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## The Fairy-Tale Forest: Developing Pedagogical Content Knowledge for teaching Primary School Mathematics in The Scottish Storyline Approach

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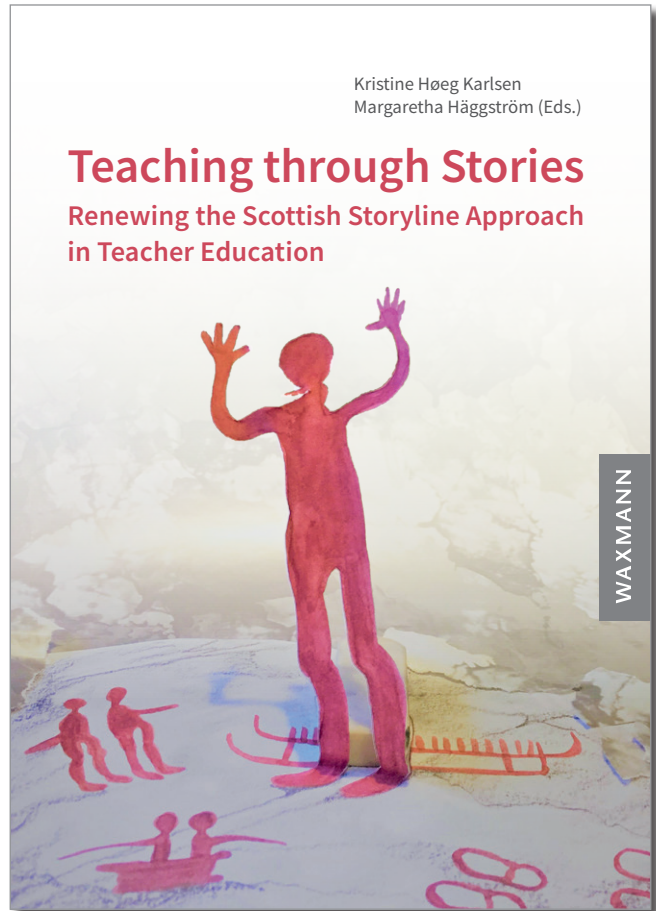
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## Chapter 8

### **The Fairy-Tale Forest: Developing Pedagogical Content Knowledge for teaching Primary School Mathematics in The Scottish Storyline Approach.**

*Kristine Høeg Karlsen, Stein Arnold Berggren, Ali Reza Ludvigsen and Ragnhild Louise Næsje*

*Abstract:* This study focuses on the development of mathematical pedagogical content knowledge when implementing Storyline as a narrative approach to organising cross-curricular learning for student teachers to become teachers in mathematics for grades 1–7. In Storyline, teachers according to Omand (2014) carefully plan “a ‘line’ of episodes, each of which has carefully designed key questions that encourage and support the learner to contextualise and create the ‘story’, promoting exciting learning” (p. 3). The study uses six semi-structured focus group interviews with a total of 24 first year student teachers. A qualitative analysis, based on the framework of Creswell and Creswell (2018), structures the process of coding. The results contribute to pedagogical content knowledge (cf. Ball, Thames & Phelps, 2008) for teaching primary school mathematics in the following three domains: i) Playing out the Fairy-tale story; ii) Preparing, exploring and performing the tasks; and iii) Learning through a Meta-Storyline. The results show that the students encountered a completely new way of learning mathematics when using Storyline. In summary, although the student teachers report awkwardness when joining the fictional in-role activities, they see the potential for facilitating playful and explorative learning experiences for pupils in primary school.

*Keywords:* Pedagogical Content Knowledge; mathematics; learning; student perspective

### **Storyline and Pedagogical Content Knowledge**

Storyline is a flexible and cross-disciplinary approach to learning where students engage in real-world challenges (Ahlquist, 2015, p. 42, 47). Storyline thus provides for a good framework according to Fauskanger (2002), where mathematics occupies a central position in the learning process (p. 308). Moreover, through Storyline the students can learn mathematics in entirely novel ways. But, to be able to carry out the work of teaching mathematics in a meaningful way that supports pupils learning, teachers must have developed specific pedagogical content knowledge, in addition to common and specialised subject matter knowledge (Fauskanger, Mosvold, & Bjuland, 2010). Theorists in the field of mathematics have defined this knowledge in several ways (Fauskanger et al., 2010, p. 35). In this chapter, we use a theoretical framework given by Ball, Thames and Phelps (2008, p. 339–402), further combined with Midtsundstad and Willbergh’s (2010a) didactic perspective on *Bildung*.

