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MATHEMATICAL IDENTITY FOR A SUSTAINABLE FUTURE: 
AN INTERPRETATIVE PHENOMENOLOGICAL ANALYSIS

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Abstract

Individual in-depth, semi-structured interviews with three mathematics teachers were conducted to investigate the dynamics of their life-long relationships with mathematics, synthesised as a mathematical identity from different identity positions in the context of dialogical self. The qualitative data was scrutinized employing Interpretive Phenomenological Analysis that displayed mostly positive instrumental relationships with mathematics and explicit connections between the teachers’ life experiences and their distinct identity voices that surfaced in interviews. Similarly, teachers appeared to be experts in different professional spheres: pedagogy, subject or didactics. The teachers’ accounts contain various models of relationships between their other-motive and self-motive as reflected in their pedagogical approaches. Emergent patterns resulting from the interaction of the teachers’ mathematical identity and their perception of students’ mathematical philia/phobia included the humanistic approach with an instrumental interpretation of mathematics and its teaching methods, self-actualization in achieving success in mathematics through hard work, and the issue of attribution of failure in mathematics either to external or internal factors. Moreover, these dialogical models and interactive patterns show alignment with one of the core competences for educators in Education for Sustainable Development, that is, achieving transformation in what it means to be an educator, in teaching and learning, as well as in the entire education system. Practical implementation of findings and limitations of the study are outlined along with venues for future research.

Key words: mathematical identity, mathematics teachers, dialogical self, competences for educators in ESD, Interpretative Phenomenological Analysis, social constructionism.

Introduction

In order to reach sustainability in education in a broad sense, we have to seek untraditional and creative solutions, such as interdisciplinary approaches and innovative ways of dealing with routine problems. One of the possibilities in this regard is to look at educational discourse through the lens of an individual’s identity as it gradually shapes synergetic relationships with the surrounding world in general and with specific areas of knowledge in a particular sense.
The recent message of bringing sustainable future through education (Fien, 2003; Newman & Robbins, 2011; UNECE, 2011), changing educational system in general, transforming pedagogy, didactics or specifics of any subject, frames the global and local context of presented study. So far, mostly the specifics of subject content and teaching methods have been empirically studied in relation to different aspects of Education for Sustainable Development (ESD) (Jonâne, 2008; Illeris, 2012; Gerretson, Howes, Campbell, & Thompson, 2008; Renert, 2011; Sánchez, 2011). However, according to Reunamo’s four-fold model for ESD research (Reunamo & Pipere, 2011), the focus on the subject’s content aligns solely with an assimilative orientation of the model, using mostly theoretical and quantitative points of view, while an accomodative stance to understand the motifs and discourse of sustainable development as a meta-content or meta-message (Sund & Wickman, 2011; Salóte, Gedžûne, & Gedžûne, 2009) could be found in qualitative research of individual participants’ interactive processes (Reunamo & Pipere, 2011).

Unfortunately, there are different avenues through which education often fosters unsustainable living. One of the most challenging issues in this regard is the competences of educators at all levels of education on how to implement ESD (UNECE, 2011). The UNECE Steering committee on ESD recently proposed guidelines for all educators in order to set the framework for their professional development since educators can become the main agents for change if they feel able and supported in their endeavour. In short, the UNECE guidelines “Learning for the Future” contain the following core competences in ESD for educators: 1) A holistic approach seeks interrelation between integrative thinking, inclusivity and dealing with complexities. Within this approach, an educator comprehends the inclusive nature of education, the complexity of our life and its issues, as well as the interrelation and interdependence of all existing; 2) while learning from the past, engaging with the present and exploring alternative futures, educators need to envision change that can be reached by critically assessing different processes and inspiring hope for their learners; and 3) they need to participate in achieving transformation in what it means to be educator, in teaching and learning and in the entire education system. Teachers need to become critically reflective practitioners who challenge unsustainable practices at all levels of system (UNECE, 2011). Since these competences were mandated quite recently, our study would be among the first to use them in empirical exploration of school teachers’ experience (see also Sims, & Falkenberg, 2013; Van Poeck, & Vandenabeele, 2013).

The sustainable identity of teachers could serve as a powerful tool for sustainable learning of their students. The teachers’ identity molds their students’ learning achievements and, ultimately, their own identity and path of life. Though the connection between the teachers’ identity and ESD is a rather new departure in a field currently undergoing major revisions (Newman & Robbins, 2011), it is urgent to observe these connections in a context of a socially and individually challenging discipline such as mathematics. The rational application of wisdom coming from science and mathematics might help us in designing sustainable future if these disciplines are able to provide means to deal with specific environmental (or even social) issues endangering the future of our planet. At the same time, a global trend of the new millenium shows a sharp decrease in the number of students accessing mathematics undergraduate courses or entering professions connected with mathematics and natural science (Di Martino & Zan, 2010). Thus, we need to find a way to make these areas of learning more in line
with the capacities and needs of society, meanwhile fostering the social, cultural, and psychological changes in educational processes aligning with the principles of sustainability.

In this article, among other things, we attempt to show if and how the teachers’ individual life experiences translated in terms of mathematical identity and dialogical self, as well as if and how related patterns of personal pedagogical theories, in the context of mathematics teaching and learning, align with the competences for educators in ESD as mandated by UNECE. Initially, we will examine the notion of mathematical identity, then the dialogical self as an intersection of different identity voices will be analysed in detail. The studies regarding the students’ mathematical philia and phobia, in addition to teachers’ perception of it will be discussed. The idea about the teachers as reflective practitioners challenging unsustainability through the prism of their life and work will bridge the gap between the teachers personal reflections and focused change necessary for the sustainable practice. Furthermore, a qualitative approach to the study will be substantiated right before presentation of the aim and research questions. The traditional review associated with the research method will be followed by the results and a discussion containing illustrative descriptions and analyses of the three teachers’ cases. The paper will end with conclusions on the topic concluding with limitations of the study, practical implications and suggestions for further research.

Mathematical identity

Today, in a situation of increasing ontological insecurity, existential uncertainty (Kinnvall, 2004) and exponential growth of knowledge, it seems more and more obvious that learning is not so much about obtaining knowledge as about the developing healthy, productive, adaptable identity (Pipere, 2003). Following the recent trends in educational research observing the notion of identity as a powerful and promising analytic tool (Gee, 2001; Kaplan & Flum, 2012; Sfard & Prusak, 2005, etc.), studies in mathematics education show the interest in identity as a structure helping to understand the learners engagement with mathematics. Although the main focus of identity research in mathematics education has been the identity of students (e.g., Anderson, 2007; Browne, 2009; Darragh, 2013; Esmonde, 2009; Nyamekye, 2010), several studies have been aimed also at the mathematical identity of pre-service and in-service teachers (e.g., Brown, Jones, & Bibby, 2004; Kaasila, 2007; Kaasila, Hannula, Laine, & Pehkonen, 2005; Stinson, 2009) as it may be comprised among the agents of teachers’ successful professional performance and their students’ positive mathematical identity.

In this study, engaging the phenomenological foundation for the understanding of more rarely studied in-service teachers’ relationships with mathematics, we will draw on the definition of mathematical identity reaching beyond the mere practices of doing school mathematics (see Browne, 2009). In general, we will position mathematical identity as a construct that describes the relationship of a person with mathematics (Bikner-Ahsbahs, 2003). Taking a more detailed view and following Martin (2007), mathematics identity will be considered as the dispositions and beliefs regarding individuals’ ability to participate and perform effectively in mathematical contexts, as well as to use mathematics to change the conditions of their lives.

