Sámi teachers’ development of culturally based examinations—a focus on teachers’ self-determination

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“We had not dared to do that earlier, but now we see that it works.” (Teacher Elle, transcript from interview)

1 Introduction

The Sámi are an Indigenous people of the Arctic, who inhabit an area that transcends the borders of several nation states; Norway, Sweden, Finland and Russia. The mathematics teachers at a Sámi lower secondary school in Norway experienced that unfamiliar contexts in the national examination disadvantaged Sámi students from the rural northern areas. Their experiences are supported by research literature, which generally indicates that ethnic minority children in Western societies have encountered problems with mathematics education (Bishop and Forgasz 2007). This paper presents two experienced Sámi mathematics teachers’ development of a culture-based local mathematics examination. Klausen (1992) defines culture as the ideas, values, rules, norms, codes and symbols that a person adopts from the previous generation and that one tries to transmit more or less unchanged to the next generation. According to Eriksen (1997), culture is the common thought patterns, habits and experiences that make it possible for human beings to understand each other. Darnell and Hoëm (1996) describe culture as the stored knowledge of a society or sub-society that enables the society to survive as a group. The Sámi is a minority in Norway and within the Norwegian school system, so this paper has chosen Darnell and Hoëm’s perspective as the main perspective. We consider culture as something personal as well as something social, so the other perspectives are considered too.

Because the teachers work in northern Norway, our focus is on Sámi mathematics education within the Norwegian school system. Tirosh (2009) asks for more attention to studying organizational issues such as the nature of assessment and the role of the cultural context. That is because these elements influence various aspects of the learning process. We intend to consider Tirosh’s point, by analysing relations between Sámi mathematics teachers’ self-determination and their development of a
culturally based local mathematics examination. We support Cai and Wang’s (2009) broad reference to cultural context as both the local-social circumstances and as historical cultural values in learning and teaching.

Smith (1999/2006) outlines an agenda for Indigenous research. This agenda is focused on the goal of Indigenous peoples’ self-determination. According to Deci and Ryan (2012), self-determination theory maintains and has provided empirical support for the proposition that all human beings have fundamental psychological needs to be competent, autonomous and related to others. To be autonomous is vital to assimilating new ideas and experiences. Balto (2005) points out that Sámi parents give children responsibility and provide them with more autonomy than Norwegian parents do. Thus, autonomy is part of Sámi culture. We have chosen to focus on teachers’ self-determination in this paper. Much research on self-determination has focused on motivation (Deci and Ryan 2012). In order to open up for other aspects of self-determination, we decided not to focus on motivation in this study. The research question is: How does teachers’ self-determination relate to their development of a culturally based local mathematics exam?


There are good reasons to believe that the Sámi were the some of the first skiers in the world (Birkely 1994), but skiing is an activity that also is common among non-Sámi Norwegians. Thus, skiing belongs to Sámi culture, but it is not a culturally specific activity. When this paper refers to culturally based activities, it is restricted to mean activities that are culturally specific for the Sámi.
2 Sámi culture and knowledge transfer

The Sámi call their land Sápmi. The area of Sápmi extends across the northern part of the North Calotte region and crosses the national borders of Norway, Sweden, Finland and Russia. The Sámi live as minorities in these countries. Their culture and their languages differ from those of the majority population. According to Sara (2004), the concept ‘Sámi traditional knowledge’ was developed in the old self-sustaining Sámi society, where people used the local natural environment as their source of livelihood. Skills directly related to these livelihood activities were developed in local settings. Sámi traditional knowledge is transmitted from the older to the younger generations through the younger working with someone older who possesses the knowledge and skills (Jernsletten 1997). According to Porsanger and Guttorm (2011), traditional knowledge has been passed down both orally and through work and practical experiences. Sámi traditional knowledge can be characterized as practical knowledge, but the knowledge also has other important aspects; it constantly examines and provides opportunity for improvement and renewal (Sara 2004).

Balto (2005) argues that the main goal of Sámi child rearing is preparing for life, “to develop independent individuals that can survive in a given environment, and to give the children self-esteem and zest for life and joy” (p.86). According to the Sámi curriculum, the Sámi School has to ensure that students get an education of quality based on Sami language, culture and society. In addition, the teaching shall promote an understanding of Sámi values (Norwegian Directorate for Education and Training 2007). Teaching that focuses on Sámi traditional knowledge will meet these curriculum demands. A local oral mathematics examination where Sámi traditional knowledge is central is in line with the recommendations of Smith (1999/2006), Hirvonen (2004), Kuokkanen (2007; 2008) and (Nutti 2010).

3 Mathematics teaching and testing

Culture influences teaching and learning in fundamental and profound ways (Pinxten 1994; Gay 2009). This means that culture is an everyday phenomenon that is present in everyone. In order for the teaching to be adequate for students with different cultural backgrounds, it has to be culturally diverse.

Skovsmose (2001) introduces the term “landscape of investigation” in order to contrast the exercise paradigm of the traditional mathematics education. He classifies milieus of learning into the
categories (1) to (6), as presented in Figure 1. Fyhn et al. (2015) focused on students’ investigations of a culturally based activity. They took Skovsmose’s ideas further by highlighting culturally specific real-life experiences that are rooted in the students’ local culture. A reason for doing so is to bring more nuances into the construct real-life experiences. More than thirty years ago, Elle created statistics tasks where the context was reindeers. One example was a task where the students were supposed to imagine four reindeers participating in a race. The question was in how many orders the reindeers could finish the race. This is a traditional exercise where reindeer is an element of the context (Figure 1, category (7)). ‘Planning a holiday trip’ (Figure 1, category (6)) is a classic open task in Norwegian school mathematics, Given some travel costs and flight or train schedules including prizes, the students are supposed to suggest a possible holiday travel for a given group of people. Tasks like this take place in a landscape of investigation. Most students in Norway can identify with this theme, whether Sámi or not. A task that is categorized as having a culturally specific landscape of investigation is most likely culturally based.

