interview protocol and the analysis of the interviews. Our methodology will also allow us to test the relevance of the following assumptions: a TR is a particular teacher because of its multiple missions, the research discipline is a marker of its professional identity, or even of the institution in which he works.

METHODOLOGY

Our data are taken from the anonymous transcripts of 12 semi-directive individual interviews, lasting between 30 and 90 minutes. To see if the institution or the length of service has any influence with respect to our question, the volunteer interviewees come from four universities² and have teaching experiences of varying length (3 to 40 years). The interview protocol was initially constructed in such a way that we can identify the norms, qualities and values assigned by the TR to his teaching practices (de Hosson et al., 2015), which give a pertinent access to his teaching professional identity by hypothesis (Cattonar, 2001; Dubar, 1996). We have amended the initial interview protocol to take into account the teaching discipline, in particular mathematics. In the table below, we give examples of questions that are related to each of these dimensions (norms, qualities, values, discipline).

Dimension	Questions
Norms	What is the objective of a course? How do you ensure that the objective is achieved? What is the purpose of an evaluation?
Qualities	What do you find difficult in your job as a teacher? Do you feel the need to be trained as a teacher?
Values	What do you enjoy most about being a TR? What would you be willing to

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	delegate/not delegate?
Discipline	What are the sources of difficulty for students? What is a good course? What is a good teacher?

Table 1 - Some examples of questions related to study dimensions

During the interviews, we discussed the following topics: organization of teaching, innovative practices, difficulties and evaluation of their students, TRs' training, the profession of TR, didactic questions (objective and content of a course). To analyze the interviews, we have conducted an empirical categorization by identifying verbatim excerpts that seem to be relevant for our research question. We consider a verbatim excerpt as a unit of meaning (Bardin, 1977), which may fall within several significant categories related to the discipline of the TR interviewed and to the attributes of its research activity. We have thus tried to spot regularities and variabilities that are intra or inter-disciplinary. More specifically, we have looked for verbatim statements reflecting the influence of the research profession on the teaching profession, student assessment or teacher training. We have thereby tried to identify elements that refer to a researcher posture in teaching practices (creativity, freedom, collegiality, peer review and peer learning) or to the transposition of research methodological elements into the activities proposed to students (problem solving, reflexivity, student presentations, group work, etc.). We have also identified tension elements (de Hosson et al., 2015) often stemming from contextual factors (institution, relationship with students, teacher training).

RESULTS

Different aspects emerge that allow us to provide various types of answers to our research question.

Mathematical difficulties and transversal competences

During the interviews, TRs were asked to identify students' difficulties when entering university. Whereas the answers to this question are varied, we can spot regularities that concern either mathematical difficulties or mathematical conceptions and skills that are related to their researcher position.

Concerning mathematical difficulties, the majority of TRs point to gaps with specific concepts taught in secondary school: continuity, derivation, tangent to a curve, lack of logical knowledge.... Thus, students have "learned to perform calculations" and do not "know how to pass from an equation to a straight line or from a curve to an equation". The fact that students misunderstand, forget or have compartmentalized knowledge is mentioned by some TRs, with doubts concerning the origin of their difficulties.

- M7: And so we cannot know whether students' difficulties are due to the fact that they have not seen or assimilated these notions, or that they have assimilated and forgotten them.

Most TRs also highlight examples of high school mathematical practices that they see as blocking factors at the university level: favoring “recipes” rather than understanding the concepts, having a local understanding of courses rather than a global vision, having problems with formalizing an intuition. Many TRs also speak of a particular difficulty in mathematics related to the production and understanding of proofs. This is both an epistemological (understanding what a proof is) and mathematical issue (understanding the different statements inside a proof and the relations between them).

M5: I think that, at least unconsciously, we think that the students know what a proof is, when to say that something is true or false, etc. and they didn't actually learn that in secondary school.

In particular, TRs deplore a difficulty for students to enter into an abstraction and formalization process, and to conceive the relations between the different mathematical objects. The different excerpts show a tension among TRs between a will to present a rich and complex mathematical universe and a feeling that students are rather in a process of learning in a “fragmented way” without trying to “put the pieces back together”.