To explain the emergence and development of mathematical identity, we will use the standpoint of social constructionism, occasioned used in teacher education research
(Bainbridge & Macy, 2008; Dobozy, 2012; Hawley, Crowe, & Brooks, 2012). From this viewpoint, identity is formed in relationships with others, extending from the past and stretching into the future (Wenger, 1998). In this regard, relationships with mathematics for the majority of adults in the Western world usually start during early childhood and are closely connected with main autobiographical turning points (e.g., preschool, elementary school, secondary school, university, workplace, etc.). In the years of formal education, as well as in non-formal and informal ways, learners come to know themselves in relation to mathematics through relationships and experiences with their peers, teachers, family, and community (Anderson, 2007).

In terms of mathematics teachers, we may hypothesize the further development of their mathematical identity after the secondary school, in the university context while studying to become mathematics teachers and mainly in relationship to university teachers, peers, and community; then, during the novice years in a school context of interacting with mentors, colleagues, students, parents, school administration, etc. Later, as experienced professionals, mathematics teachers can become involved in professional development courses, research, textbook writing, projects, preparing students for mathematics competitions, communicating with professionals, and developing their own mathematical identity in a wide diversity of contexts. However, as all these relationships and interactions are in a continuous state of change, so the content of the socially constructed mathematical identity evolve.

Drawing on existent knowledge to grasp the content of mathematics teacher’s mathematical identity, we use the recent findings from Anderson (2007), Di Martino and Zan (2010), and Kaasila (2007). In line with Gee (2001) and Wenger (1998), Anderson (2007) describes four faces of mathematical identity; in the context of the present article, we adapt these faces to the “body” of the in-service teacher’s mathematical identity: 1) engagement refers to the direct experience of teacher’s engagement with the mathematics – her self-recognized and socially acknowledged level of competence in mathematics; 2) imagination relates to how mathematics fits into the teacher’s other activities in the present, as well as the future, and what is the deeper meaning of the mathematics in a broader life context; 3) alignment means that teacher aligns her energy within institutional boundaries and requirements. In the case of in-service teachers, this could mean that those who consider, for instance, the latest developments in didactical approaches direct their energy toward changes in their teaching; and 4) the nature face of identity considers the teacher’s biological inheritance (e.g., gender, race) that is beyond the teacher’s control.

On the other hand, Di Martino and Zan (2010) in their study of students’ relationships with mathematics highlight three themes: emotional disposition toward mathematics (positive or negative), vision of mathematics (relational or instrumental) and perceived competence in mathematics (high or low). In a similar vein, Kaasila (2007) discerns the pre-service mathematics teachers’ views of 1) themselves as learners and teachers of mathematics, 2) mathematics and its teaching and learning, and 3) the social context of learning and teaching mathematics.

Therefore, in integrating these suggestions, we can assume that the mathematics teacher’s mathematical identity as based on biological inheritance would include: 1) relationships with mathematics in the broader life context of its teaching and learning; 2) self-recognized and socially acknowledged competence as a mathematics’ learner and teacher; and 3) the social and institutional context of learning and teaching mathematics.
Mathematical identity for a sustainable future: An interpretative phenomenological approach

Since social constructionism emphasizes the usage of language as a tool for social interaction and construction of identity in describing the procedural and expressive nature of mathematics identity, we should conceive of it as a constantly developing narrative designating both a person’s self-understanding, as well as how others see the person in the context of doing mathematics. Mathematical identity results from the negotiation of our own assertions and the external evaluations of others (Martin, 2007); it is a context bound as people justify, explain and make sense of themselves in relation to mathematics and to other people acting in mathematical communities depending on the audience and social conventions of how language is used (Kaasila, 2007).

The temporal context of mathematical identity, moving from the past through the present to the future, indicates the suitability of autobiographical reflections in order to deconstruct the relationships and institutional contexts in relation to this identity of the teacher. These reflections can serve, in a practical sense, as an interpretative framework for professional actions explicated as “tacit knowledge,” where self-image and task perception have roots in early childhood relations, interactions with significant others throughout the teaching career, and critical periods of life (Swennen, Volman, & van Essen, 2008).

The teachers’ autobiography bound to mathematical identity involves personally meaningful episodes, important persons and institutions, rationalizations, and explanations, as well as the development of one’s beliefs of learning and teaching mathematics. Our task as the researchers is to elaborate how the person’s earlier experiences have influenced his or her past and present mathematical identity (Kaasila, 2007).

As the mathematical identity certainly is not the singular identity of a mathematics teacher, the dialogical character of a teacher’s identity voice is described further.

Dialogical self of the teacher: interaction of identity voices

Dialogism is conceived as an explicit attempt to rise above the intersection between identity and learning. Education can develop identity through specific learning mechanisms and this development can become an important goal for education. The approach of Dialogical Self Theory (DST) can be very useful for education as it focuses on the self as influenced by context and social interaction (Ligorio & Cesar, 2013). According to DST, the self is a polyphony of voices or different I-positions constantly stiving for change and for a balance between various tensions among them (Hermans & Dimaggio, 2004; Hermans & Hermans-Konopka, 2010). The DST is also applicable when shifting focus from student to teacher.

In their profession, teachers interact with different groups of people (e.g. students, parents, colleagues, administration, and researchers) within different contexts (e.g. school, society, further education) and sub-identities (e.g. teaching, counseling, research) (Vloet & Jacobs, 2013). At the same time, in terms of the content, a teacher’s professional identity can be related to core teaching aspects such as didactical and pedagogical expertise, as well as subject matter. A teacher as the subject expert has a profound knowledge base in his/her subject(s). As an expert in didactics, he/she knows how to teach specific subject-related content emphasizing creation of learning environments that support the pupil’s learning process; as the expert in pedagogy, a teacher understands
human thought, behaviour, and communication to support the child’s development as a human being (Beijaard, Verloop, & Vermunt, 2000).

The interactive, procesual and contentwise aspects of teacher professional identity mentioned above participate in a constant interplay with other sub-identities or possible teacher voices (e.g. gender identity, identity of learner, researcher, administrator, textbook author) unremittingly searching for the meaning of these interactions. According to Hermans (1991), while constructing meaning of self, the individual grounds the self on two basic motives: self-motive aims toward self-expression, self-development, and self-defence, while the other-motive strives toward unity with others and belonging to the larger entity. The experiences of these motives can elicit positive, negative or ambivalent feelings (Hermans, 1991). To reveal the basic motives would help to understand mathematics teachers’ personal philosophy of education and, specifically, their relationships with a concrete discipline.

In our study, the “self” of the mathematics teacher is reflected both within phenomenological tradition as an experienced and enlived reality and constructed as a narrative in a specific context and at a given time (Hermans & Hermans-Jansen, 1995). According to Vloet and Jacobs (2013), professional identity can be seen as a constructed set of stories told by the teacher in relation to others. We resort to the single yet interrelated aspect of mathematic teachers’ professional identity, that is, mathematical identity, as embedded in a specific scientific discipline and subject taught at school.

