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Mathematical biography and key rhetoric

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Abstract The intention of this article is to consider the use of narrative and rhetorical inquiry as research methods. I construct a mathematical biography of one elementary teacher trainee, Sirpa, who had performed well in her advanced mathematics course in upper secondary school. I describe her development as a mathematics teacher during teacher education from her second-year methods course and teaching practice to fourth-year teaching practice. Narrative inquiry is more than a case study: Sirpa's mathematical biography is a story that describes how she constructs her mathematical identity. I also analysed the key rhetoric that Sirpa used in her talk, key rhetoric here referring to the strategy by which she constructed continuity and coherence.

Keywords Narrative inquiry · Rhetoric · Teacher change · Teacher education · Mathematical biography · Mathematical identity

1 Introduction

In recent decades, the case study has established itself as a frequently used qualitative research method in the field of mathematics education. Often, case studies focus on 'facts,' which are collected from research subjects by interview or by observation. Yet, language has a central position in the cultural system where meanings are composed (Vygotsky 1962). We can talk about linguistic turn in social sciences, and also in mathematics education. Hence the potential of case studies can be deepened by applying narrative and rhetorical approaches to data analysis.

The intention of this article is to consider the use of *narrative and rhetorical inquiry* as research methods for exploring the teaching and learning of mathematics. I focus here on

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the mathematical biography of one elementary school student teacher, Sirpa. A number of studies in the field of mathematics education have applied a narrative approach (see, e.g., Ellsworth and Buss 2000; Smith 2003; Hannula 2003; de Freitas 2004). The present research differs from these studies methodologically in that I explicitly consider the emplotment process and also the key rhetoric that Sirpa used in her autobiography.

Rhetorical psychology places an emphasis on the life story as an arena of communication: in autobiographies we are not only expressing ourselves but we communicate and negotiate ourselves with others (Komulainen 2000). In this article, my focus is on how Sirpa constructs her mathematical identity by using experiences from her own years at school and from elementary teacher education. In particular, I am interested in Sirpa's key rhetoric, the strategy by which she constructs continuity and coherence (cf. Komulainen 2000).

2 Mathematical identity and mathematical (auto)biography

There are two broad ways in which people organise and manage their knowledge of the world: the logical-scientific mode of thought and the narrative mode of thought. The first seems suited for treating physical 'things,' the second for treating people and their plights (Bruner 1986). The aim of *narrative* cognition is to understand actual human conduct. Like Denzin (1989), I consider a *narrative* to be a story relating a sequence of events that are significant for the narrator and his or her audience. A *narrative* has an internal logic that makes sense to the narrator.

In this study, the key concepts are mathematical identity, mathematical autobiography and mathematical biography. People often develop their sense of identity by seeing themselves as protagonists in different stories. What creates the identity of the character is the identity of the story and not the other way around (Ricoeur 1992). From a rhetorical point of view and in light of Maclure's (1993) view of identity, I would maintain that a (narrative) mathematical identity should not be seen as a stable entity but as something that people use to justify, explain and make sense of themselves in relation to mathematics and to other people acting in mathematical communities. People adapt their narration to their audiences and to the social conventions of how language is used. Thus, a person's mathematical identity is context bound.

A person's view of mathematics is an important part of his or her mathematical identity, consisting of knowledge, beliefs, conceptions, attitudes and emotions. I distinguish three components in students' views of mathematics: (1) their view of themselves as learners and teachers of mathematics, (2) their view of mathematics and its teaching and learning (Pehkonen and Pietilä 2004), and (3) their view of the social context of learning and teaching mathematics, i.e., the classroom context (Op't Eynde et al. 2004). One essential aspect of the first component is self-confidence, which plays a central role in the formation of a student's view of mathematics.