<table>
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<tr>
<th>Tradition of exercises</th>
<th>Landscapes of investigation</th>
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<tr>
<td>References to pure mathematics</td>
<td>(1)</td>
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<td>References to a semi-reality</td>
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<td>Real-life references</td>
<td>(5)</td>
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<tr>
<td>Culturally specific real-life experiences</td>
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Fig. 1. Milieus of learning. Skovsmose’s (2001) categories (1) – (6) and the two new categories (7) and (8). The left column represents the traditional exercise paradigm, while the right column represents investigative approaches.

Skovsmose (2001) points out that paying special attention to landscapes of investigation creates a great deal of uncertainty. The Sámi teachers’ challenge is not to enter a landscape of investigation, because the oral examination tradition focuses on open investigative tasks (National Education Office’s
Examination Secretariat 2000); their challenge is to develop culturally based investigative tasks, category (8) in Figure 1, and to assign these tasks to their students.

There are four powerful, inter-related forces that have a bearing on assessment: (a) the culture and mindset of the teacher community, (b) the style and approach followed by the textbooks, (c) the culture of the examination system, and (d) the curriculum itself (Shirali 2012). This paper does not concern textbooks. The culture of the Sámi mathematics teachers’ community welcomes new culturally based approaches to teaching. The examination system, on the other hand, is an outcome of a large national bureaucracy, which favours uniformity. Regarding the curriculum, we aim to provide an example of implementation of the Sámi curriculum.

Few discuss what testing tells us about proficiency in anything but a superficial sense (D’Ambrosio 2009). Schoenfeld (2007) warns us that students who experience skill-based instruction tend to succeed on tests of skills, but they do not succeed well when tested in problem solving and conceptual understanding. On the other hand, “[s]tudents who study more broad-based curricula tend to do reasonably well on tests of skills” (p. 63), while on tests of conceptual understanding and problem solving, these students succeed much better than those who just practise skills. This paper focuses on teachers’ development of a test that focus on students’ investigations and their understanding of culturally based mathematics. Their test does not focus on skills, and thus we consider Schoenfeld’s warning. A review of scientific papers reveals a lack of research on oral examinations in mathematics at compulsory school level, so our paper aims to contribute to this field.

Indigenous teachers and parents want Indigenous children to grow up with a strong Indigenous identity. They also want the children to succeed at school and later in society, and to have the opportunity to obtain well-paid jobs (D’Ambrosio 2001; Meaney 2001; Nutti 2010, 2013). Many Sámi parents want their children to undergo the national mathematics curriculum in order to prevent any disadvantage they might otherwise face when they reach upper secondary and higher education (Nutti 2010; 2013). Furthermore, Lipka and Adams (2004) showed that Indigenous primary school students could reach the learning goals of mathematics if they were given opportunities to incorporate their everyday activities into the mathematics learning at school. The learning goals of the Sámi and the national mathematics curricula are equal, while the way to reach the goals differ.
4 Research in Indigenous education

According to Smith (1999/2006), there are some concerns that make the Indigenous research agenda different from large scientific organizations’ research agendas. Decolonization and recovery are examples of such concerns. Indigenous research has to consider these concerns in addition to other research criteria, like trustworthiness, worthwhileness and so on. The researcher has to include new kinds of questions, like for instance: Trustworthy for those who are familiar with the cultural practice under investigation? Worthwhile for recognizing the culture? If the students investigate the length of a fence used in reindeer husbandry, the researcher has to ask if this task is trustworthy among reindeer herders and if the students approach to the task may be worthwhile for recognizing reindeer husbandry. Simpson (2014) points out the importance of re-creating the conditions within which the learning occurs, not merely re-creating the practice itself. Meaney (2002) warns those who choose activities from experiences of Indigenous students in mathematics education. Such choices may result in the original purpose of the activity becoming lost or denigrated if it is merely an embedding of Western mathematical ideas.

Smith (1999/2006) describes the Indigenous research agenda as a chart that uses the ocean tides as a metaphor. Four major tides are represented: survival (ebb tide), recovery (a bit below neap tide), development (a bit above neap tide), and self-determination (high tide). Self-determination becomes a goal of social justice, which involves the processes of transformation, decolonization, healing and mobilization of people. Within research in Indigenous education, both teachers’ and students’ self-determination are important issues. Thus, we include Smith’s tide metaphor in the framework for this paper.

The top priorities and concerns among Indigenous peoples have to do with decolonization and transformation of their societies (Kuokkanen 2006). Decolonization and transformation among Indigenous peoples mean restoring Indigenous communities and recovering control over their lives according to their own priorities and premises. Language, education and autonomy are central issues here. Teachers’ work towards a culture based mathematics examination concerns these three issues. In cultural revitalization, it may not be enough to focus on the language. In situations where the language is under influence of dominant majority languages, there is a risk that the everyday Indigenous language starts reflecting the values of the dominant societies more than its own. Kuokkanen warns us that “… we can also colonize ourselves in our very own language if we are not aware of the subtle and
more insidious forms of colonization and assimilation some of which we may have internalized as parts of our thinking” (p. 3). Her warning is highly relevant to the subject of mathematics for Sámi students, because the mathematics curriculum, textbooks and national examinations are mere translations of Norwegian texts. We consider autonomy to be a crucial issue for teachers’ development of a culturally based local examination, and thus the analyses in this paper mainly focus on autonomy and teachers’ self-determination.

According to Battiste (2000), Indigenous culturally based teaching aims to rebuild Indigenous peoples, communities and selves by “restoring Indigenous ecologies, consciousness, and languages and by creating bridges between Indigenous and Eurocentric knowledge” (p. xvii). Educational principles and working methods can be based on Indigenous people’s culture and traditions and developed in cooperation between institutionalized education and the Indigenous people’s community. The teachers’ development of a culturally based examination started as an initiative from institutionalized education and continued as an initiative from the Sámi teachers.

