Chapter 4
Toward a More Sustainable Pre-service Teacher Education: A Study in Progress

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4.1 Introduction

This chapter presents some basic ideas and discussions in a current research project at the University of Agder, Norway. The project aims to develop more holistic and sustainable teacher education by throwing light on present gaps, suggesting bridges, but also considering the gaps as resources for inquiry and new insights. The research group is interdisciplinary and consists of four research cases within the following disciplines: Mathematics Education under the leadership of Claire Vaugelade Berg and Barbro Grevholm, Norwegian under the leadership of Bente Velle Hellang and Gro-Renèe Rambø and Pedagogy running by Åse Haraldstad, Annbjørg Håøy and Aslaug Kristiansen. The chapter shows mutual competencies building. Pedagogical research and teacher education in Norway is undertaken in close collaboration with these institutions. This strong collaborative element is an important implicit part of the argument. The chapter also explores another vital

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H.C.G. Johnsen et al. (eds.), *Higher Education in a Sustainable Society*, CSR, Sustainability, Ethics & Governance, DOI 10.1007/978-3-319-15919-5_4

dimension of mutual competence building, namely that of collaboration across disciplines.

From a sustainability perspective, education in general can be of vital importance, both in terms of maintenance and of renewal of a human society. Here teachers might play a decisive role when it comes to guiding, cultivating and teaching young people, and developing their sense of humanity. John Dewey suggests that education and communication are basically necessary to form a community. He writes that a community and social group sustains itself through continuous self-renewal "... and that this renewal takes place by means of the educational growth of the immature members of the group" (Dewey 1916, p. 9). Thus, education as sharing of knowledge with new generations becomes a significant part of a society's sustainability, broadly defined as "the capacity to endure". "For humanity, sustainability is the potential for long-term maintenance of well-being and has environmental, economic, and social dimensions" (Furniss 2011, p. 40). In addition to its contribution to maintenance and endurance of the well-being of humans, education may be considered a society's platform, where further questions about how to live to ensure sustainability for humanity in a larger scale can be addressed.

Promoting the well-being of humans, according to the Ontario Ministry of Education, means helping students to build the knowledge and skills associated with positive well-being and becoming healthy, active and engaged citizens (http://edu.gov.on.ca/eng/about/wellBeing.html, 9 September, 2014). At a micro level a precondition for developing the whole student is a caring environment. People's strength, according to Nel Noddings, is better cultivated in an environment of caring, not of competition. It is a fundamental relational approach, and she uses the word caring in a broad sense: To care for the persons next to you, for the pupils in the classroom, to care for strangers, animals, plants and the Earth (Noddings 1984, 2002). In order to develop a caring environment, the teacher's qualifications are of vital importance. The philosopher Hannah Arendt notes, in a similar vein as Heidegger (see Chap. 2) that teacher education should entail knowing the world and caring for it. On this basis, the teacher can introduce the children to its richness: "... pointing out the details and saying to the child: This is our world" (Arendt 1993). Arendt's formulation "our world" involves an invitation to become able to feel part of it. To care calls for participation and for acting responsibly within a world that is cared for. To educate involves a broad responsibility. It includes the life and development of the child, as well as preservation and renewal of the society. Gillen D'Arcy Wood claims that sustainability (studies) "is driven by an ethics of the future. The word itself, sustainability, points to proofs that (...) can only be projected forward in time. To be sustainable is, by definition, to be attentive to the future" (Wood 2012, p. 14). It includes being attentive, and caring for the wellbeing of future generations (Constitution § 110b, Stueland 2014). In this connection education plays a basic role in terms of renewal of a human society (UNESCO 2014).