In a mathematical autobiography a person tells about her or his own development in learning and teaching mathematics. A mathematical autobiography usually involves personally meaningful episodes, important persons, explanations, and the development of one's beliefs of learning and teaching mathematics. *Autobiographies* are an effective tool for identifying changes in attitude towards mathematics and science over time (Ellsworth and Buss 2000). The researcher constructs the mathematical biography of another person together with that person. In particular, the researcher's task is to explicate how the person's earlier experiences have influenced his or her past and present mathematical identity.

3 The phases of teacher change

I have constructed a model that includes the phases of teacher change by combining some central elements of Smith et al. (2005) and Senger's (1999) models, as follows. (1) Problematising current beliefs and practices: the students think their views of mathematics are not the best possible for teaching pupils effectively; (2) Becoming aware of a new approach: students create new personal visions of what mathematics learning and teaching should look like; (3) Exploring and testing alternative beliefs and practices during the mathematics methods course or in practice teaching, or verbalising new beliefs; (4) Reflective analyses of benefits: students become more convinced of new beliefs they adopt; (5) Views of mathematics and teaching practices change (Kaasila et al. 2006).

4 Narrative and rhetorical inquiry as research methods

Finnish teacher education is characterised by a research-oriented approach; for example, every teacher trainee writes a master's thesis. In the Faculty of Education at the University of Lapland the aim of the mathematics methods course is that students have a full mastery of the elementary school (grades 1–6) curriculum, e.g., the number concept and place value system, operations, geometry, and measurements. In the course, students try out different teaching methods, e.g. problem-centred teaching, using manipulative models. Immediately after the methods course, students teach mathematics and two other subjects in the training school in a period of practice teaching known as Subject Didactics 2 (SD 2). The goal of SD 2 is to use different teaching methods – the emphasis is on problem-centred teaching – as well as to evaluate instruction and learning. Students give about 12 lessons, including three to five in mathematics. During SD 2, they receive guidance from me, a university lecturer specialised in mathematics education, and from a supervising teacher at the training school.

For this article, I partly reanalysed some data from my dissertation (Kaasila 2000), which included 60 elementary school student teachers at the University of Lapland in their second year of studies in Autumn 1997 and in Spring 1998. In the first lesson of the mathematics methods course, the students filled out a questionnaire in which they were asked to write about their memories from their time in school, to analyse a very teacher-centred lesson plan whose focus was multiplication by five, and to choose three of seven given features that best describe the character of mathematics. Based on the questionnaire (especially school time memories) and using my own discretion, I selected 14 students for more detailed observation during SD 2 in November and December of 1997. After my initial analysis of the cases, I selected six elementary student teachers with different backgrounds and constructed their mathematical biographies: two of them had mainly positive, two neutral, and two negative views of themselves as learners of mathematics at the beginning of the methods course. The research data included interviews conducted in two phases as well as teaching portfolios that were prepared based on the mathematics lessons in SD 2. Four student teachers' views of themselves as teachers of mathematics and views of teaching mathematics became more positive and multifaceted in SD 2 (Kaasila 2000).

I applied narrative and rhetorical inquiry as research methods. I will describe the use of narrative inquiry by presenting the mathematical biography of Sirpa, one of the six students included in my dissertation. She is selected as representative of a wider spectrum of changes manifested among student teachers. Sirpa had studied the advanced mathematics

course in upper secondary school and had performed well in it. Additionally, this is a follow-up study: I observed and interviewed Sirpa a second time during her final teaching practice over two years later in Spring 2000. (These data were not included in my dissertation.) My research data also contain the written summaries of the class lecturer who guided Sirpa during her final teaching practice and my observation notes on her three lessons. A summary of the data sources is presented in Table 1.