5 Teachers’ self-determination

Self-determination theory is built on an understanding that every human has a basic need to be autonomous, competent and related to others (Deci and Ryan 2000). Satisfaction of these needs, facilitates people’s autonomy, acting with a sense of self-approval. Thwarting of these needs either causes controlled motivation; feeling obliged to behave in a particular way—or it may cause a lack of motivation. Creativity may cause autonomy and vice versa (Deci and Ryan 2012), so creativity is considered an important aspect of self-determination. By contrast, it is difficult to imagine creativity as an outcome of non-self-determined behaviour. Teachers’ beliefs about the nature of mathematics, as well as about its teaching and learning, have an influence on their decisions (Törner, Rolka, Röskén and Sriraman 2010). Thus, teachers’ beliefs regarding culturally based teaching and regarding students’ autonomy and creativity are two points relevant for their decisions.

5.1 The bases for self-determined behaviour
Goal-directed activities can differ in the extent to which they are autonomous or self-determined, meaning the extent to which they are enacted with a full sense of choice and free will. Deci and Ryan
(2000) describe four types of regulatory processes in which the person has been less versus more effective in internalizing and integrating the regulation of an activity.

i) External regulation is the classic situation where people behave to avoid punishment or to attain a tangible reward.

ii) Introjection. The control of behaviour comes from consequences that are administered by the individuals to themselves, caused by for instance pride or threats of guilt and shame.

iii) Identification. When individuals understand and accept the real importance of an activity, and they have identified the value of the activity for themselves.

iv) Integration. This involves identifying with the importance of behaviours and integrating those identifications with other aspects of the self. What has been external regulation has been transformed into self-regulation and the result is self-determined extrinsic motivation.

Ryan and Connell (1989) found that introjection turned out to correlate positively with students’ anxiety and a maladaptive coping with their failures, while identification correlated positively with enjoyment and a proactive coping with failures; the more autonomous the reason was, the more it was associated with enjoyment. When the identification has become congruent with other identifications and experiences, the result is an autonomous form of extrinsic motivation. One example of introjection may be culturally based mathematics introduced in a secondary school where some teachers believe culturally based mathematics mainly belongs in primary school. These teachers may feel obliged to participate if their principal and colleagues have decided to focus on the development of culturally based teaching. Identification happens when a teacher agrees with the point of culturally based teaching, but is not aware of how to perform it. In order to develop a culturally based mathematics teaching, the teachers need competencies within culture and mathematics to an extent that allows them to find possible approaches.

5.2 Individual and social aspects of autonomy

Autonomy “is clearly a central issue in both individual and collective development and wellness” (Deci and Ryan 2012, p. 1). When people experience positive feedback that is authentic, they are likely to conclude that they are responsible for some good performance, which in turn means that they experience satisfaction of their need to be competent and autonomous (Deci and Ryan 2012). When students get good grades at the local examination, the teacher is responsible for the examination tasks and for the students’ learning outcome.

Social contexts in which people operate affect their wellness and effectiveness. Throughout history, people have struggled to protect their autonomy, and they have fought to gain autonomy. So it is for the Sámi people in Norway, who have been subjected to a government assault that almost
exterminated their culture (Edvardsen 2011; Sametinget 2014; Fyhn et al. 2015). The emergence of Sámi rights and the creation of the Sámi parliament that opened in 1989 are not caused just by the present government’s effort to redress the assimilation policy of Norwegianization from the early 1800s. The Sámi people are, and have been, a people with their own traditions and institutions. If we look further back, they have been independent.

The National Directorate for Education and Training is responsible for the rules for the local mathematics examination, while the municipalities are responsible for the content of this examination. The principal and the teachers are impacted by national government policies, which may either support or control their autonomy.

### 5.3 Creativity

Deci and Ryan (2012) claim, that when people are autonomous they show engagement and creativity in their life activities, relationships and life projects. Because of this, creativity indicate autonomy. There are certain agreed upon parameters in the literature that help narrow down the concept of creativity (Sriraman, Haavold and Lee 2013). Extraordinary creativity (or ‘big C’) relates to exceptional knowledge or products that change our perception of the world (Feldman, Cziksentmihalyi and Gardner 1994). Ordinary or everyday creativity (or ‘little c’) is more relevant in a regular school setting. Feldhusen (2006) describes ‘little c’ as an adaptive behaviour whenever the need arises to make, imagine, produce or design something new that did not exist before in the immediate context of the creator. Autonomy is vital to assimilating new ideas (Deci and Ryan, 2012), so little c is a manifestation of autonomy. Root-Bernstein (2003) claims that identifying, structuring and evaluating problems in ways that allow their solution to become apparent, are at least as important as just finding their solutions: “We must know what we do not know before we can effectively solve any problem” (p. 170). A well-known context enables the students to get an overview of what they know and what they do not know. Torrance (1988) specifically notes fluidity, the number of different ideas that are applied to a problem, as one aspect of creativity.

### 5.4 Beliefs

*Beliefs* is a construct with different meanings and accentuations, but there is some consensus that mathematical beliefs are conceived of personal philosophies and conceptions that include ways of teaching and learning mathematics. Curriculum-based professional development involves teachers’ beliefs about a) mathematics, b) students’ learning, c) mathematics pedagogy and d) the mathematics
curriculum (Lloyd 2002). Teachers’ goals are founded in beliefs, but beliefs do not always imply direct actions, although they definitely influence or induce defined goals. Thus, teachers’ goals are indicators of their beliefs. In this paper, teachers’ beliefs about culturally based mathematics teaching and their beliefs about students’ learning from culturally based teaching influence the development of their self-determination.