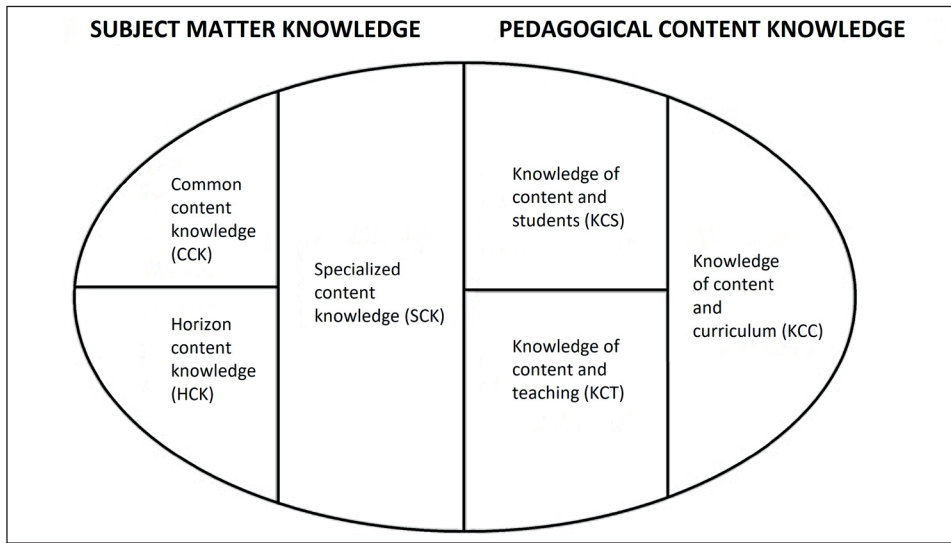


Fig. 1: Domains of *Mathematical Knowledge for Teaching* adapted from Ball et al. (2008, p. 403)

Ball et al. (2008), building on the work of Shulman (1986), have made substantial effort in developing a practice-based theory of content knowledge for teaching mathematics, divided into two main domains; subject matter knowledge and pedagogical content knowledge (see figure 1). In this study, we focus on the development of pedagogical content knowledge when students are participating in a cross-curricular Storyline. The pedagogical content knowledge is divided into three sub domains: *knowledge of content and students* (KCS), *knowledge of content and teaching* (KCT) and *knowledge of content and curriculum* (KCC). KCS is knowledge ‘that combines knowing about students and knowing about mathematics’ (p. 401). Having acquired knowledge within this domain, teachers are able to predict what students will perceive to be easy and difficult, because the teacher understands how the students are thinking (Ball, et al., 2008, p. 401). This means that the teacher can foresee ‘what students will find interesting and motivating’ (Ball, et al., 2008, p. 401). KCT is knowledge that combines knowing about teaching and knowing about mathematics’ (p. 401). Knowledge within this area acknowledges the importance of pedagogic choices and makes the teacher able to design the instruction in a way that promotes as much learning as possible for all pupils (ibid.).

To ensure that the student teachers acquire *pedagogical content knowledge* during education, the teaching and learning of mathematics within the teacher education must be adapted to the students. To correspond to the model of Ball et al. (2008), teacher educators must, according to Valenta and Enge (2015, cf. Fig. 2), have *knowledge within the field of mathematics and the student teacher* and *knowledge within mathematics and the teaching of the student teacher* (authors’ translation) in order to enable student teachers to develop the necessary knowledge for teaching mathematics during education. From the didactic perspective of Bildung theory, the prerequisite for this to happen is that student teachers become *aware* of the content of the Storyline as contributing to their own pedagogical content knowledge (c.f. Midtsundstad & Willbergh, 2010b, p. 11), a process where they also discover what the content “means to me” (Willbergh, 2010, p. 56). Within this con-

text, in line Midtsundstad and Willbergh (2010b), the professional teacher educator must thus strive to select content that the student teachers will find meaningful. Although the main focus has been on the pedagogical content knowledge in the analysis, it can be mentioned that some comments regarding *common content knowledge* (CCK) and *specialised content knowledge* (SCK) will be made within the domain of subject matter knowledge when discussing the results. The aim of this study is to focus on the opportunities created for student teachers who will become primary school teachers for grades 1–7, to gain understanding of the pedagogical subject-specific mathematical content knowledge for teaching when participating in a Storyline. The following research question has been posed: How do student teachers preparing to teach grades 1–7 perceive the mathematical pedagogical content knowledge developed in a Storyline focusing on a fairy-tale forest?