I used two complementary approaches in choosing the episodes comprising Sirpa's mathematical biography: emplotment and linguistic features. Emplotment 'relates events to one another by configuring them as contributors to the advancement of a plot' (Polkinghorne 1995). "By means of the plot, goals, causes and chance are brought together within temporal unity of a whole and complete action" (Ricoeur 1983, ix). In emplotting Sirpa's narrative I applied some ideas described by Polkinghorne (1995): I began by specifying the outcomes in Sirpa's story. The first was a positive view of herself as a learner of mathematics at the beginning of the mathematics methods course. I then asked with reference to my data: "Why did Sirpa have a positive view?" Here I was searching for clues – key events and important role models in her years at school – that seemed to have had a positive influence on Sirpa's view of herself as a learner of mathematics. The second outcome was a change in her view of teaching and learning mathematics after SD 2. I asked: "How did this change happen?" and began seeking clues which seemed to explain the change. For my dissertation, Sirpa read her mathematical biography and wrote that it fitted in very well with her story.

When searching for turning points and key episodes in Sirpa's story, I used linguistic features in the data collected on her. Tannen (1979) noted that core (or key) episodes are often characteristic of 'evidence of expectations.' In many situations a person's expectations are not realised. Tannen investigated how expectations based on past experience influence the way in which the narrator constructs his or her story. She identified different types of evidence of expectations, e.g., repetition and backtracking, hedges and other qualifying expressions, negatives, contrastive connectives ("but," "on the contrary"), which indicate a turn or a change, evaluative language (e.g. adjectives, adverbs), moral judgment, and addition. Tannen claims that expectations filter and shape perception and determine how events will be verbalised. Evidence of expectations was clearly manifested when Sirpa evaluated her second mathematics lesson in SD 2: she noticed that many things did not happen as she had expected. When I was looking for other core episodes in Sirpa's data, especially useful were excerpts in which Sirpa used evaluative language, repetition or detailed description. My description below will "zoom in" on these episodes.

Table 1 Summary of data sources (*N*=number of students)

Data source	N	Date
Questionnaire	60	September 1997
Interview	14	September 1997
Observation notes (SD 2)	14	December 1997
Teaching portfolios (SD 2)	14	February 1998
Interview	14	March 1998
Observation notes (Final practice)	5	March 2000
Interview	5	April 2000

Komulainen (1998) has studied educational life stories by Finnish women. She criticises the approach used by Polkinghorne (1988) for failing to elucidate the explanatory elements of the biography that try to defend and legitimise the choices made by the narrator. Komulainen (1998) has used the concept of key rhetoric instead of plot to emphasise the ways in which narrators actively evaluate time while constructing a sense of themselves as protagonists (see also Hyvärinen 1997). Here, I apply the idea of key rhetoric – in addition to rather than instead of – using plot. In constructing Sirpa's mathematical biography I was also interested in the rhetorical construction of mathematical identity articulated in the autobiographies (cf. Komulainen 2000; Bakhtin 1981). Key rhetoric is a coherence system through which different life events are connected and their relation is explained by dividing the narrated world into different dimensions of reality (Komulainen 2000). Like Linde (1993), I take the view that people's lives are incoherent but that they retrospectively try to construct their autobiographies in a more coherent way. Usually the narrator tries to explain to the listener things that feel exceptional: explanations are one way to create coherence in the story.

I also analysed the structuring of Sirpa's talk and narration in terms of interpretative repertoires (or discourses). Interpretative repertoires are systematically related sets of terms that are often used with stylistic and grammatical coherence (Potter 1996). I also compared vocabulary before and after a turning point: the differences between vocabulary signaled a change.

Applying the ideas presented in Komulainen (2000), I began my analysis by examining repeated vocabulary in Sirpa's data. For example, the vocabulary she used created different kinds of polarities between the past and present, especially between teacher-centred and pupil-centred beliefs. A self-development narrative was also strongly present in her story. In the next phase of analysis, I was interested in how narratives and explanations are related to the informant's key rhetoric: Sirpa told her story in order to justify her key rhetoric.

5 Sirpa: an ambitious and determined self-developer

> Motto: "A teacher's life is never-ending learning. I don't think that I will ever be complete as a teacher."