M7: More and more, a level $n + 1$ course deletes skills from the level n course.

Most TRs agree that the attitudes of many students in courses or in exercise sessions do not allow them to overcome all these difficulties: lack of personal work, difficulties with concentration or attention, lack of autonomy or self-confidence, difficulties to concentrate, be attentive, or to master the language. Some TRs, however, find mitigating circumstances for some students: financial hardship, lack of time, transportation difficulties, having a part-time job.

M8: There are some people who have a job, for example, so they have little time to work or etc. There are others who just don't have a job and do nothing.

However, what seems to be important for the TRs interviewed, is not that students work more, but rather that they really try to confront themselves to exercises or questions, so that they can “become theirs”.

M3: The work during exercise sessions cannot replace personal work, for example the course or even trying to do exercises by yourself.

For some TRs, the most important thing in a course is to insist on study processes in order to encourage students to continue the work personally, and to equip them methodologically for such a work.

M2: The subject matter itself is important, but it is somewhat the mechanism that students need to learn in thinking that can be interesting.

For some TRs, this contradicts students' expectations: to have a well-structured course and a clear identification of the elements that will be evaluated.

All TRs point the difficulty for students to adapt to university mathematics. For a large majority of TRs, they “do not do math” in secondary school, in the sense that there is a change in mathematical practices between secondary school and university, “that they do not speak the same language”.

M8: I think we have a lot of students who don't know what it's like to do math and who are in this kind of attitude where they're going to try to learn a little bit of algorithmic things, some ready-made methods, that they will reproduce in a very similar context without any thought on the substance...

The following excerpt illustrates a mathematical activity that seems unsuitable for higher education.

M1: In the first year, perhaps, I think that there is a first difficulty in adapting to our requirements. Which is not necessarily related to the matter itself but which is linked to when we define a concept, what does it mean to understand a concept?

This inadequacy is sometimes expressed as a difference between a research practice that requires almost permanent questioning, and students' expectation of a reassuring practice.

M4: As a teacher-researcher, the researcher is not safe because he or she is looking for a way to disrupt everything he or she knows, as soon as there are things he or she doesn't understand, he or she is often faced with difficulties. That's what we'd like to do in our classes.

Assessment practices

The actual evaluation practices of TRs are quite diverse. The assessment may consist of a written and/or oral examination or of a continuous assessment followed by a written examination. It may concern questions about the course, exercises closely related to those presented in exercise session, new problems or a combination of these possibilities. Although the practices differ from one TR to another, we identify a similarity between them: they are generally not satisfied with the way they evaluate students.

M5: Then I'd like to evaluate them on their ability to look a little bit, ask questions that are more open than those I'm actually asking in the exam, where they would look, think, etc. and we don't have time to do that. The exam is too short.

The ideas developed in this excerpt are shared by most of the TRs. In fact, for a large majority of interviewees, the main objective of the evaluation is to determine if students have a thorough understanding of the courses. For this

reason, many people want to assess this understanding, particularly through problems in a different context from the exercise sessions. However, they do not do so because of several reasons: lack of time, lack of staff or because it would require too much investment on their part to the detriment of research. In addition, they want to mix various evaluation methods such as continuous monitoring, lectures, homework, mid-semester midterms, etc. The following excerpt clearly shows this trend.

M6: The ideal is still to have a mix of continuous evaluations and evaluations, say at the end of semester or possibly mid-semester.

As a result, very few TRs assess what they really want to test and they seldom vary the forms of assessment. In our view, this reflects a tension between what they value as evaluation methods and what they actually practice. In addition, they are aware that students' success or failure at an examination is not significant in terms of their understanding of the course

M3: It seems horrible to me, but at the same time I can't put the whole system back into play like this, this is the way it works, so I find that sometimes the grades aren't, apart from the very good and the very bad students, but sometimes the grades don't always correspond to the student's understanding of what he's doing.

In the analysis of the interviews, we then identify two tensions related to TRs' assessment practices: one between what is valued and what is evaluated in the exam and another between students' understanding and success.