Internationally, there has been an increased amount of research focusing on teachers' mathematical content knowledge in both the context of *primary- and lower secondary school* (cf., Depaeppe et al., 2015; Krauss et al., 2008) and *teacher education* (cf., Blömeke, Suhl, & Kaiser, 2011; Niess, 2005; Valenta & Enge, 2015). However as far as we know, there is not a single study that critically examined the opportunities offered by Storyline for student teachers to develop mathematical content knowledge (also confirmed by Karlsen and Lockhart-Pedersen, 2020, systematic map presented in chapter 19 in this anthology). Having said that, there are quite a few studies within the field that focus on mathematics and Storyline in more general terms. A large portion of these studies aim to give school teachers a practical tool for teaching mathematics, such as Storylines “The Tivoli” (Fauskanger, 2003), “The Magic Trolls” (Fagernæs, 2003b) and “Danish Animals” (Christensen, Børnebyen, & Christensen, 2011). Other studies aim to contribute with more comprehensive knowledge relating to how and why The Storyline Approach can serve as a framework for cross-disciplinary teaching and learning in schools where mathematics plays a central role. Håkonsson (1997) for example, discusses the possibilities for pupils to solve mathematical problems and becoming imaginative when using fantasy as part of the Storyline (p. 133), while Fauskanger (2002) in her study, challenges and postulates whether mathematics should be within or outside the fictional activities in a Storyline. Solstad (2009), based on the Storyline “The Zoo”, which first-year student teachers implemented during their teaching practice in school, aimed to examine the student teachers' experiences with using Storyline as a strategy for teaching literacy (Norwegian) and numeracy (Mathematics) in practice, and further, their attitudes towards using Storyline as future teachers. These studies and two other studies on Storyline within teacher- and adult education, which do not have a particular focus on mathematics (cf. Falkenberg, 2016; Karlsen, Lockhart-Pedersen, & Bjørnstad, 2019a; Murray, 2016) together with the theoretical framework described above, create a backdrop for this study. In the following, we will describe the Storyline implemented in teacher education, before going in depth into research design and methodology.

## The Fairy-tale Forest Storyline

In this part the context of the study, *The Fairy-tale Forest*, a Storyline developed for student teachers to become teachers in mathematics for grades 1–7 will be described as it is important for understanding the data analysis, interpretation and discussion of the result.

### A Storyline with Focus on Mathematics

There are various types of Storyline: book-based, historical and the here-and-now (Storhaug, 2009). Our project is a book-based Storyline, named *The Fairy-tale Forest*, because the five fairy tales; *Cinderella*, *Beauty and the Beast*, *Snow Queen*, *East of the Sun and West of the Moon* and *Maiden Rosewing of Santavaja Isle*<sup>1</sup>, make up the thematic framework. The fairy-tale genre is a theme in the subject description in Norwegian for primary school students. *The Fairy-tale Forest* is also what is known as a *Meta-Storyline* (Karlsen et al., 2019a), where the Storyline is used to teach the students *about* Storyline (p. 152). The students work in groups of four or five (ten groups in total). The Storyline Approach (TSA)<sup>2</sup> was undertaken by five teacher educators and includes the two compulsory subjects in this programme; mathematics and Norwegian, as well as the subject of pedagogics and drama. Storyline forms the basis of four events (see the overview in Table 1). The learning approach is designed in such a way that student teachers should ultimately be able to implement an adapted approach in primary school (grades 1–4).

### Three Events Organise The Fairy-tale Forest Storyline

In the first event, *The creatures*, the thematic framework is established through a fantasy journey into a Fairy-tale Forest (see Table 1, activity 1 below). The students are tasked with creating their own creatures and playing out their role, (Table 1, activity 2). The activities in line with Omand (2014), were “carefully planned to provide opportunities to introduce, learn and practise new skills” (p. 6). The activities in event 1 are driven by the following key question: What do you think the creatures in the *Fairy-tale Forest* are like in terms of their size and appearance? For more information about importance of effective questions, see chapter 14, Carol Omand, in this anthology. The design of the shape of the stick dolls were to promote an exploratory approach to different geometric shapes, lengths and sizes. The students were given guidance to make them aware of the use of mathematical terminology (*circle* instead of ‘rounding’). By enabling discussions focusing on the precision of subject terminology, the aim was for students to experience how they can strengthen the oral skills of future pupils as a basic skill in mathematics (see The Norwegian Directorate for Education and Training, n.d.). Image 2 shows student work from two different groups working with *Beauty and the Beast*.