Teachers’ perception of students’ mathematical phobia and philia

In the context of the qualitative study, we ground the notion of mathematical phobia in a broader discourse, binding it not only to affect-oriented constructs like mathematical anxiety, as generally displayed through the physiological symptoms of negative emotions (e.g., fear) having to do mathematics (Ashcraft, 2002; Hembree, 1990) or of negative attitudes toward mathematics as conceiving its’ emotional, cognitive and conative aspects (Domino, 2009; Hannula, 2002; Zan & Di Martino, 2007; Zan et al., 2006; Di Martino & Zan, 2010), yet embracing all complexity of factors that causes failure dealing with mathematics in different contexts. In a similar way, the notion of mathematics philia will be connected with a wide array of factors fostering the successful mastering of mathematics not only in the classroom, but in all life situations.

The literature does not bring us thorough empirical evidence of the causes of mathematical phobia, though some studies find it rooted in early school experiences (Pan & Tang, 2004; Humphrey & Hourcade, 2009) or connected with teaching based on high demands and little support (Turner et al., 2002). Some studies dealing with mathematical phobia (Humphrey & Hourcade, 2009; Woolfolk, 2007) mainly advocate for change in teaching and learning: to reduce competition, clarify instructions, minimize time and other pressures, collaborate with a skilled partner, start with small achievements to generate initial success, etc.. Also, to invoke mathematical philia, passionate teachers with love toward the subject are needed (Rameau & Louime, 2007). Very few studies focus on the mathematical teachers’ perception of their students’ mathematics phobia and philia (Insook, 2009; Wilbert, 2008; Zan & Di Martino, 2007). In general, teachers attribute the causes of a negative attitude toward mathematics to students’ characteristics and behaviours, e.g., lack of interest and effort by students, thus hiding the teacher’s responsibility in creation of such an attitude. While Zan and Di Martino (2007) reveal
that teachers’ diagnosis of students’ “negative attitude” toward mathematics presumably is a final result of teachers’ interpretation of students’ issues, in our study we went further and directly asked teachers to explain their view on the causes of the students’ mathematical phobia and philia.

**Teachers as reflective practitioners: challenging unsustainability**

As it is mentioned in the introduction of this article, only to become critically reflective practitioners teachers will be able to challenge the unsustainable practices at all levels of the educational system, ranging from the identity development of the learner up to the inclusive societal contexts of economic, cultural and political evolution.

The term ‘reflective practice’ has multiple meanings that range from the idea of professionals engaging in solitary introspection to that of engaging in critical dialogue with others (Finlay, 2008). In this study we are looking at teachers as reflective practitioners in collaborative dialogue with the researcher. Moreover, according to Larrivee (2000), the examination of own teaching from the position of a reflective practitioner enriches teachers’ professional identity. The literature about reflective practice starts from Dewey (1933) and is followed by Schon’s (1983) seminal work where he emphasises the development of reflective practitioners and suggests two types of reflection: reflection-on-action and reflection-in-action. The presented study is linked with teachers’ reflection-on-action, namely, thinking after the event, where teachers consciously review, describe, analyse and evaluate their past practice with a view to gaining insight to improve future practice (Finlay, 2008). In some cases and in developing educational systems, the system itself is not conducive for such kind of reflection-on-action, limited by, for instance, lack of teachers’ autonomy, the absence of a culture of openness and questioning, time, financial and other resource constraints and others (Sangani & Stelma, 2012).

The plethora of literature points to the connection between the professional’s reflection and change in his/her practice. As Kemmis has already noticed in 1985, “reflection is action-oriented, social and political. Its ‘product’ is praxis (informed, committed action), the most eloquent and socially significant form of human action” (p. 139). The more detailed account on reflection perfectly matching the context of our study gives Johns (2000), comparing reflection with a window through which the practitioner can view and focus self within the context of her own lived experience in ways that enable her to confront, understand and work towards resolving the contradictions within her practice between what is desirable and actual practice. Through the conflict of contradiction, the commitment to realize desirable work and understanding why things are as they are, the practitioner is empowered to take more appropriate action in future situations.

In the context of the presented research it is important to stress that the teachers’ reflections during the research could lead to their personal and collective growth and therefore, to the change of unsustainable practices into more sustainable ones.

**Qualitative phenomenological approach to the study**

In the field of ESD and also in mathematics education, qualitative methods are used quite extensively since they display the tacit knowledge that is hard to obtain through
more objectivistic and quantitative projects (Buttigieg & Pace, 2013; Pipere, Reunamo, & Jones, 2010; Di Martino & Zan, 2010). Interpretative Phenomenological Analysis (IPA), currently widely used in the fields of health and psychology, is very new to education research, only a couple of studies are available on teacher education and professional development using IPA (Bleiler, 2012; Bainger, 2011; Bailey, 2011). The present study tries to search for the ways to bridge this gap using IPA in the field of mathematics teachers’ professional development, focusing on their mathematical identity and further consequences on professional practice in the context of ESD. IPA sees the participants as experts in knowing about and describing their own experiences (Reid, Flowers, & Larkin, 2005) and, in this way, helps to find out how individuals are perceiving the particular situations they are facing, as well as how they are making sense of their personal and social world (Smith & Osborn, 2008). Hence, the theory of IPA can be the ideal tool to use for study in the field of education.

The methodological distinction between this study and quantitative research in the field of ESD or qualitative research that focuses directly on the assessment of educational content or pedagogical methods for ESD should be noticed. In this respect our research draws on the phenomenological approach within a paradigm of critical constructivism (Kincheloe, 2005; Goodman, 2008) – a variety of social constructivism. Collaboration between the researcher and teacher (co-researcher) during the interview, fostering self-reflection on teachers’ personal and professional development, allows for the creative organization and navigation of process where interviewee independently arrives at constructing unique critical discourse on personal, institutional, community and societal level. For the researcher it only remains to evaluate how close these reflections are to the essential principles of sustainability and formalized requirements for ESD competences.

One of the strength of qualitative research, that is particularly beneficial for this study – indirect and unobtrusive inquiry in subjects’ views on research problem. Hence, deep phenomenological interviews that elicit lengthy (in comparison with other methods) and deep self-reflection scale up the scientific rigour of study in terms of credibility and confirmability (Lincoln & Guba, 1985). If an experienced professional is allowed for extensive and detailed reflection on his/her life and professional activities, reacting to the researchers’ incentives he/she anywise will come to the aims, meanings, values, content, competences, methods, impact of this work on interviewee, other people, his/her community, society, etc. In this way, such interviews can be used to provide the insight into the sustainability of teachers’ personal and professional activities in social and institutional context.

In summary, the aim of this study is to explore the dialogical models of mathematic teachers’ life-long relationships with mathematics toward uncovering interactive patterns emerging between the teachers’ mathematical identity and their perception of factors influencing the mathematical philia/phobia of their students in relation to ESD competences for educators. To elaborate, the analysis of qualitative data will help to understand: 1) What are the major features of interviewed mathematics teachers’ mathematical identity? 2) What kind of dialogical models emerge for making sense of mathematics teachers’ mathematical identity in a life-long perspective? 3) What interactive patterns can be observed between the mathematical identity of teachers and their perception of students’ mathematical philia/phobia? and 4) How these dialogical models and interactive patterns align with the ESD competences for educators?
Method

Sampling

A large number of participants is not necessary for IPA to obtain sensible data; consequently, three mathematics teachers, who are doctoral students doing research on mathematics education were recruited for individual in-depth, semi-structured interviews. The search for the relevant research participants lead to these persons with a unique configuration of identities in relation to mathematics teaching, learning and research. Several other studies using IPA have been published using three participants (see, for instance, Bainger, 2011; Bates, 2012).