In our context, sustainability refers to pre-service teachers' recognition of becoming the professionals of the future, and having the necessary and relevant research-based background and ability to face challenges, investigate problems emerging from their teaching practice, and making judgments based on the basis of sound evidence. Furthermore becoming professionals implies developing a

careful understanding of their teaching practice, and being able to justify their decisions and compare their approach with colleagues. A sustainable teacher education includes developing pre-service teachers' awareness of the advantages and consequences of adopting a critical stance: a stance where one looks critically and self-critically at everyday-teaching practice, and aims at improving it in order to achieve pupils' meaningful understanding of the subject matter. We aim to supply teachers with relevant skills that make them become well-qualified teachers with a lasting professional competence, who will stay in their profession throughout their working career.

In Norway there is historically a strong tradition for public education all the way from primary school to the university level. After a reform in higher education (1997), teacher training colleges were included in the university structure, and thus, introduced to a university culture. A rather durable ideal has been that the school should be an open arena, where pupils from different backgrounds and social classes freely could take part and form a community. Thus, we find a high educational level throughout the population of Norway, regardless of social and economic background. This education model promotes important values closely linked to our broad understanding of sustainability. It promotes *equity*, in its possibility for all inhabitants to have an education and preparation for future work and income. At its best, it provides the inhabitants with knowledge, and at the same time a critical and analytical approach to this knowledge, basic skills that are needed to establish and maintain a functional and sustainable *democracy*. Both equity and democracy are main concepts in a sustainable society where people are able to live together, sharing common aims, beliefs, aspirations and understandings, and it addresses the content and importance of pre-service teacher education.

In light of a continuously changing world context, one of the most significant questions in our educational sustainability perspective is what kinds of competencies should be developed during pre-service teacher education, and how. What kinds of competencies and skills will turn out to endure, to be sustainable and ensure that the teacher stays in his/her profession? The aim of this chapter is to present some preliminary answers and suggestions to these questions, and present the way we approach them.

A challenge is to identify some "shared values" that both the teacher education and the society can commit to. We believe that developing teacher education as sustainable implies inviting our pre-service students in engaging in research and inquiry. As the professional knowledge and skills needed are not static, but dynamic, prospective teachers need to be prepared for change and development, and to be able to build new knowledge, for example from research, on their earlier knowledge. In our project we wish to support and develop an educational programme that nurtures students to become professionals who are curious, and engage in exploring, questioning and developing critical and independent insights into their profession, in other words we aim at enhancing our students' capacity to become *inquirers* (Jaworski 2006). In this context, the concept of *sustainability* is closely related to that of *inquiry*.

4.1.1 A Research Based Teacher Education

In Norway the demand for research-based teacher education has been explicit since the curriculum from 2003 (Ministry of Education and Research 2003). We believe that through developing awareness of the deep interconnection between and complementarity of theory and practice, pre-service teachers will develop an interest and an understanding of the research process and its importance and benefits for their future practice as teachers. This implies recognising the need for asking relevant and researchable questions, choosing a suitable theoretical approach, conducting experiments while observing, noticing, and collecting appropriate data, and finally analysing and evaluating information. Furthermore we see "inquiry" as a core dimension in our project, where inquiry is understood both as a tool and as a stance (Berg 2011, 2013a, b; Berg and Grevholm 2012; Cochran-Smith and Lytle 1999; Jaworski 2006, 2008). This approach is consistent with The National Guidelines for Teacher Education Programmes received from the Norwegian Minister for Education:

> Pursuant to the Act relating to universities and university colleges, the primary and lower secondary teacher education programmes are to be research-based. Their anchorage in research must be both implicit and explicit. This entails the education programmes teaching about and engaging the students in scientific working methods, critical thinking and recognized, research-based knowledge. Research-based learning processes are to advance the students' independence, analytical skills and critical reflection so that they as teachers are able to make use of new knowledge and further develop both themselves, their profession and their place of work after completing their education (Ministry of Education and Research 2010b)

Further, The National Curriculum Regulations for the Teacher Education Programmes claim:

> The Regulations aim to ensure that teacher education institutions provide integrated, professionally oriented and research-based primary and lower secondary teacher education programmes of high academic quality (Ministry of Education and Research 2010a)

In addition to emphasising the importance of integrating teaching and discipline-based research, the Minister for Education refers explicitly to the need for offering pre-service teachers pedagogical and specific subject content knowledge which enables them to become well qualified research-based practitioners in the future. For example, the specificity of mathematics as subject-matter has been addressed elsewhere (Berg 2013a, b).