Cross (2009) investigated high school teachers who taught ninth grade algebra. She found that teachers’ beliefs about the nature of mathematics were highly influential on their beliefs about pedagogy and students’ learning. The teachers’ beliefs regarding their students’ learning, mathematics pedagogy and mathematics curriculum also concern their beliefs regarding students’ creativity and students’ autonomy.

6 A four-step study

The teachers in this study work at a Sámi lower secondary school, which is located in a rural municipality in the northernmost part of Norway. The population density for the region is very low, and reindeer husbandry is the most important livelihood for the Sámi inhabitants of this municipality. The school has one hundred students. Approximately 95% of them have Sámi as their mother tongue, while the others understand and speak some Sámi. In 1992, the municipality board decided that Sámi language is a compulsory school subject. Since then all students with Sámi as their home language have been taught in Sámi. Most of the teachers are functionally bilingual in Sámi and Norwegian, and all the teachers participate in Sámi cultural and social life. The participating teachers’ relations to each other and their school were relatively stable throughout the project period. They are both experienced mathematics teachers and neither of them participated in further studies of mathematics during the project period. Thus, this study’s focus concerns teachers’ autonomy. The teachers’ self-determination will be analysed with respect to a framework consisting of the following four categories: i) Deci and Ryan’s (2000) four types of regulation: external, introjected, identified and integrated; ii) the four levels in Smith’s (1999/2006) tide metaphor: survival, recovery, development and self-determination; iii) creativity as the presence of a) everyday creativity (Feldhusen 2006) and b) flexibility (Torrance 1988); and iv) teachers’ beliefs about culturally based teaching and learning mathematics. The students’ tasks will be categorized as belonging either to the exercise paradigm or to landscapes of investigation, and as to whether they are culturally based or not.
6.1 The two teachers

Elle and Ovlla were born and raised in the local Sámi culture. They are experienced mathematics teachers whose ideas about the education and the activities they want to bring about are quite clear. Both of them have been members of the national examination assessment committee in mathematics for several years. Elle is the school’s principal. She is probably one of the individuals in Norway with the longest experience in teaching mathematics at a Sámi lower secondary school. Ovlla has been a member of a group at The Norwegian Directorate for Education and Training, which worked toward adapting the mathematics examination tasks to Sámi conditions, if necessary. The members of this group also participated in professional development courses that focused on the distinction between open-ended and closed tasks in mathematics.

At the end of compulsory school, Norwegian students undergo two examinations in mathematics, one national test and one local test. The national examination is a written test where all students get identical tasks. The local examination is an oral test where the mathematics teachers in each school design the tasks. The 2000 guidelines for the local examination (The National Education Office’s examination secretariat 2000) point out that the test has to ensure that the students a) experience the situation as their arena, b) get a reasonable amount of time for planning and preparations, and c) get opportunities for being individually active as well as for cooperation. According to these guidelines, the teachers are authorised to construct the examination. The common interpretation of point a) in the guidelines is that the aim of the test is to support the students’ autonomy, while the interpretation of point c) is that the test should enable the students to relate to each other. All in all the guidelines highlight the students’ self-determination and autonomy; the guidelines are in line with Balto’s (2006) description of Sámi child rearing. Elle and Ovlla had followed these guidelines for ten years when they first met the researchers in this study.

6.2 Focus group interview

A focus group interview is an interview focusing on the issue to be researched. The interview is open and invites the participants to bring forth their own ideas. The participants’ experiences, important attitudes and views are discussed at a group level (Bojlén 2001). Focus groups often produce data that are rarely produced through individual interviews, and they allow taking “the interpretive process beyond the bounds of individual memory and expression to mine the historically sedimented collective memories and desires” (Kamberelis and Demitriadis 2005, p. 903). In a focus group
The intention behind our interview was to bring out the teachers’ vision concerning the contexts in the national mathematics exam. Each individual develops her or his perspective and contribution in interaction with the others in the group. This individual development results in a different outcome than individual interviews with the participants would have done. The mathematics teachers at one school is not a homogenous group of people, and it was important to gather as much insight as possible about their perspectives.

6.3 The teachers’ plan for the mathematics day

A common aim of all the examination tasks was that the students should describe aspects of their culture through mathematics and that they should apply mathematics to culturally bound situations, situations beyond mathematics itself. Each task included carefully chosen illustrations that intended to guide the students’ process of investigating their own culture. Table 1 presents context and mathematics for the three tasks. In the third task, the students have to choose one of two contexts. The mathematics content in the tasks was narrowed to two given subject areas in the curriculum, and in addition the students should choose one subject area themselves. The tasks covered all subject areas in the mathematics curriculum, except functions. The tasks were categorized as (8) in Figure 1; culturally based and investigative tasks. The teachers would participate in discussions with the students, with the aim of functioning as stepping-stones for the students’ investigative processes.

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<tr>
<th>Task</th>
<th>Context</th>
<th>Subject area in the curriculum</th>
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<tbody>
<tr>
<td>1</td>
<td>Reindeer husbandry</td>
<td>Measurement Numbers and algebra</td>
</tr>
<tr>
<td>2</td>
<td>Local Sámi dress</td>
<td>Geometry Statistics, probability and combinatorics</td>
</tr>
<tr>
<td>3</td>
<td>a) Sámi woven bands</td>
<td>Geometry</td>
</tr>
<tr>
<td></td>
<td>b) A traditional wooden sledge</td>
<td>Measurement</td>
</tr>
</tbody>
</table>

Table 1. Context and subject area for the tasks designed by the local teachers.