Memories from school time Sirpa had mainly positive memories of mathematics teaching during her years at school. She had succeeded well in elementary (grades 1–6) and secondary (grades 7–9) school but had her most positive experiences in upper secondary school (grades 10–12):

> Our class was small; it consisted of seven pupils who had chosen advanced studies in mathematics...All of us had very good motivation. Our group was good: the boys badly wanted to help me and the other girl in the class.

In the above excerpt, Sirpa describes in a very idyllic way (as in a paradise) the advantages of a small teaching group: everyone was interested in mathematics and the students collaborated instead of competing. Sirpa felt that she benefited from being female.

In describing the characteristics of a good mathematics teacher, Sirpa used her upper secondary teacher as a positive role model: "A good mathematics teacher tries to plan

varying lessons and make mathematics a challenging topic. He also has time for everyone, and he is demanding enough." This excerpt includes a great deal of evaluative language and moral judgment.

Positive experiences of mathematics were also reflected in Sirpa's view of herself as a learner of mathematics: "If you see that you can do it, then you think, 'This is very nice.'" Like her own teacher, she emphasised that it is a challenge to solve problems: "I liked to think about them, and it was really nice when I discovered the solution." The joy given by AHA! experiences was important for her.

In the questionnaire administered at the beginning of the mathematics methods course, students were asked to analyse a lesson plan where the teacher draws a table for multiplication by five on the board and pupils read it aloud. Then the pupils do exercises on the topic. Sirpa wrote: "At first, the teacher shows a model of how you can make the multiplication table. Then the teacher and pupils discuss together what the idea of multiplication by five is. In the end, the pupils try to construct the multiplication table by themselves, so the last phase is pupil-centred." It seems that, because of her recollections of her own years at school, Sirpa accepted the main idea of the lesson plan.

Second-year teaching practice In SD 2, Sirpa taught division in the second grade. In the first lesson, she mainly went through the content that had been taught the previous year. Sirpa's self-evaluation shows that she could not yet analyse the phases of her lesson from the pupils' perspective: "You must think beforehand of how to give instructions to the pupils and control your tone. Think how long every phase of the lesson lasts." Her focus was clearly on her own actions. This talk, like her analysis of the lesson plan presented in the previous paragraph, belongs to a teacher-centred interpretative repertoire.

Sirpa's second lesson also reflected the same interpretative repertoire. However, her comments contained clear evidence of expectations:

> My second lesson, the topic of which was the measurement of length, could have been good if I had given the pupils more opportunities to measure objects by themselves. Now I showed them different kinds of measures, and they thought about what they could measure with them. I should have let them explore the measures independently and to look for things to apply them to. The pupils answered when I asked them, but not nearly in as intensive a way as they could have.

This self-evaluation emphasises a criticism of teacher-centred teaching: many linguistic features, especially the sentences beginning with the word "if" and "but" and the use of a negative sentence and conditional, show that Sirpa's beliefs are changing: she realised that it is useful to analyse the lesson from the pupils' perspective. At the same time, she presented very concrete suggestions for what could be done differently. This talk already has evidence of a pupil-centred interpretative repertoire.

Sirpa wrote that her third lesson was the best one: "I made six different posts for the pupils and everyone visited them in turn in groups of three. At every post, the pupils at first estimated the volume of an object and then measured the object. At the end of the lesson, they thought about why the result of the estimation and the result of the measurement possibly differed from each other."

Sirpa gave the reasons for her self-evaluation in a clear manner: "My third lesson was absolutely my best one since I achieved my goals and the lesson was pupil-centred...In the end, pupils made self-evaluations and it certainly also influenced their internalisation of the content." She also realised the character of the process of change: "During teaching

practice, I got the idea of how effective this kind of concrete learning with manipulative models is, and how important it is to teach the pupils to learn...My lessons got better the whole time towards the end, the more I gave my pupils opportunities to experiment rather than just stubbornly speak in front of them while they listened." In this excerpt, Sirpa uses many evaluative expressions when criticising her two first lessons. A pupil-centred repertoire (ethos) was also clearly manifested in her teaching practices.