We understand the Minister for Education's claim as a demand for preparing our pre-service teachers to a professional attitude where life-long learning is a core element: a sustainable teacher education. This was further underlined in June 2014 when the Ministry of Education and Research in Norway decided to extend teacher education from 4 to 5 years (from 2017), and even more important: to integrate a master's degree into the teacher education. The Minister for Education, Torbjørn Røe Isaksen, states in a press release:

> The teacher education programmes and the teacher profession in Norway need to an extended degree be characterised by broad insight, research and developmental work.

> As a master's student, prospective teachers will learn to know where to find and how to use research-based knowledge. Through an education which focuses on research-based knowledge, the teacher will be better skilled to prepare his/her own teaching. This is not just another year of pre-service teacher education. The master's degree is research-based, says Thorbjørn Røe Isaksen (Ministry of Education and Research 2014)

In our project, a research based teacher education can be seen as a main organising theme for the three disciplines. It involves a particular focus on educating inquiry-oriented future teachers (Toom et al. 2008).

In the following we explain how we adapt the thought of research and inquiry into each of the three disciplines, in order to fit our aims in teacher education, and to an extended degree to promote a sustainable teacher education. The concept of sustainability is understood in a broad sense, beyond environmentally related issues: "At the university, sustainability goes beyond reducing our footprints and environmental impacts: it is about improving prospects and quality of life for students and staff, and in the local, national and global communities we serve" (Ryan and Tilbury 2011, p. 2). This involves ideas and values like caring for, responsibility, equity, democracy and inquiry. The description of the following cases is centred on three gaps, where we think that the teacher education programmes contain possibilities in a more sustainable direction.

4.2 Description

4.2.1 Mind the Gap(s)!

As teacher educators we often experience three different gaps in teacher education: transitions between entering the university as a newcomer, and developing gradually an identity as a professional teacher. We see a fundamental shift from considering the students as receivers of knowledge to recognising them as producers of knowledge and as valuable participants in a research process (Healey and Jenkins 2009), and we consider these transitions as potential growing points, where questions can be raised and new knowledge emerge. In the following we explain some of the challenges which might arise from these gaps.

Firstly, there is a transition at the very beginning of the programme. The novice student needs to change perspective, from being a student herself, to developing a teacher approach. This includes a change of perspective toward a professional identity. Secondly, there are transitions within the study programme of teacher education, as a result of a model where several subjects are taught in during each semester. Here, we focus on these kinds of transitions within the first year, like between subjects in first and second semester. An important question in approaching this gap is whether the students experience continuity or differences within the education's progression. Thirdly, we know from research (Hertzberg 1999) that there is a gap between the teaching of a subject/discipline within the frame of the teacher education programme and the students' experiences in relation to their own teaching during the pre-service practice: The students ask for

ready-made teaching activities, whereas the pre-service teachers want students who reflect themselves. The students request subject specific knowledge which they can use unchanged in their pre-service practice, whereas the pre-service teachers stress that what they aim at as a result of their teaching, is to enhance their students' capability to judge themselves how subject specific knowledge can best be taught as teacher professionals, facilitating their different future pupils.