Smith and Osborn (2008) advise that an IPA sample should consist of relatively similar (homogeneous) cases rather than extremely different examples. So, first of all, the selection of gender was determined by the domination of women in mathematics teaching in Latvia. An overview of real-life experiences of the participants show a similarity of main facets of personal history being students enrolled in a mathematics enrichment class at school, university students at mathematics teacher training programs, school teachers of mathematics, and doctoral students in Pedagogy. The aim of sampling was to recruit a purposive sample as opposed to a strictly representative sample. The results in this study represent the specific group of mathematics teachers and are not representative of all mathematics teachers in Latvia.

The first participant (pseudonym Ann) is a 45 years old woman with a university diploma in secondary school Mathematics/Physics teaching and a Master degree in Pedagogy. She has 10 years teaching experience at school and 3 years at the university level, as well as 8 years experience as a school principal. Ann has designed many in-service teacher training courses and is the co-author of textbooks on mathematics. The second participant (pseudonym Irene) is a 37 years old woman with a university diploma in teaching secondary school Mathematics, Physics and IT, as well as a Master degree in Mathematics, specifically Geometry. She has 17 years of teaching experience at school. The participant has been engaged in several EU projects and gained recognition as one of the best elementary school mathematics teachers in terms of achievements of her students at national Mathematics Olympiads. The third participant (pseudonym Elsa) is a 37 years old woman with the university diploma of elementary school Mathematics and IT, as well as a Master degree in Pedagogy. She has a lengthy teaching experience of 15 years.

Procedure and interview

The participation to interview was voluntary, anonymous, confidential, and based on written informed consent. A date, time and location for the interviews were arranged at the convenience of the participants. An interview schedule was prepared prior to the interview starting with a wider picture and then focusing on the detail (Howitt, 2010). Specific open-ended questions reflecting the research objectives were generated on the basis of a review of the relevant literature. The main areas of interview schedule were: A. Mathematics and its meaning for participant (general context); B. Doing mathematics: social, institutional and self-evaluation; C. Relationships with mathematics in different social roles, and D. Mathematics philia and phobia in educational context: concepts, causes, fostering and impeding factors (see Appendix for general interview schedule).
Throughout the interviews, a process of probing was adopted and interviewer often requested further details to obtain rich accounts. All interviews were recorded on an audio recorder with participants permission and transcribed verbatim by the first author. The questions were flexibly adapted to the direction and pace of interview for each participant.

The interviews were conducted by the first author of publication, a female academic researcher and teacher, in the university while delivering the doctoral programm (n=2) and in the school where one participant was working. The interviews lasted for between 67 and 90 minutes. The atmosphere during the interviews was open, friendly, and motivating.

Analysis

IPA intends to explore how the participants experience their world, and consequently, provides an insider’s perspective of the phenomenon under investigation. The rigorous analysis derives themes from the data itself, as opposed to categorising data on the basis of pre-determined categories or a priori assumptions (Dickson, Allan, & O’Carroll, 2008). The analysis process for each transcript was based upon a model from Smith, Flowers and Larkin (2010): 1) reading and re-reading of transcription, 2) initial noting based on free associations using descriptive, linguistic and conceptual comments, 3) developing emergent themes, and 4) searching for connections across emergent themes considering subordination, contextualization, numeration and function of themes.

The three transcripts consist of 32,363 words in total. Initially, the first interview transcript was analyzed by the two researchers (authors of this paper). During several readings, emergent comments on the semantic content and language were noted in the margins alongside the text. These notes were listed separately and searched for patterns, repetition or connections while creating a table of themes. The two researchers met to compare their findings and agreed upon a preliminary framework of themes and subthemes. It is a common practice within IPA for an indepth analysis of a subset of interviews to form the basis for analysis of the remaining transcripts (Adams et al., 2005). Therefore, both authors returned to the remaining transcripts and, guided by the preliminary framework, created the analysis of the two remaining interviews, including additional themes as required. The authors met a second time to coordinate and finalize the analysis of all three interviews looking for patterns across cases. Progress throughout was reviewed by both authors to ensure that there was an agreement between the thematic interpretations and their reflection in the teachers’ personal narratives.

Results and discussion

Although presentation of IPA results usually is based on emergent themes (Smith & Osborn, 2008), in order to provide systematic answers on the four research questions set, this further account will be structured in a more deductive way. The answers on each research question will be grounded on the emanated subthemes acknowledged as important by researchers and illustrated with exact quotes from the interviews’ transcripts (Howitt, 2010). It should be noted that during the process of inductive analysis, the researchers were not guided by any preconceived categories or theoretical structures.
Theoretical insights presented at the beginning of article were induced based on the results of IPA.

The mathematics teachers’ mathematical identity

Major features of mathematics teachers’ mathematical identity are displayed in line with a theoretically developed structure of mathematical identity: 1) relationships with mathematics, 2) competence and 3) social and institutional context.

Relationships with mathematics

Following the study by Di Martino and Zan (2010), relationships with mathematics teaching and learning are analyzed in a broader life context, highlighting their properties and emotional tone. For all interviewed teachers these relationships differed to some extent. In the case of Ann, we observed the positive instrumental relationships with mathematics using it as a lifebuoy in practical life situations that were in tune with her general positive social and emotional orientation during the interview. In the case of Irene, her love towards mathematics as a unique exclusive subject and positive relationships, as well as instrumental relationships, are apparent though not so much as helping in daily hassles as in developing the entire personality and, especially, cognitive processes:

"...yet mathematics is a queen and my great wish is to serve the queen not to the science just helping other sciences to process data or likewise. Mathematics is too beautiful to be just a supplementary aid, it is not enough to see it as conceived just for some practical purpose." (Irene)

As to Elsa, for her the instrumental relationships with mathematics are particularly strong, though, they serve more as a general coping strategy in life; her overall emotional attitude toward mathematics is ambivalent and changing.

These perspectives coincide with the conclusions from Kaasila and colleagues (2005) that different views of mathematics may be explained by the socially emotional orientation and coping strategies of research participants. Hence, the common theme for all three teachers was instrumental relationships with mathematics, although using it for different purposes: to solve professional and life situations, to develop cognitive skills and the entire personality or to aid as a psychological coping strategy. None of the teachers admitted to negative relationships with mathematics regardless of mentioned hardships while learning or teaching it.

Competence as mathematics’ learners and teachers

Many authors (e.g., Anderson, 2007; Gee, 2001; Wenger, 1998) stress the main role of self-recognized and socially acknowledged competence as mathematics’ learners and teachers in the construction of mathematics identity for teachers and students. Although, the interviewer did not ask direct questions about the teachers’ mathematical competence, an analysis of the transcripts reveal it at a very small detail yet showing significant variations in this area. Di Martino and Zan (2010) observe patterns in the essays of students that low perceived competence often correlated with an instrumental vision of mathematics. Similar patterns are noticed in the teachers’ interviews: those teachers
whose answers revealed comparatively lower perceived competence, focused their narratives on an instrumental vision of mathematics at a larger extent. The answers by Ann show the alternating level of perceived competence: a solid confidence at primary school, some hard moments with mathematics during secondary school and university complemented with attempts to justify these hardships mainly by external factors (e.g., overly theoretical studies at university). The high level of self-recognized and socially acknowledged competence was noticed in the narrative of Irene, dovetailing with her love for mathematics as an exclusive science. As for Elsa, it seems that her pattern somewhat matches with one from Ann, showing confidence at primary school and some problems at secondary school and university.