In the second event, *The map*, a messenger visits the creatures in the Fairy-tale Forest with a letter urging them to close the portals between the two universes. Evil forces in the human world will fight for power in the Fairy-tale Forest (activity 5, Table 1). The students describe to each other what they think the Fairy-tale Forest looks like using

1 These fairy tales are written by the following authors: Snow Queen (H. C. Andersen), Beauty and the beast (Jeanne-Marie Leprince de Beaumont) and Maiden Rosewing of Santavaja Isle (Regine Normann). The two fairy tales Ciderella and East of the Sun and West of the Moon is respectively collected by Brødrene Grimm and Asbjørnsen og Moe.

Translated versions of two of the fairy tales can for example be found here: <http://nordlandsnatt.blogspot.com/2016/06/the-maiden-rosenwing-of-santavaja-isle.html> and <http://nordlandsnatt.blogspot.com/2016/06/the-maiden-rosenwing-of-santavaja-isle.html>

2 Following Karlsen, Lockhart-Pedersen & Bjørnstad (2019a) we use the abbreviation TSA.



Img. 1–3: Examples of creatures developed by students for the fairy tale *Beauty and the Beast* (Belle and two versions of Belle's sisters). Photo: Kristine Høeg Karlsen.

role play (activity 6). A subject loop concerning maps, scales and number systems gives students an opportunity to revise these topics (activity 7) before they have to produce a scale map of the Fairy-tale Forest (activity 8). The students had to make sure that distances between the various landmarks and destinations on the map match. Two key questions form the basis for the activities in event 2; What do you think the environment in the fairy tale is like? and, What numerical system is used in the Fairy-tale Forest? These questions challenge the students to make choices concerning extent and size to complete the maps. When it comes to scale, some groups opted to use the decimal numbering system, while others chose a more creative approach (see Image 3). This is a way of incorporating mathematics into the approach in such a way that it becomes part of the fiction (cf. Fauskanger, 2002).

Tab. 1: Extract from the storyline 'the fairy-tale forest'

Storyline	Event	Key questions	Activity in role	Activity outside role
'The creatures'	<i>Event 1:</i> Establishment of the fairy-tale universe using a fantasy journey. The students create the creatures in the fairy tale.	What people or creatures will be in the fairy tale? What do you think these creatures will look like in terms of their size and appearance?	<i>Activity 1:</i> Fantasy journey into the fairy-tale universe. Led by the teacher educator. <i>Activity 2:</i> The students make stick dolls to represent their creature. Guidance-based. <i>Activity 3:</i> The students prepare a small role play where they introduce themselves: What do they say when they greet each other in the forest and how do they behave when they meet? Presentation to the class.	<i>Activity 4a:</i> Subject loop: The students will be given a brief presentation of the ways in which Storyline can be used as a cross-curricular and exploratory approach in mathematics. <i>Activity 4b:</i> Subject loop relating to Storyline and collaborative learning.
'The map'	<i>Event 2:</i> A letter arrives for all the creatures in the fairy tale. They are asked to make a map of the Fairy-tale Forest.	What do you think the environment in the fairy tale will be like? What numerical system is used in the Fairy-tale Forest?	<i>Activity 5:</i> 'Teacher-in-role': One of the teachers takes the role of 'messenger' sent by the good people who send an important message to the creatures of the Fairy-tale Forest. <i>Activity 6:</i> The students close their eyes and try to imagine the fairy-tale worlds where they are (house, surroundings). Role play in groups: The students describe what the world looks like. <i>Activity 8:</i> The students create a scale map of 'The Fairy-tale Forest' with supervision from the teachers. They choose the scale, numerical system and numerical symbols themselves.	<i>Activity 7:</i> Subject loop: Mathematics relating to maps, scales, numbers and numerical systems.
'The story'	<i>Event 3:</i> The students prepare mathematical stories with suggested solutions.	Which narratives are pivotal for 'The Fairy-tale Forest'?	<i>Activity 9:</i> The students prepare and solve mathematical stories. Guidance-based.	<i>Activity 10:</i> Subject loop relating to mathematical stories and their use in primary school for grades 1–4.
'The celebration'	<i>Event 4:</i> Conclusion with a display and storytelling.	How can you present an extract from the fairy tale to include all the creatures?	<i>Activity 11:</i> Teacher-in-role as queen of the 'Forest'. A legend is told (subject loop relating to 'communicating orally') <i>Activity 12:</i> Prepare a 'narrator's chest' and storytelling session involving a short role play based on the fairy tale that the students have been working on. Fairy-tale drinks and Fairy-tale cakes are served.	<i>Activity 13:</i> The students prepare a display of what they have produced during the Storyline (stick dolls and map, etc.)