The following concrete advice given by the class lecturer played an important role in the change that took place in Sirpa's beliefs and teaching practices: (1) "Every time you are doing something, think about what the pupils are doing"; in other words, take the role of the pupils when you are making a lesson plan. (2) "Let the pupils set learning challenges for themselves." Sirpa seemed to internalise this advice very well. Sirpa's view of mathematics also changed. During the first interview, her beliefs about the nature of mathematics were partly dynamic (mathematics is] a "human invention" and "one language among others"), and partly traditional ("remembering facts and rules"). After SD 2, Sirpa crystallised her view of mathematics as an utterance of the 'science of understanding.' This expression describes well the process nature of mathematics. This talk reflects the "understanding is important" repertoire.

The guidance given by the supervising class lecturer was crucial to the process of change. The social norms of the class also played a key role in that pupils were accustomed to using manipulative models, reflective thinking and problem-centred learning in mathematics lessons.

Final teaching practice In her final practice a little over 2 years later, Sirpa reviewed the concept of fractions in the fifth grade and taught the expansion of fractions as well as their connection to decimals as new content. She deepened the principles and activities she adopted in her second year of practice:

> Overall, I feel good; the pupils came up with nearly all the content themselves. It really wasn't necessary to tell them 'now we are converting fractions and must do it in this way.' Instead, I gave them problems and the pupils told how they solved them...If you see that it works, it is easy to follow through with it.

The supervising class lecturer wrote the following summary of Sirpa's mathematics lessons:

> Positive things: the lessons were versatile; the pupils had much to do, making calculations and drawing. The phases of the lessons were good. The lessons were pupil-centred. Manipulative models were used very much. The teaching was carefully planned and relaxed. She encouraged the pupils to think for themselves. An area to perfect: In some lessons, the question technique was not very good. Sirpa must learn that not all pupils learn immediately; it takes time.

I agree with the class lecturer's observations but would add to them the importance of problem-centredness, which Sirpa used with versatility.

In her self-evaluation, Sirpa further emphasised many constructivist-oriented principles. She also considered it important to strengthen pupils' self-confidence. She summarised her experiences as follows: "I had the great opportunity of making my lesson plans independently. I made some mistakes, but I learned through them." Here Sirpa emphasises the importance of autonomy in planning lessons, which had clearly developed compared with the lessons during SD 2. This discussion of autonomy is also a part of the rhetoric of self-development (or lifelong learning).

During her fourth year of studies, Sirpa completed 15 credits of specialised studies in mathematics and acted as a substitute mathematics teacher in secondary school. Accordingly, she considers mathematics teaching one of her stronger areas:

> It [mathematics] is the subject I know best, or another reason might be that it is so interesting for me to teach mathematics...Nowadays, I don't need to plan lessons in such a detailed way as earlier.

Sirpa's attitude towards the pupils is captured in her use of the utterance of pedagogical love: "I want to be a teacher who really cares how she acts. Pedagogical love – the word feels suitably descriptive. It includes caring for oneself as a teacher and as a human being." The central factors that deepened the change were her cooperating with other teacher trainees of the class and emphasising pupil-centricity also in her teaching of Finnish and English.

Emplotment Sirpa related mainly positive memories of mathematics during her years at school. She emphasised the creation of a positive and challenging atmosphere in her class and the meaning of cooperation between the pupils in her idyllic core episodes of upper secondary school. Positive experiences from her school years and a positive role model (her teacher in upper secondary school) were clearly reflected in her view of herself as a learner of mathematics: it was positive in the beginning of the mathematics methods course in teacher education. Sirpa's position with regard to mathematics was that of an insider. Yet, because of her recollections of her own years at school, her view of mathematics was partially traditional (remembering facts and rules) and she had mainly teacher-centred beliefs of teaching mathematics: she accepted the main idea of the lesson plan presented in the questionnaire (see Table 2).