In taking a closer look into these three gaps, from our different subjects' orientation and aims, we try to uncover possibilities for developing pre-service teacher education in a more sustainable direction by implementing research and inquiry as method and attitude during education. In a broader sense, we seek to contribute to the National Guidelines' description of the education's institutional responsibility and organisation:

> The Teacher Education Programmes must be organised so that they promote the integration of theory and practice training, academic progression, consistent professional orientation and a research basis. The Education Programmes are to make it possible to have collaboration between teacher educators at the teacher education institution and in teaching practice (Ministry of Education and Research 2010b)

4.2.2 Leaving School and Entering the University

The case or the study focuses on the transition from being a pupil in a primary and high school to become a novice student in the teacher training programme. It is said that when a Norwegian student enters a teacher education programme, he or she has experienced approximately 12,000 h of instruction with up to 50 different teachers, before even starting at university (Terum and Heggen 2010). We assume that these experiences have caused these students to develop certain views on both schooling and teachers. According to Robert Bullough (1991), teacher educators typically ignore new student's prior knowledge about teachers and teaching, and the prior knowledge of teaching could serve as a filter through which students respond to teacher education (Robert Bullough 1991, p. 43). There are signs that suggest that this knowledge too, can have an impact on other transformations. Schaefer and Clandinin (2011, pp. 292–293) show that beginning teachers "live by" histories "composed on their personal landscapes prior to beginning teaching". They write further: "Without knowing what has brought teachers to teaching, or what their imagined stories of teaching are, we wonder if we will ever know what might keep them in the profession" (Schaefer and Clandinin 2011, pp. 292–293).

We think that in order for beginner students to be able to learn and facilitating self-awareness, they must be connected to their experiences. In short, our aim for the study is to make these experiences conscious ones, to bring in new perspectives and together with the students widening the perspective through processes of narrative inquiry. A narrative inquiry is open to critical searching and investigations, and as such open to larger questions of meaning, matters of existence, and about worthy forms of life and thus, thereby to see things in a wider context or perspective. According to Clandinin (2007) narrative inquiry makes it possible to

explore "personal meaning, love, hate, aesthetic considerations, religious experience and narrative coherence of individual lives" (Clandinin 2007, p. 44). As such a narrative approach may be an arena for navigating doubt: "At the hearth of inquiry is the asking of questions", Petra Munro Hendry (2010) writes, and inquiry begins with doubt (Munro Hendry 2010, p. 73). The asking of questions can be stimulated by puzzling phenomena, sudden gaps in knowledge and difficult edges that are hard to overcome. They are all places where new insights can be born. We aim at providing the students with the necessary space for inquiry and for developing their ideas and their professional stands (Clandinin 2008). According to this methodology, we attend to the living, telling, re-telling and re-living of stored experience. In our project the students are invited to re-tell and re-interpret their experiences together. According to Ricæur "learning to tell others about oneself, is also learning to tell about oneself in a different light" (Uggla Kristensson in Ricoeur 2011).

In 2012, 2013 and 2014 we have collected student narratives, about 180 each year. The beginning students were asked to write about a significant event from their previous school experiences. The narratives were analysed and sorted into different plots that were further discussed among the students. By sharing their own stories with their co-students, reflecting on other student stories and retelling the stories from the perspective of other persons, new perspectives might emerge that could make their story "thicker" and more robust. Right now we are analysing data from the sharing and rewriting process.

The knowledge basis for this narrative research project is interpretation and a social foundation of knowledge (Buber 1958; Ricoeur 2011). Knowledge is developed through participation, interpretation and discussion. The researcher is moving between being in an outsider position to being in the middle of the crowd as an eyewitness and participant (Buber 1978). The knowledge in the project is discussed along three dimensions: Temporality, sociality and space (Caine, Estefan and Clandinin 2013). We consider these dimensions also to be relevant for a sustainable framework of thinking about education. Regarding time: in the situation here and now, the student is looking back to previous experiences but at the same time is looking toward the future: What kind of teacher do I wish to become? Changes in the histories are based on believing in the future. The student is located in a landscape, a place, which implies a particular perspective. The following questions can be asked: From which position is the thinking developed? What do you see if you move to another position? To enter a new landscape involves walking with people. The relationship toward the other, and toward the surroundings, raises ethical consideration about trust, equality, dialogue, reciprocity and sustainability.