6.4 The data

The study is divided into four steps. Step 1 includes an introductory focus group interview in March 2010 with all the mathematics teachers at the school, and a preparation meeting before this interview. Step 2 took place two years later, in January 2012. Here the teachers Elle and Ovlla prepared a pilot examination/the mathematics day in collaboration with two researchers Anne and Ylva. This meeting took place the day before the mathematics day. Step 3 is evaluation of the mathematics day,
which included a) one meeting at the end of the mathematics day, b) an evaluation meeting the day after and c) two phone conversations five months later, in June 2012. The mathematics day provided the teachers with some experiences that motivated them to implement a culturally based local mathematics examination for the same group of students\(^1\) in May 2012. Step 4 is a retrospective focus group interview between Anne and the two teachers three years later, in March 2015, and e-mails from Elle and Ovlla just after this interview.

The data consists of handwritten notes from Step 1, audio recordings from step 2, audio recordings from the meetings in step 3, field notes from the phone calls in step 3 and field notes from step 4. Step 1, the very first meeting between the two researchers Kristine and Anne and the team of mathematics teachers was not appropriate for audio recording. This was an introductory meeting between people who did not know each other, so audio recording was never a theme. Instead, one of the researchers wrote down what the teachers said during the discussions. Step 4 was not audio recorded because it was a short interview where the researcher wanted the teachers to have time to reflect on their answers and to agree upon how to put things down in words. The analysis of the introductory focus group interview concerns the national written examination while the other analyses concern the local oral examination.

7 Findings

Three researchers discussed whether the national mathematics examination in Norway was in line with the Sámi curriculum; Kristine and Anne explained the situation for Bharath, who was a foreigner. Kristine suggested a meeting with Elle because of her experiences and skills. Anne and Bharath visited Elle and her eight-grade mathematics class in January 2010. This meeting resulted in the introductory focus group interview, which took place six weeks later, in March.

7.1 Step 1: The introductory focus group interview

Anne and Kristine had developed new-context versions of three tasks from the latest national mathematics examination. The researchers’ intention was to create alternative, culturally based tasks that largely test the same mathematics skills as the original tasks. According to Deci and Ryan (2012), contexts vary in the degree to which they either support people’s autonomy or control their behaviour,

\(^1\) Norway has a ten-year compulsory school.
feelings and thoughts. The differences between the new and the original tasks were the main theme in this interview. The interview revealed information about the teachers’ beliefs, that the learner benefits from a teaching that is based on the local culture (Fyhn and Nystad 2014). However, the teachers did not teach culturally based mathematics. This is interpreted as an example of the level of recovery, or below neap tide, according to Smith’s (1999/2006) tide metaphor. The teachers had no experience with culturally based open tasks in mathematics, category (8) in Figure 1. From Deci and Ryan’s (2000) perspective, this lack of experience can be interpreted as a need for competence, competence that was needed in order to achieve identified regulation.

The principal, Elle, welcomed the researchers to interview the teachers about context and content in the national examination. She was convinced beforehand that this examination disfavoured Sámi students from rural northern areas. Ovlla introduced himself and provided an example from the national group that worked with adapting national examination tasks for Sámi conditions. In one task, the group replaced an archipelago motor boat (Skjærgårdsjeep) with a different boat, because there was a risk that Sámi students from the northern areas would be distracted by the unfamiliar boat. Ovlla said that the introduction of a new curriculum caused this national group to be closed down in 2008. That represented a decrease in autonomy for the Sámi. According to Smith (1999/2006), that event can be described as a backwards move from development to recovery, or from above neap tide to somewhere below neap tide.

The interview revealed weaknesses in the use of illustrations. For instance, Ovlla referred to a speedboat task that he knew from the external examination committee. The task showed pictures of three racing boats and informed that the maximum speeds were respectively 65 knots, 100 km/h and 30 m/s. The task also informed that 1 knot = 1.852 km/h and 1 m/s = 3.6 km/h. The question was which boat was the fastest, and the students had to provide reasons for their answers. Ovlla said that some students with knowledge about boats had argued that boats with two bows are faster than those with only one, and that the more a boat rear up the faster it goes. These arguments were not given credit. This is what Schoenfeld (2007) warns about; this task could make students believe that mathematics is not supposed to make sense.

One task concerned an express train timetable. The two northernmost counties in Norway have no railways, so many of the students had never seen a train. Elle (2010 March 9, notes from meeting)
claimed, “[t]he students had seen tasks like this in their textbooks, but they might wonder whether the illustration shows the railway”. Ovlla followed up,

... But all those who have relations to trains, to the airport express train, might have an advantage here. Even though our students have travelled by plane and with the airport express train, the task for us is that the students shall see mathematics in this. But I agree with Elle that the visual part is unclear. It could have been a more square like table with columns. (Ovlla 2010 March 9, notes from meeting)

The teachers claimed that illustrations in these two tasks disfavour students from rural northern areas. They agreed that illustrations, which do not provide useful information, should be left out.

Elle saw no point in including names of localities that the students were unfamiliar with, like for instance Asker, which is a municipality close to Norway’s capital. The group of teachers agreed that they believe well-known contexts are supporting the students, but they also pointed out the students’ need to learn about contexts outside of their local community. Several times the discussion returned to the question of unfamiliar versus well-known units of measurement; the local students were familiar with miles and kilometres per hour as measures for velocity, while knots represented something unfamiliar. At the end of the interview, Ovlla said, “We should have had such discussions more often.” Ovlla’s closing words and his utterances during the interview indicate that he was motivated to change the examination so it could support their students. The group of teachers believed that the choice of contexts in the national examination disfavoured their students.

7.2 Step 2: Preparations for the pilot test

One year later, the school agreed to participate in a research project about Sámi culture and discrete mathematics (Fyhn et al. 2015). The teachers decided to include a broader aspect of culturally based tasks in this project. Their initiative is a strong indication of autonomy; it was the teachers’ own suggestion. The principal, Elle, was one of the participating teachers, and the school’s leadership was hence involved with the initiative. This initiative resulted in “the mathematics day”, a culturally based pilot examination, which included some Sámi culturally based tasks for the students in grades nine and ten. The day before this pilot test, the teachers had a preparatory meeting. Elle opened the meeting and said that they had to start the day by informing the students about how to work.