Table 2 Development of Sirpa's mathematical identity

Memories from advanced math courses in upper secondary school	Idyllic, co-operation challenging atmosphere
View of oneself as a learner of mathematics	Very positive; Insider
View of upper secondary school teacher	Positive role model
View of mathematics (before 2nd year teaching practice)	Remembering facts and rules One language Human invention
View of mathematics teaching (before 2nd year teaching practice)	Mainly teacher-centred beliefs
View of mathematics teaching (during 2nd year teaching practice)	Change towards pupil-centred beliefs and teaching practices
Meaning of guiding community	Very central
View of mathematics (after 2nd year teaching practice)	"Science of understanding"
View of mathematics teaching (during 4th year teaching practice)	Pupil-centricity deepened
Importance of guiding community	Already partly in the background
Teaching mathematics and other subjects	Pupil-centred beliefs and teaching practices
Mathematical proficiency	Deepened
Attitude to past mathematical identity	Dialogue Self-examination
Autonomy of planning	Very far
Main repertoires of speech (after 4th year teaching practice)	"Pedagogical love" Lifelong learning

Sirpa's views of mathematics teaching changed in a constructivist direction during SD 2 (see Table 2). Initially, she conducted teacher-centred lessons. The turning point can be seen in her self-evaluation of the second lesson, and the third lesson indicated that there was a significant change from teacher-centred thinking and activities towards pupil-centredness and the use of manipulative models. In her process of change, the guiding community (especially the advice of the class lecturer) was very important. She internalised the advice given by the lecturer: 'when you are making lesson plan, take the role of pupils.' After SD 2 Sirpa's view of mathematics ('a science of understanding') had changed in a more dynamic direction. SD 2 also showed that Sirpa was an ambitious self-developer.

These principles deepened further during the final teaching practice. The biggest change after SD 2 occurred in the autonomy of planning mathematics lessons. Additionally, Sirpa's mathematical proficiency and pedagogical thinking in mathematics had developed: "Of course they have changed after SD 2, because I had begun 15 credits of studies in mathematics, where I'd learned much more about what mathematics is, and how to teach mathematics." At the end of teacher education, the main repertoires in Sirpa's speech were "pedagogical love" and "lifelong learning." The first of the two has much in common with the ethics of care presented by Noddings (1995).

Key rhetoric Key rhetoric refers to the strategy by which a person constructs continuity and coherence in his or her autobiography (Komulainen 2000). I identified three kinds of key rhetoric in Sirpa's mathematical autobiography: (1) the tension between a satisfactory and unsatisfactory mathematical identity, (2) the dialogue between her past (bad) and present (better) mathematical identity and (3) invoking educational literature.

(1) The narrative of tension can be captured in her Motto: "A teacher's life consists of everlasting learning. I don't think that I will ever be finished with my training as a teacher..." Later she told: "I see many challenges in my future job as a teacher and hope I will continue as a learner, too. I don't think anybody will ever be ready as a teacher." We can also call this kind of talk a self-development or a self-improvement narrative. The principles of self-development and lifelong learning appeared at many points in Sirpa's talk: you must learn by reflecting on your experiences. The roots of self-development and lifelong learning rhetoric are in Western culture and they are strongly emphasised in teacher education. To cite Komulainen (1998), self-improvement narratives describe a tension that either divides the protagonist against herself or brings her into conflict with other people. In these stories, identity is viewed as though it were a separate object. In Sirpa's mathematical biography, her mathematical identity is open-ended, never completed. Sirpa criticises the unsatisfactory half of her mathematical identity.

On the other hand, because Sirpa had few negative experiences, she very seldom had a need to use explanations. She said directly that she made mistakes but that they are not dangerous; more importantly, one must learn through mistakes. She had no need to protect her mathematical identity through explanations. If a student has a negative mathematical identity, ego-defensive talk is often reflected in his or her narration (Kaasila et al. 2005).