Narrative knowledge is able to connect fragmented experiences, and to handle great complexity. Our assumption is that a narrative approach enables us to reflect on doubts, as well as to bridge some gaps between personal knowledge and professional knowledge. Narratives are able to address questions about the future. As such, we consider a narrative approach to be a facilitator for students to develop a robust professional teacher identity: not only at the beginning of the educational

programme but also all the way through it (Hermandsen and Rendttorff 2002, p. 20).

4.2.3 From the First Semester Courses to the Second Semester Courses

The beginner teacher student enters two different courses in the first semester: One is freely chosen, the other one is called "Pedagogy and pupil related skills" and it is obligatory. The course includes educational theory, as well as practical work in schools. In the second semester they switch and study Mathematics Education and Norwegian. In these courses two the students spend some weeks teaching in schools. We were interested to know more about the transition between the two semesters: Do the students experience a gap regarding basic ideas, content and approaches to the profession?

The concept of coherence is central in this discussion. Coherence is explained as a tight integration among courses, and between course work and clinical work in schools (Grossman, Hammerness, McDonald and Ronfeldt 2008). It means that courses are designed to intersect with each other, tightly interwoven with the advisory process and students' work in schools. Grossman et al. studied the relation between the students' perceptions of coherence. They also suggested a number of structural features of the teacher education, to help develop a stronger relation between the fieldwork and coursework, and define this interaction more closely. According to the National Guidelines (Ministry of Education and Research 2010b), "pedagogy and pupil related skills" should be used to integrate and make coherence and consistency within teacher education.

In a pilot study in spring 2014 we conducted a focus interview with a group of students that had entered the spring courses. Our main questions were about whether they recognised a research basis for each subject, and how this was utilised in different ways during courses and clinical work in schools.

Data from focus group interview with the students indicated that the content of the subjects are experienced as research based, both in lectures and syllabus. Some of the theories they had learned in pedagogy were tried out in their field work as they were asking: "What works?" Didactic concepts from pedagogy were also emerging in mathematics, and they were asked to inquire, to find out and to search for alternative perspectives and solutions. The preliminary findings revealed that at a pragmatic level or at "how to do" level the students were able to create coherence and to find some overlapping ideas.

The result from the pilot study was more positive then we had expected beforehand. On the other hand these preliminary results also indicate that there are challenges, especially when we come to more academic knowledge. We think that in the future more research should be conducted in order to deepen the findings and the questions, in order to promote well-integrated and coherent, research based

and professional oriented teacher education. The students' own evaluations and reflections are of vital importance for improving the situation. Such an effort may further lead to re-thinking and to critical reflections about the education programme in general.

4.2.4 From Research to Subject Didactics in the Subject 'Norwegian': Theory and Practice

The objectives of teacher education (TE) study programmes are multifaceted. On one hand, they aim to educate qualified professionals, in the sense that they meet those demands and expectations that are expressed in curriculums, regulations, laws and plans. Furthermore they seek to match expectations to the professional roles that are found in the specific culture in which the profession exists. In addition to this, supporting the personal development of the individual who is on her way into the role of this profession academically is highly valued. In some sense, the academic subject specific knowledge on one hand, and the practices of the professional role on the other, could cause challenges for students following teacher training programmes. These challenges are caused by experienced contradictions between what the students find to be important and necessary academic knowledge, and their experiences from pre-service practical training during their education (Hertzberg 1999). This is commonly referred to as the gap between theory and practice.

In 2010 and 2013, broad evaluations of the study quality in the Norwegian teacher education programmes were conducted by SINTEF (Finne, Mordal, and Stene 2014), on behalf of the Ministry of Education and Research The conclusions from these evaluations correspond with the description above, and in addition, there is no progression in overcoming the gap from the first to the second evaluation, although this was an explicit intention in the teacher education reform in Norway in 2010 (Ministry of Education and Research 2010a) The report from 2013 describes theory and practice in the teacher education as different circuits that are not able to take advantage of the learning potential existing in the relationship between them. Especially two different challenges have been emphasised: the co-operation between the practice field and the education institutions, and the relationship between theory and practice, which the report refers to as the "theory—practice gap" (Finne et al. 2014, p. 63).