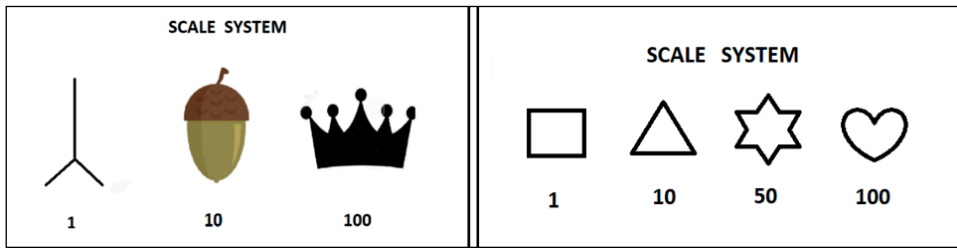


Fig. 2: Two examples of numerical systems developed by the students in the work in producing the map for the fairy tales *Cinderella* and *Beauty and the Beast*. The numerical system in *Cinderella* is made up of a crow's foot, nuts of varying sizes and crowns, but geometric shapes have been used in *Beauty and the Beast*.

In the third event, *The Story*, the students must prepare mathematical stories based on their maps (activity 9). We define *mathematical stories* in line with Klemp, Nilssen, Strømman, and Dons (2016) as, “open assignments where students write a narrative based on specific mathematical operation [...] either on the basis of a given calculation, or by having the students use their own calculations, which can then be solved by mental arithmetic and illustration” (p. 133, authors’ translation). The answer to the story is, according to Klemp et al. (2016) provided by a combination of the text and the illustration. This is a mathematical activity but may also be viewed “as a source of inspiration for text creation” (Wie, 2007, p. 17, authors’ translation). The work of developing the mathematical stories, is based on the key question: Which narratives are pivotal for *The Fairy-tale Forest*? Students must use their maps and associated scales and numerical systems in the design of the mathematical stories and solution proposals. The students must then solve each other’s mathematical stories, which include reading and writing, mathematics and use of formulas in calculating. An example of one group’s story is: “There are 2.500 flowers in the meadow. 950 of the flowers were roses. Beauty picked 53 roses. How many roses were left in the meadow?” The students were also given a subject loop (activity 10) illustrating the ways in which mathematical stories can be used in primary school to stimulate calculating, reading and writing within mathematics in the same learning process, in line with *knowledge of content and curriculum* Ball et al. (2008). Through their work with the map, the Fairy-tale creatures manage to close the portal to invaders and triumph over the evil people on Earth. Event 4, *The Celebration*, concludes *The Fairy-tale Forest Storyline*. This is marked in *The Fairy-tale Forest* with a storytelling session where the students conduct a short role play session. Fairy-tale cakes and Fairy-tale drinks are served. The students also prepared an exhibition of the stick dolls and maps. Image 4 presents an example of a section of one of the maps that were produced.

## Research Design and Method

*The Fairy-tale Forest Storyline* was offered to student teachers as part of the ordinary but non-compulsory teaching. The students were recruited to our research project because they had participated in this teaching, and because we had access to these students as





Img. 4: Example of a map from the environment in *East of the Sun and West of the Moon*.  
Photo: Kristine Høeg Karlsen.

respondents. They were given information in advance regarding the purpose and scope of the study, along with information regarding what participation involved. Confidentiality was observed and all of the data collected was processed in accordance with applicable research ethical norms, described in Guidelines for Research Ethics, Social Sciences, Humanities, Law and Theology<sup>3</sup>. The students gave their informed and explicit consent for participation in the research project in line with the Norwegian Data Protection Authority (DPA). It was specified that participation in the study was voluntary following Silverman (2014, p. 148), and that the students could withdraw their consent without giving a reason (ibid., p. 149). The study did not involve the processing of either direct or indirect personal data or sensitive data and was not notifiable according to the Norwegian Centre for Research Data (NSD)<sup>4</sup>.