In primary school I had a teacher who was very clear with her instructions, I had only the highest marks, teacher told us (material) and probably because of my auditory memory I could literally repeat everything in an hour or three hours. Then the teacher changed and we let things slide….I let my knowledge slide....(Elsa)

In this specific case of a vacillating level of competence, one could recognize the constant efforts to find some person or institution responsible for causing strong emotions.

Social and institutional context of learning and teaching mathematics

The societal attitude toward mathematics was evaluated by interviewees as mostly negative since society views mathematics as a dry, unnecessary science disconnected from life. It seems that Irene’s competence in mathematics allows her to set higher expectations toward a career in mathematics that has yet to be fulfilled because of the unsustainable status of mathematics as a fundamental science in Latvia and a lack of economical benefits of a career in mathematics. She also emphasizes the unsustainability in education caused by a negative economical situation that leads to extensive migration:

Each year I see 2-3 pupils in every form to go abroad, those who intend to leave do not plan to go deep in mathematics, they think more about the languages...Nowadays to think about mathematics is pointless...we need to think about how to raise the children abandoned by their parents (going abroad) and the majority of them will leave (the country) already while at school or before or after the university. (Irene)

In terms of the influence of surrounding people, all teachers acknowledge a lack of restrictions from their parents in their professional choices. In the case of Ann and Elsa, strong emotional and material support from family while achieving an education is evident from time to time. In the stories from Ann and Irene, persons mentioned most often are teachers at school and university; but for Elsa it is her father who awakened her interest in mathematics during early childhood (see Swennen, Volman, & van Essen, 2008):

I remember, when I was a child we drove as a family around a lot (in car) and father all the time proposed me to do mental arithmetic, e.g., we are driving with 40 km per hour, how much we have to increase our speed as to be at aunt’s place or elsewhere in two hours? [… ] I always had to ground and explain him the invented result. (Elsa)
Teachers’ mathematical identity and other identity voices: dialogical models

To reveal what kind of dialogical models emerge for making sense of teachers’ mathematical identity in a life-long perspective, we turn to 1) dialogue between the identity voices of teachers, 2) interplay of subject, didactics and pedagogical identity (Beijaard et al., 2000), and 3) self-motive vs other-motive and psychological functions of elicited themes.

Dialogue between the identity voices

As the description of the sample shows, the participants had a lively bouquet of various sub-identities or identity voices. However, not all of them are reflected in the interviews, only the most salient voices surface and are elaborated in detail. For Ann, the most engaging dialogue is observable between her identities as pedagogue and mathematics teacher, where pedagogue identity took a dominating position:

…but really, I wanted to become a pedagogue, definitely. In what subject – this could be played out differently. (Ann)

In all her identities, except in the role of school principal where mathematical skills help to deal with practical problems and view them from the different angle, the emphasis is on non-mathematical aspects. To Ann, mastering of mathematics is determined by responsibility toward students, as well as a wish to feel secure and confident as a teacher.

Irene stressed her desire to study mathematics at university; the pedagogical subjects at the teacher training program were just add-on to the serious mathematical courses. Her main identity voices, intertwined in balanced dialogue, were voices of mathematics teacher and mathematician. In terms of Social Identity Theory (Turner, 1982), both Ann and Irene as mathematics teachers show the notable in-group favoritism of taking pride in their identification with mathematics teachers whom they perceive as an elite subgroup of teachers. Stronger in-group favoritism is observed in the case of Irene who cares both for the image and future of mathematics teachers and takes pride in the mathematics teachers of her town in times of insecurity and threat (Voci, 2006):

Speaking about the mathematics teachers’ level of knowledge, they are elite, they know very much, they have studied a lot – 2-3 times more than all other teachers, and now at schools they work 2-3 times more as other teachers because to prepare for the mathematics lesson is harder as to prepare for, let’s say, sports.

Because of a few ignorant teachers, all teachers have been scolded. For a long time I could not understand why mathematics teachers have been criticized (in Latvia), when attending teachers’ professional courses I suddenly realized that the mathematics’ teachers of our town and those coming from rural areas are two absolutely different worlds. And I do not know how to change it because nobody wants to work as a mathematics teacher in the country. (Irene)

As for Elsa, her sub-identities as teacher and doctoral student are entangled with deeply hidden voices of family member and woman. She acknowledges her extensive quest before arriving at her current identity: initial rejection of the teacher profession, changes in professional choices (i.e., psychology, forensic medicine, teacher of chemistry and
physics, teacher of IT) and experimenting with teaching elementary grades before realizing that her calling is for lower secondary school. Possibly, because of this quest, the identity of mathematics teacher is not so salient and pride-evoking for Elsa as it is for Ann and Irene.

**Interplay of subject, didactics or pedagogical identity**

The identity voice similarly important for all interviewees was their professional identity pertaining to core teaching aspects such as subject matter, didactics and pedagogical expertise (Beijaard et al., 2000). For Ann, the prevalence of pedagogical and didactics expertise depicts the dominating position of her identity of teacher:

> however that may be with mathematics, but we need to see that we teach a person, and the teacher needs to be so intuitively wise as not to miss the moment when mathematics becomes unattainable for the person. The person can master some basic knowledge in this field but you should not tear him/her down to reach more, maybe he/she will be able to deal with it somehow differently. And, maybe this way we would make his/her life cooler. (Ann)

In the case of Irene, the internal dialogue between the mathematician and teacher of mathematics leads toward the expertise in subject matter as a core aspect of her teaching, especially evident in her successful preparation of pupils for the mathematical olimpiads. For Elsa, her emerging teacher identity in professional terms was mostly grounded on her ideas on changing teaching methods, thus designating her expertise in didactics.

**Self-motive vs other-motive and psychological functions of themes**

This facet of dialogical models is the most individualized one, showing the psychological commonalities and differences of participants. Some linguistic features discovered in the narratives will also be compared to drop a hint on the personality of each teacher.

Prevalence of other-motive over self-motive eliciting mostly positive feelings is observed in Ann’s answers. The themes elicited from her answers function as a self-defense for some failures with mathematics at school and university, boosting self-esteem of teacher as well as showing a high level of responsibility and hiding insecurity in front of students while expressing the empathy toward the learner, probably caused by the ability to put herself in their situation. The terms and expressions she used more often are saturated with compliance and immersion (i.e., “a little bit”, “sniff it out”, “to work it through”, “to dig it out”). As to the use of pronouns, the usage of “we” dominates over the usage of “you”, while “I” is applied more seldom than in the answers from other teachers, also stressing the other-motive.