One student from each group would draw a task, and then they get ... we have not prepared this much for the students, but at least they know that they will work with the subject [mathematics]. And this examination form actually ... that we are trying out ... that we get some experiences with it. And the method is so that they get the tasks in the morning, and then, during the examination, there they will ... prepare for a certain number of hours and then present in the end of the day. (Elle 2012 January 30, Transcript from meeting)
The teachers aimed at creating tasks that encouraged the students to think creatively and not just copy examples from the textbook. They wanted tasks that opened up for creative solutions, and they even suggested that students could be more creative than their teachers could. The teachers were following Torrance’s (1988) principle of looking for variations in students’ solutions in the form of originality, flexibility and elaboration. They wanted to support the students’ autonomy, and according to Balto (2005), autonomy is more important in Sámi traditional child rearing than among Norwegians. The teachers were aware of Skovsmose’s (2001) point that entering a landscape of investigation would result in a lack of control for the teacher.

Like in the focus group interview, the teachers believed that tasks from well-known cultural contexts could lead to learning goals of the curriculum being realized. They claimed that Sámi handicraft, duodji, and mathematics usually are left-outs in school-based project work. Now these two subjects had an opportunity to cooperate. The discussion resulted in a focus on creating mathematics tasks based on duodji. The teachers agreed that the tasks had to be open, but Elle wanted some limitations.

Task one, that is boazu, reindeer. There is not much text: You have to show as much mathematics as possible … that belongs to the theme. Maybe this task … that our tasks are too open. The more open a task is, the more demanding is it for the students. (Elle 2012 January 30, Transcript from meeting)

Ovlla pointed out that students nowadays were getting more and more used to open tasks and he suggested confining this reindeer task. One researcher suggested that each task could focus on some of the subject areas in the curriculum, and after a short discussion the teachers concluded that each task should concern two given main subject areas and that the students would have to choose a third area. Illustrations in combination with the main subject areas intended to guide the students toward focusing on some aspects of the given theme. Each task would show pictures from cultural contexts that are well known to the students; they had to identify and describe as much mathematics as possible from this context. The teachers believed that these tasks would make it possible for the students to reveal much knowledge of mathematics. The tasks belong to a culturally based landscape of investigation, category (8) in Figure 1. The focus group interview revealed that the teachers experienced a gap between local cultural contexts and this kind of task, thus, category (8) was new to them.

Elle and Ovlla described their mathematics teaching practice as belonging to the exercise paradigm, including some sporadic experiences with creating culturally based tasks like category (7) in Figure 1 beforehand. Ovlla reported some experiences with creating real-life tasks like category (6),
We have had a tendency to provide tasks involving things like traveling and ... sports and my first flat. Much like that. We have not been brave enough ... we do not dare to let go of ... we are too much bound by the national. (Ovlla 2012 January 30, Transcript from meeting)

Ovlla’s honest utterance explains how a national control or a lack of teacher autonomy has influenced their mathematics teaching. The national rules have been an obstacle to their development of a culturally based mathematics teaching. This can be explained by Ryan and Connell’s (1989) finding that anxiety is related to introjected regulation and external causality, while enjoyment is associated with intrinsic reasons. From Deci and Ryan’s (2000) perspective, Ovlla describes how the national rules have acted as an external causality for their behaviour. According to Smith’s (1999/2006) tide metaphor, the teachers had been stuck in a state of recovery without proceeding towards development, as if the tides would not increase above neap. Now they were preparing for a new goal, namely to carry out investigative culturally based mathematics teaching. They had for a long time recognized and accepted the value of a culturally based mathematics teaching, but they lacked experience with this way of teaching. One possible way to gain this experience was everyday creativity (Feldhusen 2006); this is an example of interplay between creativity and autonomy where the outcome is increased self-determination. Support from authorities outside their school community may foster that kind of experiences. Their everyday creativity is necessary for them to carry out a completely new approach to teaching mathematics. A mathematics day based on explorations of different elements in their local cultural context represents a move from comfort to risk, where openness to the unforeseen can lead to vulnerability. The teachers agreed that it was exciting to approach a day where they did not know what would happen. This is a strong indication of enjoyment: The reasons for their behaviour have become internal.

The meeting was closed by Elle, who claimed that they should have worked this way earlier when the students worked in groups with given problems. Now “... they will formulate a problem on their own, then solve the task ..., and then present it ... OK.” (Elle 2012 January 30, transcript from meeting). Here she is highlighting students’ everyday creativity. Her utterance reveals that she believes in the students’ autonomy. The teachers claimed that their participation in the research project had encouraged them to create tasks that were not in line with the national tasks. This shows how support by researchers resulted in everyday creativity (Feldhusen 2006) and flexibility (Torrance 1988). The teachers’ participation in the research project about culture and discrete mathematics supported their
autonomy, and now they were preparing for creating a social context that would support their students’ autonomy.

7.3 Step 3: The teachers’ reflections after the pilot test

The teachers were impressed by the students’ performances; the students had solved open investigative tasks to a greater extent than expected.

It was very exciting to see that they really managed to connect mathematics to well-known issues from their daily life and from Sámi culture. We are not used to that, ... this was a very useful experience, and maybe a small contribution to helping the students understand the mathematics subject a little better. (Elle 2012 January 31, Transcript from meeting)

This comment reveals Elle’s beliefs about mathematics and about students’ learning; mathematics is relevant for the local real life world and clarifying such connections may support the students’ understanding of mathematics. The comment also reveals that Elle believes mathematics has to do with understanding; it is not just application of some given rules. Elle’s words “we are not used to that … this was a very useful experience,” are a strong indication of a move from what Deci and Ryan (2000) call “somewhat external” to “somewhat internal” causality. Her experiences with how students related mathematics to their daily life and to Sámi culture influenced her beliefs about mathematics pedagogy; she had gained new competence. Ovlla said, “It is very exciting to see what they have managed to do in the limited amount of time; this shows that they are able to work this way —actually, this is a new way of working for us as teachers as well as for the students.” Both the students and the teachers had invented something that was new to them; this is an example of what Feldhusen (2006) calls ‘little c’ creativity. Both Elle and Ovlla said that inspiration was an important issue for the students’ learning; inspiring tasks support the students’ autonomy.