### Selection, Recruitment and Data Collection

We performed a strategic selection (Thagaard, 2009) to ensure variation amongst the participants and to identify different perspectives relating to TSA. Six groups with a total of 24 students were invited to participate in focus group interviews after completing

3 <https://www.etikkom.no/en/ethical-guidelines-for-research/guidelines-for-research-ethics-in-the-social-sciences--humanities-law-and-theology/>

4 A discussion with NSD on 23 November 2018 revealed that the new changes in the legislation were not retrospective. The study does not need to be reported retrospectively.

the Storyline. Everyone consented to this. We conducted semi-structured interviews based on an interview guide or script covering four topics (Brinkmann & Kvale, 2015, p. 156). These were the students' perception of i) Fairy-tale fiction, the events and activities, ii) individual learning outcomes, iii) relevance to future teaching in mathematics and iv) the interdisciplinarity of the approach. The interview guide outlined 15 suggestions for brief and simple interview questions (cf. Brinkmann & Kvale, 2015, p. 160). Examples of the questions are, 'Which parts or activities in Storyline did you like best?', 'Do you think this is an approach you will use in future professional practice?' The aim of focus group interview is to "bring forth different viewpoints on an issue" (ibid., p. 175). The risk, according to Bryman (2016) is that individuals or the entire group can take over the discussion (p. 522). Specific and critical follow-up questions guided the respondents through the interview, and at the same time helped to specify, structure and verify the responses of the participants (cf. Brinkmann & Kvale, 2015, p. 160–162). All the interviews were recorded, and each lasted an average of 45 minutes.

Focus group interviews may be challenging to transcribe because it is difficult to distinguish individual voices and interpret the content at the same time (Bryman, 2016, p. 521). A professional transcriber was used to transcribe the data in this study. The six interviews that were transcribed amounted to 125 pages. To ensure reliability, the transcriptions were compared against the audio recordings by the researchers and were considered to be satisfactory for research purposes. According to Tanggaard and Brinkmann (2010), the reliability "between different transcribers who transcribe the same passage, is very low" (p. 35), we have therefore chosen to use our own transcriptions in the quotes presented in this chapter. Furthermore, the quotes have been reproduced in a formal language to make the text easier to read, which means that hesitation, dead ends, jargon and dialects have been removed in line with Hjerm and Lindgren (2010, p. 133).

## Data Analysis

In performing qualitative analysis, we used Creswell and Creswell's (2018) overall framework (p. 193–198). The data was coded in a number of rounds, that constitutes an iterative analysis process (cf. Bryman, 2016, p. 23). The first stage included a reading through all data to gain a 'general sense of the information and an opportunity to reflect on its overall meaning' (Creswell, 2018, p. 193). Thoughts and tentative codes were written in the margin. Then, data was hand-coded line-by-line based on open coding; a process that started by tagging specific units of data with tentative *in vivo* codes (Corbin & Strauss, 2015, p. 85). The codes formed the basis of a comprehensive coding process where key sections and central concepts of the data were identified and named with more refined codes. In cases where two different key words (or codes) were used to code the same type of content in the data, one of the key words was selected. If a code name was closely related to a theoretical concept, we chose to replace it (see Bryman, 2016, p. 581–582). This coding process provided a good overview of the data (see Table 2, coding). The coding formed the basis for a textual description (see Lysne & Postholm, 2018, p. 75) of each of the six interviews (presented below).