In the case of Irene, her self-motive exposed in her strive for constant self-development is well balanced with other-motive (e.g., identification with mathematics teachers, care for the future life of children): however, if self-motive elicited mostly positive feelings, other-motive produced the ambivalent affection that is well discernible in the psychological functions of her themes. In these themes, in the same manner as Ann, Irene boosts her self-esteem by reflecting on past achievements, but her disappointed mood is revealed in her disillusionment about educational system and economical benefits of the chosen discipline, as well as in her critique of conservative teachers and administration avoiding the self-development and intolerance toward lazy pupils and
students. The term used more often was “tricky”, while the usage of pronoun “I” dominated over the usage of “we”.

In its turn, Elsa’s self-motive dominates over her other-motive and both motives arouse ambivalent feelings. The themes noticed in her reflections, even more as for Ann, serve as self-defense for her failure with mathematics at school and university, though sticking to external attribution. Similarly, as in the cases of Ann and Irene, helped her boost her self-esteem; only in her case, it is with the help of external factors. Elsa’s other-motive is significantly dominated by the critique of her own teachers, both the educational system in general and specific aspects of it. However, positive relationships with father, taking pride in a “top level” commission at graduation examination, “showing off” with her mathematical skills in front of the handsome boys at school, and helping a lawyer to solve a simple mathematical problem disclosed the masculine and power-related discourse of her identity construction process. Such terms as “awful/awfully” and “dear”, when addressing somebody, were used quite often and, similarly as with Irene, usage of “I” dominated over the usage of “we” and “you”.

The relationships between the self-motive and other-motive can be included in a list of features to illustrate a person’s orientation towards sustainability, and it seems that a permanent domination of self-motive would lead to unsustainable relationships with the surrounding world and specific areas of knowledge. According to Linde (1993), defending one’s self through explanations is an important part of any type of autobiography. Kaasila with colleagues (2005) found that the largest number of explanations in stories of pre-service teachers regress to negative views of mathematics. Although, none of the interviewed teachers expressed a negative view of mathematics as in the study by Kaasila and colleagues (2005), we encountered a lot of explanations as well as critical views.

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**Teachers’ mathematical identity and their perception of students’ mathematical philia/phobia: looking for interactive patterns**

The nontraditional aspect of the analysis was the cross-checking for the coherence or collisions between the teachers’ mathematical identity and the way they see mathematical philia and phobia in their students. For each teacher we will define her pedagogical “slogan”, main approaches to deal with the mentioned issue, possible causes for these approaches found in her past experience, and direction of her critique.

The pedagogical “slogan” of Ann sounds like this: “Key value – person, not mathematics”. She sticks to the humanistic approach (freedom, avoiding pressure, respect for diversity, humane attitude, dignity, responsibility for the students’ path of life, pedagogical optimism, cautious teaching methods) and instrumental interpretation of mathematics and its teaching methods (practical applicability in life, career, gradualness/spiral approach) not to the excellence in mathematics at any cost. Ann feels great satisfaction from pedagogical work and been accepted as she is:

_In the morning I go to the class in total turmoil and conflicts inside and then, in a moment I see the children, all these conflicts fade away and in three minutes I do no recall any of things that bothered me, I have this specific situation, all these specific people who need me exactly as I am and everything happens. (Ann)_
She votes for stability, consistency in teaching and suggests that putting larger efforts can gradually build the learners’ motivation.

The roots of this approach can be traced back to the very friendly classmates at school, sincere and understanding teachers at school and university, as well as the fact that she was not forced to choose teaching mathematics as her career or to master mathematics at high level. This approach coincides with her positive instrumental relationships with mathematics and general positive socially emotional orientation. Since Ann encountered some trouble with mathematics at school and university, it is more natural for her to feel empathy toward all learners having some problems with mathematics. With a dominating identity of teacher having strong didactical and pedagogical expertise she stresses not so much the subject as the development and life quality of the learner. At the same time she suggests the gradualness and putting some efforts in dealing with mathematical tasks as she admits her own fighting spirit and perseverance dealing with hardships. Ann is strongly convinced about the mathematics as a subject securing the future life of learner and takes pride in her ability to use mathematics in different identity positions (working as principal, teacher at school, university, writing textbooks, etc.). Her answers do not contain the critique of pupils, while the required performance of teachers is described at length.

Irene’s pedagogical message can be summarized as a self-actualization achieving success through hard work. She puts an emphasis on continuous self-development of educator, individual psychological peculiarities of students and the roles of surrounding persons, as well as on routine work and perseverance. Although she admits that a main goal of education is to find oneself, not necessarily to master mathematics, her own success has been connected with her love toward mathematics, overcoming the difficulties and reaching the high competence in it. She recognizes the gradual change in her point of view toward pupils having problems with mathematics, evolving from incomprehension during schooling to acceptance as an experienced teacher. Irene sees the causes of mathematical phobia, both in internal factors (e.g., learning difficulties in mathematics, laziness, lack of regular practice, a wish for immediate results) and in external factors of motivation (e.g., learning for exams or for parents, parents’ hindrance of children’s self-esteem in mathematics). To ensure philia of mathematics, Irene suggests perceiving mathematics as a friend in daily life or even as a hobby. Regarding teachers’ performance, she indicates that clear instructions and a positive attitude toward children, as well as the need to model the love for the subject in front of learners (see Rameau & Louime, 2007).

Her expertise as a subject matter teacher is high on the horizon of teacher professional identity. The life story of Irene is interspersed with moments of challenge and the thrill of overcoming the difficulties in mathematics creating a certain addiction to success:

If you succeed with mathematics, your psychology changes. You want to reach the same outcome again, then even bigger one, then you understand that you change. Probably, mathematics changes entire person, his/her way of thinking, process of thinking. First time succeeding in olympiad or some difficult test you think that you are special as not everybody can do this and this self-confidence changes your life. (Irene)
Changes in her self-esteem and entire personality have occurred not only through hard work and accomplishments but also because of her openness, curiosity and critical mind. Critique of pupils and their parents, as well as other teachers of mathematics, is noticeable in the texture of Irene’s answers, though the positive input of teacher is emphasized more.

The major challenge observable in the life story by Elsa is the issue of attribution of achievement and failure in mathematics. That is are they caused by external or internal factors? She calls for radical changes in the Latvian educational system/structure ensuring the adequate functioning both of external factors (e.g., parental influence, material resources, standards, structure of school) and pupils’ internal factors (e.g., development of their cognitive strategies and research interests, possibility to use the mathematics to deal with real life problems and rise of self-esteem, finding proper internal motivation for learning mathematics as a subject at school and university). Unlike Irene, Elsa does not speak so much about the necessary changes in teachers and herself, the main transformational emphasis is on factors, external to her as a person or entire professional group of teachers, protecting her self-motive. Speaking about the pupils’ learning, she discerns such cognitive factors as thinking strategies, discovery approaches, development of algorithms; from the affective point of view, she talks about a rising interest toward the application of mathematics in real life, such as taking pleasure in doing sums and developing a humane attitude, as well as an opportunity for individual expression of the learner. Similarly as Irene, she criticizes parents for their influence on pupils’ external motivation and for attribution of their children’s failure to heredity, overemphasizing the fourth face of mathematical identity — nature (Anderson, 2007):

> How is it possible that a parent can come and, in front of her child, announce to me: you know, I have never understood mathematics, my child will not understand it too. And the child sits there and listens, and he is given the green light not to understand the mathematics, because of his mother. And then I am telling her: imagine, you will need to look for a special school for your grandchildren, since learning difficulties will progress not regress with each generation... (Elsa)