The relationship between subject specific knowledge that is conveyed and processed during the study programme, and the profession the students are on their way into, is important. In a pilot study conducted in December 2013, a commonly expressed opinion among second year teacher students was that subject specific knowledge and research was less important than teaching methods and pedagogical strategies. As one of the students responded to a question related to the connection between subject specific knowledge provided during education and

experiences from the field of practice: “I think that some of the subject specific knowledge is irrelevant, since we do not need it when we are going to work as teachers. What we need is more pedagogy!” On the other hand, university teachers argue that updated subject specific knowledge and research is fundamental for maintaining a sustainable teacher education. In this study we draw the attention towards how on campus teaching in ‘Norwegian’ contributes to bridging the gap between the academic content of the programme description in ‘Norwegian’ and reported experiences from the students’ practical training. Experiences of connections or disconnections between theory and practice are important for the further development of a professional identity as teacher.

In all parts of the subject ‘Norwegian’, literacy and communicative competence are main issues. To examine the transition between research-based specialised knowledge in these fields and expected competencies linked to future teacher practice, we will focus on how students recognise and understand connections between subject specific theoretical knowledge, subject specific didactics and experiences from the field of practice during pre-service teacher education. In particular we focus on one of the mandatory assignments that the students are required to do during the Norwegian subject study in the primary teacher education (years 1–7). The assignment is a text project, running over a week. It comprises lectures, group work and individual writing on the basis of authentic texts written by pupils in primary school. These texts are subject to inquiry-based analysis on all kinds of text levels, addressing subject matters highlighted in the curriculum plan and focused on in previous on campus teaching. These analysis levels range matters like coherence and grammatical constructions, genre competence, communicative function and writing skills in general. The work is process oriented, as the students in each group present and discusses their text analysis observations, and on this basis all students produce one or two written individual text responses. The responses and the original texts are then handed back to the pupils. In order to conduct this project, co-operation between the field of practice and the more theoretically grounded on campus training is vitally important.

By focusing on how the students reflect upon this co-operative project, we hope to contribute to an understanding of how educators in teacher education study programmes can support development of an active and critical attitude towards research and school related practice. In the pilot study from December 2013, several of the students mentioned this project specifically when they were asked to evaluate the importance of on campus training for their future role as professional teachers. As one of them said: “Grammar teaching was good for being able to evaluate texts written by pupils, and the work gave me some input related to subject didactics”.

In our project we are using standardised questionnaires with open answer alternatives to survey how students returning from their last pre-service practice period during their ‘Norwegian’ studies understand and reflect upon relationships between research, on campus-teaching and activities from the field of practice. We will also conduct focus group interviews, in order to have the possibility to go in depth on central issues concerning these aspects, making sure that our data is really focused on our specific subject, ‘Norwegian’, and not confused with other more

general opinions. A third approach will be to conduct interviews with in service teachers providing the pupils' texts as well as university teachers leading the text project. Our overall goal is to contribute to developing awareness of the deep interconnection between and complementarity of theory and practice, by shedding light on if and how pre-service teachers seem to develop an interest and an understanding of the research process and its importance for a sustainable future practice as teachers, by using inquiry based methods themselves.