Tab. 2: Example of analysis

raw data	codes	theme
<p>Student 1: I thought it was very positive. I just sat there talking about it with [fellow student], saying that I was looking forward to school because we could carry on. I really like being creative and making things, and I think this could be a good learning experience for children [...]</p>	<p>Positive experience  Learning by doing/activity Learning outcome of pupils</p>	<p>Preparing, exploring and performing the tasks (theme II)</p>
<p>Student 2: I think it was a good thing to bring into maths because you don't really think about the fact you are doing maths, even though you actually are.</p>	<p>Broadened view of mathematics The mathematics is hidden/practical</p>	
<p>Student 3: I think Storyline is quite well suited to grades 1, 2 and 3.</p>	<p>Relevant to students in primary school</p>	
<p>Student 1: Yes, yes, yes, you take it</p>	<p>Learning by doing/activity</p>	
<p>Student 4: ...you're just not sitting there doing maths and Norwegian, but you're still learning about it all the same, just in a completely different way...</p>	<p>Learning by doing/activity</p>	<p>Playing out the Fairy-tale story (theme I)</p>
<p>Student 1: ... from if you were just sitting there doing maths, you would have just been told 'this is what a circle looks like' and that's how it is, while with this you see you see it properly [...]</p>	<p>Teacher-in-role/positive experience</p>	
<p>Student 4: I also thought it was great fun when [the teachers] came in and had dressed up because it created... Student 2: A good atmosphere because you could see that the teachers were taking it just as seriously as we were [...]</p>	<p>Cooperation in relation to learning</p>	

The next stage involved identifying links between the coded categories identified and expressed in the overall themes. The themes identify different perspectives in the material and are supported by many different quotes in line with Creswell and Creswell (2018, p. 194). In this way, the themes constitute ‘the most central element’ of a qualitative analysis (see Hjerm & Lindgren, 2010, p. 119) and constitute the main findings of the study (see Creswell and Creswell, 2018, p. 194, authors’ translation). The themes in this study were developed through a dialectic process between data and theory with the aid of a so-called abductive reasoning (Bryman, 2016, p. 394). The description of the six interviews together with the coded transcribed material were used in the analysis. Text extracts were grouped around the patterns that manifested themselves in the material. We consider these patterns to be central to the research question, in line with Hjerm and Lindgren (2010, p. 118). Table 2 provides examples of the thematisation of the codes, arranged in a hierarchical system (see Hjerm & Lindgren, 2010, p. 116). The objective was to find patterns and connections between the categories to identify opportunities and limitations that the Storyline *The Fairy-tale Forest*, gave for the teaching of the students across the interviews.

The analysis identified the following three central themes: i) Playing out the Fairy-tale story; ii) Preparing, exploring and performing the tasks; and iii) Learning through a Meta-Storyline.

## Textual Description of Each of the Six Interviews

This section presents textual descriptions of each interview emerging through the open code process, constituting six narratives (A-F) that contextualise the students’ perceptions and experiences of the Storyline. The narratives show trends in the material in relation to the opportunities and limitations stemming from TSA as regards the learning of mathematics.

### Narrative A

The four students in this interview gave a clear indication that participation in activities 2, 6 and 12 (c.f. table 1) helped them to realise that, in addition to involving the body and emotions, mathematics can be both explorative and creative. The students said that their own participation in the Storyline had given them a broader perspective on the teaching of mathematics. They found that mathematics can be included in fiction, where they use mathematics without reflecting on the fact that they are in a learning situation. They also discover the everyday mathematics as shown in this excerpt,

- Student 3: Perhaps you see the subject in a slightly different way [...]
- Student 4: Maths in practice like...
- Student 2: Yes, in daily life
- student 4: It’s very easy to think that maths is  $1+1=2$ , but maths is of course in *everything* in a way, or is at least involved in an awful lot of what we do in some way.

The students believe that TSA will captivate many pupils, especially in primary school, as one person put it, 'I really wish we'd worked more like this at my school'. It's the surprising elements (activities 1, 5 and 11) and the creative, playful and craft activities (activities 2, 8 and 9) in particular that they believe will attract the pupils. The time frame proved to be the largest challenge in this particular Storyline. This led to unnecessary stress and allowed less of an in-depth focus than these students desired. Switching in and out of the fiction and narrative through the subject loops (activities 4ab, 7 and 10) also proved challenging. They convey a desire to try out TSA in the following placement practice in schools and claimed that the experience they had gained through TSA gave them far better learning outcomes than a three-hour lecture session for example. About this, they said,

Student 1: No, it would have been like 'yes, we've got it', but now we've actually tried it out

Student 4: I think it's now also more that we would like to *use* it. I don't think I'd have been so enthusiastic if we had just heard the teachers describe 'Storyline – this is this, and this, and then you do this and so on'.