In the case of Elsa, it is evident that her tale about the love of mathematics in childhood because of her father and her disappointment later in life of not being able to restore these loving relationships at the same rate call for some explanations and defences. She actively criticizes her teachers, her pupils’ parents, the school environment; probably, she is instinctively aware of her own difficulties with mathematics. However, she is quite approving toward her father’s individualized but authoritarian pedagogical approach, as it formed her strategies of logical thinking and fostered her love to calculation. In her work with students, she is trying to mold similar strategies and understanding about research, speaking in favor of rather individualized approaches. She highly values interest in mathematics, since she tried many other fields before she arrived at the profession of mathematics teacher. Answers by Elsa contain the critique of diverse factors external to teacher: pupils, parents, school system, etc.
Dialogical models and interactive patterns: alignment with the competences for educators in ESD

To see how the revealed dialogical models of teachers’ identity and their pedagogical theories align with the educators’ competences in ESD, we examined the detailed table of educators’ competences (UNECE, 2011) and summarized parts and elements of table corresponding to the approaches explicitly or implicitly encountered in the interviews. Eventually, approaches from all three teachers mostly coincides with the third feature of ESD, namely, achieving transformation in teachers, learners, pedagogy and educational systems. The strongest association with this feature is noticed in the humanistic theories of Ann and in Elsa’s critical outlook at unsustainability around her. At a less rate, it is observed in the subject-oriented pedagogy by Irene. In the text, the competences as they are included in the UNECE document are underlined.

All three teachers, from the position of critically reflective practitioner, both in their dialogical models of identity and pedagogical mentality enounced how engagement in real-world issues enhances learning and makes difference in practice:

We need to do it a little bit differently, it should be some real possibility to apply what you know. Possibility to direct your mathematical knowledge as to be able to engage in some entrepreneurship and mathematically calculate your business activities. We (as a society) lack this initiative... to be responsible for something from beginning to end. (Ann)

Several competences for ESD were exposed by two of the teachers: for instance, both Ann and Elsa show understanding of a need to transform the way we educate/learn and demonstrate their attempts to facilitate participatory and learner-centred education that develops critical thinking and active citizenship:

I have one very good game related to the theory of probability that grounds the games of chance.... [describes the collective game with candies]. And pupils are so extremely excited with this game and they say: “Thank you, teacher, for this lesson, now I do not buy the lottery tickets at all!” Afterwords we have this theory of probability and children grasp it easily and they are interested in it. And they come to me with single-handedly calculated enormous figures and they are in such a delight: teacher, can you imagine -- such a probability! (Elsa)

In her answers, Ann revealed the importance of building on the experience of learners as a basis for transformation, perceiving herself as a facilitator and participant in the learning process when she told about her learning together with her pupils at school and students at the university. As it was already mentioned above in her interactive pedagogical model, she emphasized the necessity of engagement with learners in ways that build positive relationships more often than the two other teachers. To conclude about the point of view used by Ann in a context of ESD, it can be stated that such an approach doesn’t reach beyond the anthropocentric horizon of human as an ultimate aim; however, the social orientation “all for humans” could serve as an initial point for sustainability that is clearly better than pure selfishness or egocentrism (Salõte & Pipere, 2006). Possibly, overall respect toward external entities, in this case another person, will become a foundation for reaching aims for sustainable development to ensure qualitative and sustainable interaction of a person with the surrounding social, cultural, and natural world.
On the other hand, the answers from Elsa contained the strong wish to challenge assumptions underlying unsustainable practice. Synthesizing on her approach, it should be admitted that search for unsustainability practices and active critique of the surrounding world are positive goals to build on the further development, but only if we are able to complement them with adequate self-analysis, self-criticism, and a quest toward the changes in ourselves.

In the case of Irene, we also found a stronger social orientation and motivation to make a positive contribution to other people and their social and natural environment, locally and globally that is included in the section of ESD competences related to envisioning change. Possibly, to develop cognitive processes (e.g., critical thinking), perseverance and curiosity would help to solve the unsustainability problems in our world. Though the proper aim should be set, it should be a motivating and socially recognized one.

In general, the interviewed teachers want to transform something or somebody; their implicitly suggested transformations aim to master the subject to use it in life or to develop specific skills or even a mathematician personality; however, the meta-content or meta-message (Sund & Wickman, 2011; Salöte, Gedžune, & Gedžune, 2009) regarding sustainability are not so evident.

Conclusions

In this article, we have presented an extensive qualitative study aimed to explore the mathematics teachers’ mathematical identity by utilizing dialogical models of teachers’ relationships with mathematics. Interactive patterns emerged between this identity and teachers’ perception of factors influencing the mathematic phobia of their students. These models and patterns are also explored in relation to the competences for ESD educators in order to verify possible evidence of these competences in the answers from teachers as a meta-content implicated in motivations, values, and main discourses.

We summarized the findings in relation to each research question framed as much as possible for phenomenological study valued for the richness of specific details. Each question and its interpretation can serve as a foundation for further inquiry to be based on. The common theme of teachers’ mathematics identity was their instrumental relationships with mathematics using it to solve professional and life situations, to develop cognitive skills and entire personality or to aid as a psychological coping strategy. As nuanced as they were, none of the answers expose clear negative relationships with mathematics notwithstanding the differences in obtained level of competence. However, comparatively lower perceived competence related to the instrumental vision of mathematics at a larger extent. In general, negative societal attitude toward mathematics and mostly positive impact of family and surrounding people on the choices, interests and identity development of teachers were reported.

The dialogical models, emerged in relation to the teachers’ mathematical identity, show how different life experiences can lead to different identity voices surfacing in interviews: for one teacher it was a domination of pedagogue identity over the identity of mathematics teacher; for another, it was a balanced dialogue between the voices of mathematics teacher and mathematician while in the third case we can speak about the sub-identities of teacher and doctoral student entangled with several other hidden voices. The interviews also contain striking in-group favoritism of mathematics teachers taking pride in their self-identification with this specific group perceived as an elite subgroup.
of teachers. The most salient identity voices guiding the dialogical processes become apparent as the priorities in the area of teachers’ professional expertise: one teacher appears to be an expert in pedagogy and didactics, another in subject matter and the other in didactics. Interestingly enough, the accounts of the three teachers contain all possible variations of relationships between the other-motive and self-motive. For the placidly oriented expert in pedagogy and didactics, prevalence of other-motive over self-motive elicited mostly positive feelings. For the subject expert with her strive for self-development, self-motive was balanced with other-motive and self-motive elicited mostly positive feelings while the other-motive elicited contending passions. For the didactics expert with a strong inclination toward self-defence, the self-motive dominated over the other-motive arousing ambivalent feelings. These uncommon entanglements ask for a deeper investigation although we already could question the sustainability of dominance of self-motive for the teacher. As in several other studies (Bainger, 2011; Kaasila, 2007), this study also reveals the serious drive toward defending one’s self through explanations. Furthermore, the elaboration, orientation and content of these explanations differed in each account.

The patterns displaying the interaction of the teachers’ mathematical identity and their perception of students’ mathematical philia/phobia included, for instance, the humanistic approach and instrumental interpretation of mathematics and its teaching methods as practised by the teacher with expertise in pedagogy and didactics having a dominating teacher identity, other-motive and positive affective orientation. She emphasised not so much the mathematics as the development of motivation and life quality of learner and kept avoiding serious critique toward any subject, yet still illustrating the required professionalism of teachers.