4.2.5 Research-Based Mathematics Teacher Education

Inquiry-based mathematics teacher education (IBMTE) is a research project currently running at the University of Agder. Its aims are to strengthen mathematics teacher education at UiA by making explicit the link between theory (results from research in mathematics education) and teaching practice, and by emphasising and bringing to the fore the specificity of mathematics as subject-matter while developing students' awareness of the importance and the relevance of the use of semiotic representations (Berg 2013a, b; Duval 1995, 2006). We see these aspects as crucial for future mathematics teachers and the idea of inquiry is used as a means to achieve these goals. We see "inquiry" as a core dimension in the project, where inquiry is understood *both* as a tool and as a stance (Berg 2011, 2013a, b; Berg and Grevholm 2012; Cochran-Smith and Lytle 1999; Jaworski 2006, 2008). Inquiry is not a new concept in education, but is has been used in many different ways over the years (Skovsmose and Säljö 2008). If we take mathematics as an example, inquiry as a tool implies asking questions, recognising problems, investigating, exploring and seeking answers while making hypothesis explicit, and thereby engaging in an inquiry cycle (Berg 2013a, b). Inquiry as a stance means adopting a critical attitude to one's own development, as a means to raise awareness of the specificity of mathematics as subject matter.

In the project, inquiry is used at three levels: at the first level, *inquiry in mathematics* as pre-service teachers engage in exploring and solving mathematical tasks, at the second level, *inquiry in teaching mathematics* as pre-service teachers reflect on ways to enhance and develop further their teaching practice, and finally inquiry at the third level aims at capturing *inquiry into pre-service teachers' professional development* as they are encouraged to reflect on their experiences as researchers (Berg 2013a). These three aspects clearly illustrate the interdisciplinary nature of the didactics of mathematics, where the subject mathematics is central, but issues of teaching and learning (communication, language, didactics and pedagogy) are interwoven in the discipline.

In addition the IBMTE project seeks to facilitate the transition from being a student teacher to becoming an in-service teacher (Grevholm 2003, 2010). These ideas are implemented in a course in teacher education at UiA where second-year students are invited to conduct a small scale study on a chosen theme. During fall 2013 pre-service students had the possibility to choose between the three following

themes: pupils' difficulties with words problems (Selter 2009), pupils' difficulties with finding and using patterns in linear generalizing problems (Stacey 1989), and finally the use of diagnostic tasks: their advantages and limitations (Brekke 1996). Pre-service students are invited to formulate relevant and researchable questions, to collect and analyse data, and to write a research-based essay where they report on their study and summarise their experience as researchers. The aim is to capture and trace the students' professional development, and to identify aspects enhancing and facilitating the emergence of their identity as mathematics teachers.

4.3 Discussion

By implementing the idea of sustainability in teacher education we aim at raising pre-service teachers' awareness of the complexity of the practice of teaching. Through the four different research cases described above, we seek to promote a research based teacher education that prepares the future teachers to keep curiosity and to learn all the way through their lives. In this chapter we suggest that inquiry as a tool as well as a stance can be beneficial in the process of educating future teachers with the autonomy required to meet future changes and complexity. By the three subjects' approach to the gaps, our aim is to explore and investigate how we, as teacher educators, may facilitate the transitions between them by building bridges and by improving students' professional qualification.

Even though our projects are still in progress, this does not prevent us from recognising central features and questions arising, which could be fruitfully developed in what we consider to be a sustainable teacher education. As mentioned above, we recognise that pre-service students meet several transitions during their education. The first transition concerns leaving school and entering university. This implies getting used to another culture of studies and knowledge. As teacher educators, a way of facilitating this transition is to be aware of using and building on students' previous knowledge, and not to expect pre-knowledge in areas where it does not exist. One way of achieving this could be to encourage the students to write about their experiences, as a means to develop a professional language and to get deeper opportunities to reflect on their own learning (Grevholm, Berg, and Johnsen 2006). Our results so far indicate that students seem to value this aspect as a good learning opportunity. Another transition refers to the phase when students leave university, and go to schools as part of their in-service practice training. This can be an overwhelming and stressful experience for students, and a careful preparation in seminars with the teacher educator may be a good support for them. Through reading research articles on teaching and discussing them in seminars, students can get some preparedness for what is coming in class. Another difficult transition is when the students are leaving university and entering into the profession. Sometimes the conditions in school can be a shock to the new teacher (Grevholm 2004) and support from a mentor in school is valuable as well as some preparations in the end of the university studies. Caring aspects in mathematics

education have been discussed recently by several authors (Sztajn 2008). To bridge all of these transitions we consider a research-based approach to be beneficiary. It is based on the notions that the knowledge base of the study programme is dynamic, and that student teachers are active processors of knowledge (Zeichner 1983, p. 7).