Teacher-researchers' training

TRs were asked whether they thought it was desirable to have access to continuing education and if so, what form it could take. A first striking aspect is that all TRs agree that, in the case where there is such a training, it must necessarily be non-disciplinary. Indeed, mastery of discipline is taken for granted in the profession of TR.

Second, two major trends emerge from the interview analysis. The first concerns TRs who believe that the training of higher-education teachers is not useful. This concerns about half of the respondents. Some TRs also question what "learning to teach" might mean, as the following excerpt shows:

M9: There is nothing that trains to teach in the strict sense. At the same time, I believe that in a university context, it's not really necessary... when someone knows his field well and... spends time preparing for his course... it's very rare that they actually make a bad course.

The other half of TRs are not opposed to continuing education, provided it has practical aspects that take many forms in their comments. For example, training could cover aspects that are not necessarily disciplinary, such as managing a group of students or how to get them to work more effectively.

M10: I think, for example, of the possibilities to use the ENT³, computers, this kind of thing, it's a little bit up to each person to go and discover it for himself [...], let's say, but nothing very pedagogically precise.

Finally, some TRs mention their lack of knowledge concerning didactics and believe that it would be positive to better understand this field of research through training.

DISCUSSION AND PERSPECTIVES

In this contribution, we have deliberately limited ourselves to presenting results in mathematics. We return here to our general issue concerning the impact of the discipline on teaching practices by pointing out some comparisons between our results and those of Physics.

We have identified that the vision of the discipline is clearly reflected in the statements made by TRs in mathematics, particularly when they point out students' difficulties (difficulties in entering into an abstraction and formalization process, in questioning themselves, etc.). In addition, their posture as researchers is highlighted when they evoke the elements they propose (or would like to propose) to students (research problems, for example). They also raise tensions in the way in which students are evaluated at university.

Thus, the norms, qualities and values mobilized by TRs are strongly marked by the image they have of their own research discipline. They are also marked by the institutional constraint represented by the evaluation standard, particularly at the beginning of university. Similar results have been obtained among TRs in physics that have been interviewed, such as a tension between what they value in terms of forms of assessment (oral, open-ended questions, etc.) and the evaluations they actually propose. Although mathematics are seen as an obstacle for learning physics, TRs in physics say that they still manage to “do physics” with their students: this contrasts with TRs in mathematics who do not manage to “do math” with theirs. For TRs in physics, it is possible to “do physics” because their discipline is at the crossroad of several disciplines and very much related to phenomena that can be observed in everyday life. We also find a strong imprint of their discipline in teaching objectives and practices (group work, reflexivity, creativity, etc.).

These first comparative results between mathematics and physics show some disciplinary disparities but also a strong anchoring of the research profession in teaching practices. In this respect, we find similarities with the theoretical framework presented above, which we need to deepen: the influence of the previous experiences of the TRs interviewed, identification with the research discipline (particularly in relation to learning), the socialization effect,

³ ENT : digital work environment.

particularly in teacher training. Through a more detailed comparison between the three disciplines, it would be necessary to analyze our results on the basis of the five psychological processes that influence teachers' professional identity (van Lankveld et al., 2017). At least, we observe certain similarities with these processes, thus reinforcing our research hypothesis.

In addition, this research should allow us to identify enough variables to design an online questionnaire (simple or multiple responses, or simple text) to confirm or refute our results and move towards statistical representativeness of the TR population. Another objective is to study *in situ* TRs' practices in order to refine our results (van Lankveld et al., 2017).

Finally, the results presented in this contribution are also encouraging to provide some answers to the problem of university pedagogy mentioned in the motivation for this study. This would enable us to report on the results obtained on TRs in universities where interviews were held, or even during training courses dedicated to university pedagogy. The objective here would be to show TRs a representation of their own practices in order to initiate a discussion on different aspects that could better capture the complexity of practices. Here again, the disciplinary aspect is highlighted, in particular by the desire expressed by some TRs in the three disciplines to deepen their didactic knowledge.

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