The following morning the teachers met their students, and later that day all teachers in the team evaluated the pilot examination/mathematics day. The evaluation meeting started with Elle and Ovlla’s presentations of their students’ experiences with the mathematics day and the students’ opinions about this kind of test as an oral examination. Ovlla’s students were satisfied with the day, but they wanted more traditional tasks for the examination and they preferred an individual test. Elle’s students provided diverging answers. Elle claimed that she believed in working this way, but not at the oral examination.

My conclusion is that I might believe that these students cannot have an examination of this kind; we are too late [for that kind of examination]. But as a working method, it is a good working method. And we have learned to connect mathematics to Sámi culture. We have not
dared to do that earlier, but now we see that it works. And it works quite well, too. (Elle
February 1, Transcript from meeting)

Elle here explains that when the teachers’ causality was somewhat external they did not dare to try out
this kind of test. Now they have experienced that it works, and their autonomy is no longer controlled
by national authorities. Their belief about culturally based mathematics teaching has developed too,
because of this new experience. Elle said that this day the students had to produce mathematics, while
they were used to mere reproduction. She pointed out that there was a great difference between the two
approaches, and referred to one group who formulated a mathematical problem that they solved. Ovlla
continued,

They [the pupils] say that traditional tasks are easier. That means tasks they find in textbooks,
where they can look up and check for similarities. Here they had to think differently. Here they
had to find mathematics in some concrete material. It was not as simple as looking up a
completed example in a textbook ... then they had to look at the examples, but that did not
provide any direct answer, and they had to reformulate; they had to think it through; they had
to think differently (Ovlla 2012 February 1, Transcript from meeting)

Ovlla describes an example of everyday creativity where the students had to identify, structure and
reformulate their problem. Like Elle, he highlighted everyday creativity or ‘little c’ (Feldhusen 2006);
the students had to make, imagine, produce or design something new that did not exist before in their
immediate context.

One group of students created a task about building a round-shaped reindeer separation fence and
how to find its circumference or length. Elle said that the students first suggested that the fence was
five kilometres long. Then she asked the students how long time they needed to walk five kilometres
from where they were seated in the school building, and the students claimed that the fence had to be
shorter. When she left the group after some discussion the length had shrunk to 3.6 kilometres, and
when the group presented their work, the fence had become 1.6 kilometres long. The students’
knowledge about the cultural context made them able to decide whether the length of the fence was
reasonable or not. Elle pointed at the learning process that took place in this group. Her belief
regarding mathematics pedagogy is in line with Deci and Ryan (2012); when people are more
autonomous, they exhibit greater creativity. Both teachers claimed that group work in mathematics was
challenging for the students as well as for the teachers.

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2 This kind of fence might be up to one kilometer long. Elle said, in a later phone call interview
about the task, that “you must have experienced a fence like that—you must have been inside it—to
imagine it and draw it on paper.”
At the end of the meeting the teachers explained how participating in a research project caused them to work systematically with a culturally based investigative approach to mathematics, “I am changing. These two [the researchers] have started something …” (Ovlla 2012 February 1, Transcript from meeting). Elle (2012 February 1, Transcript from meeting) claimed, “… It is good that we were involved in this project. It is very stimulating and hopefully something that can help us grow …” Using Smith’s (1999/2006) tide metaphor this would be an example of development and a move towards self-determination. From Deci and Ryan’s (2000) perspective, this is an example of how the teachers have moved from external to internal causality—they took control over the content of the teaching instead of being controlled by some national authorities. The teachers explained that the reason for their development was participation in a research project, but their utterances also point to feedback from their students as a supportive factor. Their self-determination has increased, which has caused them to enter the risk zone and use everyday creativity in creating an investigative approach to mathematics.

7.4 The culturally based examination
Elle and Ovlla suggested giving the students similar tasks for the local examination four months later. The researchers warned that an examination might not be a proper occasion for a new way of working. The teachers did not care about the warnings and just carried out the local examination without informing the researchers. The cause for the teachers’ decision was internal; this is a highly autonomous decision. Local culture was an obvious choice for context, and working in pairs was preferred at the examination.

A telephone conversation with Elle after the examination revealed that each student had to prepare for expected and unexpected questions from their teacher during and after the presentation. The teachers and the students experienced the examination as a success. The external examiner from the neighbouring municipality was a bit sceptic to letting the students give prepared presentations. However, after listening to the presentations, which included students’ answers to questions from teachers and examiner, the scepticism faded away. The examiner was impressed by the amount and level of described mathematics in relation for instance to the local Sámi dress or just a simple sled. The teachers experienced that their students got a closer relationship with mathematics because “the subject became more alive.”
7.5 Step 4: The retrospective focus group interview

Due to the success, the teachers established this examination form at their school. Three years later, they met the project leader in a focus group interview. They answered three questions: 1) why did you arrange a culture-based examination with open-ended tasks when the researchers advised you not to do so? 2) What do you think is the benefits of such an oral examination versus a traditional oral examination? 3) Open versus traditional tasks - what are your beliefs? The teachers were shown a drawing similar to Figure 1 when the first question was asked. Elle said their decision was caused by a spontaneous reaction at the team meeting after the mathematics day. Ovlla said that it was important to them that the context was close and well known to the students. Their aim was to facilitate for the students’ success, to create conditions that can support the students’ autonomy. Therefore, three years later the teachers still believe in culturally based investigative tasks. They also kept an eye on the development of the national rules for the local examination. The teachers feared that new national rules for this examination would lead back to a more controlled and less autonomous local examination; in Smith’s (1999/2006) terms, from a level of development to a level of recovery.