The demand for research-based teacher education in Norway has been introduced late compared to other university education programmes that have always been expected to be research-based (Grevholm 2004). This might have been caused by the fact that teacher education in earlier days took place in special institutions and not at the universities as it is today. Another factor could be that teaching was considered to be an art and the artist builds on talent and practice rather than on research and theory. This gap between theory and practice it still present in both teacher education and in teachers' professional life. It is not a straight forward process to bridge this gap between theory and practice. A research-based teacher education could include aspects linked to methodological, theoretical and practical knowledge. Included in this would be the use of research-based course literature, promoting work forms which offer a view of knowledge and methods like those used by researchers, engaging students in research work as part of the education through inquiry, systematic work and public presentation and debate, enabling them to reason, argue and defend their own conviction (Grevholm 2004, 2006).

Teachers who get the ability to actively create and design their own teaching will be able to develop and follow new demands in society, and to enter a life-long learning process, which is necessary in a quickly changing society. The concept of sustainability is inherently linked to the future. The impossibilities of predicting the political, societal and technological demands and challenges teachers will meet in 20 or 30 years calls for our deepest attention. Therefore our aim must be to find ways of offering the students rich learning experiences, creating a solid platform from which they will be able to develop further their expertise as teachers, and adapt to the world of tomorrow.

4.4 Conclusion

Our inter-disciplinary approach has brought together teacher educators from different faculties: mathematics education, pedagogy and Norwegian, all crucial subjects in the teacher education. Together we seek to develop a coherent and relevant research-based education for our pre-service teachers, where our interest in inviting students as inquirers and researchers originated from our exploration into ways of making meaningful and explicit the relation between teaching and discipline-based research. This inter-disciplinary approach implies a broader field of knowledge and experiences that might contribute to better understanding and clarifying of the complex problems we are studying.

Sharing different viewpoints, contributions and scientific traditions opens up a better understanding of the uniqueness of each discipline/faculty. The co-operation provides a possibility to articulate tacit knowledge and therefore it can be a

continuous source for enthusiasm, curiosity and inquiry. Regarding improvement of teacher education, a common research approach means a commitment that is drawing in the same direction. Such a common commitment can facilitate the students' teaching and learning processes by creating better coherence and integration of different knowledge traditions. The co-operation might also contribute to a development of positive attitudes among students toward different knowledge traditions, to give a better understanding on how they, from different angles, are able to throw light on different aspects of a problem or challenge. This might contribute to laying a better foundation for the student's qualification for meeting future challenges in their professional lives. The inter-disciplinarity does not only provide new knowledge, it provides *different* knowledge, thereby reflecting on the part of the teacher educators the dynamics and complexity of teaching itself. Such co-operation amongst teacher educators might lay the ground for building a more coherent teacher education with an explicit common goal and understanding.

The explicit focus on the connections between the research-based approach in teacher education and teacher's everyday work in the field of practice, the gap between theory and practice, links well to expressed opinions about what teaching in a modern world comprises: "Teaching in today's world needs dynamic competences and a high level practice calls for the kind of inquiry-oriented approach that reflects the general level of research-based teacher education." (Toom et al. 2008, p. 13). This is our contribution to the always recurring question on how to achieve more sustainable teacher education, in a complex world where sustainability, in all its different meanings, insists on being "a moving target, a distant goal, not a permanently achievable plateau of being" (Slovic 2012, p. 187).