(2) In light of Komulainen's (1998, 2000) theoretical formulation, I would conclude that in Sirpa's narration there was a hierarchical distinction between her past and present mathematical identity. In SD 2 she entered into a dialogue with her past mathematical identity and after her third lesson she criticised her earlier beliefs and teaching practices as too teacher-centred. The way she distances herself from her earlier

mathematical identity is one form of her key rhetoric that she uses for effect: a past identity serves as a baseline against which the present mathematical identity is seen as a progressively advancing. In her final practice Sirpa's construction of her present mathematical identity also contains a notion of autonomy, an ability to act without subordination to teacher educators.

(3) Sirpa also drew on academic conceptualisations to provide a framework that added coherence to her mathematical biography: she used the research literature on educational science (cf. Elbaz-Luwisch 2002). Invoking educational literature was an effective rhetorical device to justify her opinions. Moreover, connecting theory and reflective practice seems to be useful in developing a reflective disposition. Personal theories highlight how a narrative and reflective orientation to teacher education can enhance the process of learning to teach mathematics by acknowledging the affective factors involved in developing an autonomous mathematical identity (Smith 2003).

6 Discussion and conclusions

The focus of this article was to consider the use of *narrative and rhetorical inquiry* as research methods in mathematics education. These approaches can be seen as making three methodological contributions. First, although the use of emplotment shares some features with an ordinary case study, case studies typically do not include retrospective explanation, which is an important goal in constructing a mathematical biography. Indeed, emplotment provides a useful explanation why Sirpa's mathematical identity changed during her elementary teacher education. Second, when reading Sirpa's data it was useful to analyse linguistic features she used. Some features helped identify turning points and key episodes in her story. Third, because Sirpa adapted her story to her audience – me and the readers of this article – it is reasonable to consider the key rhetoric she used. The key rhetoric was also a useful way to crystallise Sirpa's style of narration.

Sirpa reflected on her experiences in a proficient way during every interview and in her teaching portfolio as well. The emplotment of her mathematical biography was not a very difficult task. She gave a coherent picture of herself. In Sirpa's mathematical biography, there seemed to be a single basic plot: the importance of her mathematics teacher and the positive experiences from upper secondary school were clearly reflected in a positive mathematical identity. A turning point in Sirpa's view of mathematics teaching appeared in SD 2: Changing her perspective and taking the role of a (weaker) pupil was a strategy that helped her overcome the imbalance between her past – teacher-centred – and present – pupil- and problem-centred – views of teaching mathematics. We know that a change in beliefs does not necessarily mean a change in teaching practices (Vacc and Bright 1999) but many documents (the lesson plans, the observation notes of the supervising class lecturer and myself) support the conclusion that a change also occurred in Sirpa's teaching practices.

Like Barthes (1988), I take the view that the accounts in Sirpa's mathematical biography are not direct copies of her experiences but, rather, are relevant to her experiences in one way or another. Teacher trainees know very well that teacher education entails expectations of change. Hence it is important to analyse rhetoric in trainees' talk. Therefore, I applied the idea of key rhetoric in addition to using plot. Different kinds of key rhetoric revealed how Sirpa constructed coherence in her mathematical biography. In my view, emplotment and key rhetoric used in parallel complement each other; they are not mutually exclusive approaches.

The model of teacher change used here, in which I applied and combined some central elements of the models of Smith et al. (2005) and Senger (1999), seems to describe well the phases through which Sirpa's mathematical identity has developed. Yet, it may be difficult to pinpoint the factor that has been most significant in her process of change. Both of the classes in which Sirpa was practice teaching were important communities of practice for her. Discourse communities are important in the process of change. In this study, the discourse community (guiding community) consisted of the supervising class lecturer, myself as the researcher, and the teacher trainees teaching in the same class. Like Putnam and Borko (2000), I see discourse communities as providing the cognitive tools – ideas, theories and concepts – that trainees appropriate as their own through their personal efforts to make sense of experiences. Later it could be interesting to study how permanent the change was that occurred in Sirpa's mathematical biography.

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