Elle commented that they had tried out examination in pairs earlier, so that part was not new. She added that the researcher Bharath inspired them to believe in culturally based teaching at the very first meeting in her class. This is an example of how external support can lead towards intrinsic causality or autonomous behaviour. Ovlla said, “It was the glow we observed in the students. We awoke the interest in some students whom we never reached with the standardized examination.” The observation of “glow” in the students is a type of feedback that made him really identify the importance of culturally based teaching. This feedback contributed to a change of cause for his behaviour; it moved from what Deci and Ryan (2000) call “somewhat external” to “somewhat internal”. In terms of Smith’s (1999/2006) tide metaphor, the feedback supported his move from recovery to development, from below neap tide to above neap.

One month later, Elle and Anne exchanged e-mails about how to present the content of this interview correctly. Elle wrote

... for my part, this was because we had just completed a 30 ECT study called «Inclusion and equality – the principle part of the Sámi curriculum», which concerned dissemination of Sámi traditional knowledge in school. It was a spontaneous reaction, which had matured in my head over time and it was released as a result of a holistic recognition of Sámi School, which we experienced during the study (Elle, personal communication April 24 2015)

Just before the examination, she and ten other teachers at the school completed this study, which was offered by the Sámi University College. She explained her decision regarding the culturally based
examination; during this course, she experienced that Sámi culture was recognized as important in education. Elle’s utterance expresses one important reason for her decision: The course contributed to a move from external to internal regulation, in Ryan and Connell’s (1989) terms. In terms of Smith’s (1999/2006) tide metaphor, they had entered the level of development and were moving towards high tide.

8 Discussion

A person’s background consists of events that have taken place, while the foreground is events that might take place (Skovsmose 2011). A person’s background can be seen as a determining factor for the foreground—to some extent, the background frames the foreground. Gathering food from nature by fishing, hunting or collecting berries will probably be part of the foreground of a person who has many positive experiences with those activities. The foreground is an open situation; it is how the person experiences possibilities. Experiences of meaning concern experiences of relationships. How students construct meaning depends on how they connect their learning activities to their foreground and to their overall situation. Sámi youths with a background from reindeer husbandry, who want to spend their future life working with reindeers, have foregrounds similar to their backgrounds. Thus, the distinction between background and foreground is not relevant for the case of these young Sámi reindeer herders. According to principal Elle outdoor life was the most popular subject among the students at her school in the school year 2014–2015. Thus, outdoor life is in the students’ backgrounds as well as in their foregrounds.

According to Walkington, Petrosino and Sherman (2013) the idea that interest can support students’ learning of mathematics in secondary school is largely untested in educational research. They suggest that interest may support situational understanding, allowing students to construct models of actions, objects and relations. Their suggestion is in line with Elle and Ovlla’s observations, that the students’ interests in and experiences with reindeer husbandry would allow them to use their experiences and situational understanding in creating and solving open-ended tasks. The creation of open tasks is an example of everyday creativity (Feldhusen 2006).

Liljedahl (2009) investigated the rather complex relationship between teachers’ beliefs and professional growth. He claims that we can no longer assume that there exists a strong connection between teachers’ espoused beliefs and their intentions of practice. Our study reveals a clear
connection between two experienced teachers’ espoused beliefs and their intentions of practice. This appears clearly in the very first meeting after the mathematics day, when Elle described how exciting it was to see their students’ work.

Bedford (2009) observed that teachers expressed a desire to change teaching in school, but according to various personal, cultural and structural barriers, they did not always realize their desire. According to Planas and Civil (2009), teachers’ empowerment can be a way for them to improve the teaching as well as their teacher profession by means of gaining ability, confidence and motivation to succeed professionally. Nutti (2010) took Bedford’s perspective and identified teachers’ drive, ability and possibility to act towards school-change. The teachers in her study developed and implemented Sámi culturally based teaching activities. The most important factors that made the empowerment process possible seemed to be the international research field and the collaborative work between teachers, researcher, and cultural resource persons. Findings from our study is in line with this, the teachers declared that their participation in research was one reason for their development of the culturally based examination.

9 Concluding remarks

The teachers Elle and Ovlla participated in a research project about culturally based discrete mathematics. Parallel to this work, they decided to conduct a mathematics day/a pilot mathematics examination where the students worked with culturally based tasks. Despite warnings from the researchers, the teachers decided to carry out a culturally based examination for the same group of students four months later. The reasons for their decision were a) the observed response from their students during the mathematics day, and b) their participation in a 30 ECT study about principles for the Sámi curriculum.

The analyses reveal that when the teachers experienced controlled autonomy they did not dare create culturally based tasks. On the other hand, when they experienced supported autonomy, they viewed entering a culturally based landscape of investigation as something exciting. This is similar to Ryan and Connell’s (1989) findings, Supported autonomy correlates with enjoyment, while controlled autonomy correlates with anxiety. Entering a culturally based landscape of investigation for the first time is an example of what Feldhusen (2006) calls “everyday creativity”; the teachers had to come up with something that was really new to them.
Elle and Ovlla believe that decreased control from the teachers may cause increased student autonomy. In turn, they believe student autonomy opens up for students’ everyday creativity. Their beliefs about student autonomy is in line with Balto’s (2005) point that autonomy is more in focus in Sámi traditional child rearing than among Norwegians. Their beliefs about student autonomy have not changed during the project period.

The teachers’ increased self-determination can be described by Smith’s (1999/2006) tide metaphor as a move from a level of recovery to a level of development, from below neap tide and towards high tide. The analysis shows the importance of support for teachers when moving from recovery to development.

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