The life story of the other teacher is full of excitement and explanations of challenge dealing with difficulties in mathematics and arriving at success that requires relentless development to reach it again. Being a mathematician deep in her heart and having strong expertise in subject matter, she summons toward self-actualization of achieving success through hard work stressing need for the continuous self-development of educator and knowledge on individual psychological peculiarities of students. Although she affords the critique of pupils, parents, and teachers of mathematics in general, the positive input of teachers is recognized too.

As for the third teacher, she struggles with the dilemmatic issue of attribution of failure in mathematics either to external or internal factors. It is especially hard for her because of her emergent mathematics teacher identity that tries to find its place among the other identity voices, with dominance of self-motive and a lower perceived level of mathematical competence. After all, positioning herself as an expert in didactics, she deviates from the required changes in mathematics teachers or herself as a teacher by actively and elaborately criticizing and calling for transformation of factors external to her or her current professional group: such as her own teachers, pupils, parents, and the school environment.

The hallmarks embedded in the biographical reflections of experienced teachers show partial alignment between the dialogical models and interactive patterns found in the accounts of teachers and competences for educators in ESD mandated by UNECE. Remarkably, all three teachers emphasized the sole feature of ESD competences for teachers: achieving transformation in educators, pedagogy and educational systems in all aspects of learning to know, learning to do and learning to be (UNECE, 2011). As
critically reflective practitioners, they all reported connections between knowledge and its practical application for life issues, as well as acknowledged their wish to transform education, facilitate participatory and learner-centred education toward developing higher order thinking. Some of the teachers reported on the transformation based on their experience of learners, perceiving themselves as facilitators and participants in the learning process. Moreover, positive relationships with learners, challenging assumptions that underly unsustainable practice and motivation to make a positive contribution to other people were noticed. All in all, the life experiences of all interviewed teachers created the transformative disposition of their mathematics identity although, in the context of sustainability, this disposition lacks the meta-orientation toward higher order goals rising above mastering the subject matter as a simple tool to improve one’s own life and oneself. Among others, one strength of this qualitative research could be its’ tactical and catalytical authenticity (Guba & Lincoln, 1989) envisaging that engagement in extensive collaborative professional reflection could lead to the teachers’ personal and collective growth and, therefore, to the changes in teachers’ practices.

We conclude with a reflection on the limitations of the present study. They include: 1) a small sample that is typical for IPA studies and, therefore, the contextual nature of obtained data; 2) situational bias related to the emotional and cognitive context of the teacher on the day of the interview; 3) social desirability or wish to present themselves in a more positive light to the researcher; 4) some psychological issues (e.g., self-esteem, personal and professional insecurities) impinge on the content and form of participants’ verbal expressions during the interview (cf. Bainger, 2011). However, at least in terms of generalisation it is not a serious issue as IPA does not claim to create general or grand theories (Smith et al., 2010). One more limitation, especially visible in the case of IPA, concerns the fact that the analysis of the results is influenced by “the researcher herself; her own experiences in the field, her beliefs, biases, tolerances, prejudices, preconceptions and motivations” (Bainger, 2011, p.33). This issue was partly dealt with by using the integrative point of view from two independent researchers during the data analysis and interpretation. Due to space constrains, only some of the most important facets of analysis and quotes from interviews are included in this paper.

To use the qualitative study in other contexts, replication needs to be wisely adapted to the local circumstances; the results of the presented study provide some implications for practice at least on the Latvian scale. Initially, implementers of the ESD competences for teachers would utilize already existent aspects of transformation, within any sphere of educators’ competence, as the grounds for implementation of two other features: holistic approach and envisioning change. Strong in-group favoritism of mathematics teachers would be a good sign for educators of future mathematics teachers to recrute new students into these programs demonstrating excellent professional role models and attesting to the high professional status of mathematics teachers. Teachers’ pedagogical theories explaining students’ mathematical phobia and philia can be used by designers of teacher education programmes and by mathematics teacher educators to show future teachers the potential diversity of approaches and emphasize their explicitly contextual nature. To conclude, these findings state a suggestion for educational philosophers and politicians to consider an apropriate immediate aim for all stakeholders in education in order to enhance its’ share in the sustainable future: Would the focus be mainly the search for unsustainability in our external world and taking pride in criticizing it? Or, would it be on humanistic caring for the well-being of all human beings, envisioning
success, achieving outcomes by hard work and constant self-development in specific areas as the resultant secondary goals. The third option would be stress on the importance of specific areas of knowledge in order to create a sustainable society and realize achievements of an individual learner in this or that area as a prerequisite of personality development.

This study calls for further research using the promising Theory of Dialogical Self in the area of teacher education and empirically observing the correspondence between the existing competences of teachers and the ESD competences constructed by UNECE, which seem more like an ultimate aim to be adapted to the current situation. This area needs more profound and detailed research employing also the quantitative approaches to grasp the ways in which teachers’ mathematical identity can influence their students’ mathematical identity and, ultimately, not only their achievements in mathematics but also their life skills, cognitive strategies and development of personality. It would be useful to conduct further research to reveal and compare the general attitude toward mathematics in different social groups not connected with mathematics in their profession or daily activities. Another avenue of inquiry is the integration of ESD competences in in-service and pre-service teacher education programmes on local and global levels.

Transformation is not an easy job and asks for the right tools and proper virtues. Stinson (2009), in his qualitative self-reflective dissertation about the mathematics teachers’ journey of identity construction, stresses the power of self-examination in constructing his identity and points to the “humility, desire, courage, and honesty necessary for change” (Stinson, 2009, p.5). Ultimately, this study is not so much about grasping some school subject’s content as about our prospects to reach sustainability during our lives in the immediate, distant future or not at all. Yet, we would like to ask: What kind of teacher would you choose to master mathematics with?

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Appendix

Mathematics and its meaning (general context)
1. What is mathematics? What concepts, images, and associations come into your mind?
2. What do you feel when you are doing mathematics, teaching mathematics, write and research on issues related to mathematics?

Doing mathematics: social, institutional and self-evaluation
1. How did/do your contemporaries perceive you as the university student of mathematics, teacher of mathematics, designer of teaching aids, researcher in mathematics?
2. How did/do you perceive it?
3. How does society in Latvia perceive doing mathematics in present conditions (before crisis and during crisis)?

Relationships with mathematics from different social positions
1. Please, characterise your personal relationships with mathematics beginning from the kindergarten/school until the present moment.
2. What changes in your personal relationships with mathematics happened because of changes in your social positions (pupil, university student, teacher, doctoral student, university teacher, etc.)?
3. Which positions brought the largest changes in your relationships with mathematics?
4. What factors had the strongest impact on these changes?

Mathematical philia and phobia: concept, causes, fostering/impeding factors
1. How could you comment on mathematical philia/phobia?
2. Suggest the causes of your own mathematical philia (or phobia).
3. Characterize mathematical philia/phobia in your social surroundings and institutional context (your classmates, group mates, colleagues, subordinates, students, scientific advisors, colleagues in doctoral studies, etc.).
4. What factors did you notice as eliciting their specific attitude toward mathematics?
5. What would you suggest as to sustain the mathematical philia and avoid the mathematical phobia for mathematic learners at different levels?
6. What are you future plans and intentions in relation to mathematics?

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