### **Narrative B**

The four students in this interview found TSA to be exciting, educational and useful because the activities can be taken straight into primary school. The students most liked the activities where they themselves could be creative and active (activities 2, 8 and 12), in addition to the activities where the teachers also took on roles (activities 5 and 11). TSA gave the students new ideas for teaching mathematics that stimulate play, exploration, fantasy and a desire to learn. The following text extract provides an example of this,

Student 5: I feel that it doesn't just need to be calculations in front of a blackboard or in a book. It can be done in many ways, using play, painting or by cutting and sticking. Just like when we used geometry and sizes in the work with [the creatures]. These are things that you have to learn in mathematics.

Student 8: [...] and in a way, the fact that you entered another reality, so when you use maths, I felt that this wasn't a boring super-sized maths lesson, but I felt 'Yes, this is something we have to figure out', you know. I think that children are also even more involved with the thought that 'Oh, we have to work this out, don't we, so that we can solve something fun'. I think that's really good.

The students explained that Storyline enabled them to understand how mathematics can form part of a cross-curricular approach to teaching, and how mathematics is part of daily life,

Student 6: It might be a bit better for those who don't like maths, that it is sort of like a secret conscious fool-your-way-into the Norwegian.

- Student 5: [...] for example, when we were working with shapes, this was of course mathematics, because it involved similarities between shapes and the different sizes of the shapes. And perhaps it made the pupils more aware and think 'look, maths is actually involved here'
- Student 6: [...] And then the pupils might actually feel like 'Oh! That was actually fun! We've done lots of maths! I got it!' This gives a good sense of mastery.

In general, these students believe that Storyline will captivate many pupils because, amongst other things, 'they are drawn into an entirely new world' and the subject of mathematics becomes more fun and interesting. The students also noted that pupils with learning difficulties would particularly benefit from a teaching approach that places an emphasis on activity, creativity and cooperation. The students felt that the time frame was a challenge and that the subject loops (particularly subject loop 7) could have been developed further so that the subject matter could be reviewed in greater depth. The students were agreed that they would like to see more Storyline as part of the teacher education, and last but not least, they would like to try out Storyline at school.

### Narrative C

These three students felt TSA was fun and educational. They like fairy tales and the fact that they share, quoting two students 'a common interest in fairy tales [with the teachers]', and 'the fact that the teachers wanted to communicate with us in this way was very good'. They describe a co-student who does not like fairy tales, and that 'this version of Storyline may perhaps have been more challenging for her'. For these students, the biggest challenge was the oral in-role presentations of the creatures (activity 3) and the 'Fairy-tale time' (activity 12). The event was sprung on them too quickly in such a way that they did not have enough time to mentally prepare themselves for the performances. The time frame was too tight and resulted in stress.

Nevertheless, the students felt that Storyline provided new and practical input into working with mathematics in schools. They explained that they did not recognise the mathematics in the Storyline, but that the supervision when working with the creatures (activity 2), the map (activity 8) and the mathematical stories (activity 9) helped them recognise it, for example, by the fact that the fairy tales had magical numbers and shapes, and the maps had scales. They felt that the Storyline brought out a more playful and humorous side in the teachers. The cross-curricular teaching was also characterised as positive and timesaving because more than one subject was covered. Seeing the link between several subjects is meaningful according to the students, who also gained a greater understanding of how much planning is involved in such a teaching approach,

...Perhaps I now consider the role of teacher to be a bit more demanding than I first thought when I started the course. I now see how much work goes into an approach like this and how much responsibility we will have when we leave school. There's a lot of preparation involved.

They felt TSA would be very educational for the pupils, particularly those with learning disabilities. They would like to use Storyline in the future, as long as other teachers are on-board with it. Personal experiences of Storyline are crucial in determining how it can be used in practice.

### Narrative D

The three students in this interview liked the fact that alternative approaches to teaching are being highlighted in teacher education, although they did not like every aspect. Some were ‘frightened by the fact that they would have to take part in role play’ (activities 3 and 6),

- Student 15: It’s a bit strange to have to stand in front of quite a new class and try to be in character, to be completely absorbed in the role [...]
- Student 13: It was also a bit strange to suddenly have to get into character [...]
- Student 14: I felt that when everyone stood up and explained who their character was, there was a little bit of giggling going on because we didn’t take it completely seriously. We struggled to take it seriously.

They would rather have had a demonstration of the task with some pupils, so that they didn’t have to take on roles themselves. The fact that everyone had to present themselves in role, was seen as pressure. They explained that they were unable to enter into the spirit of the fiction because it felt a bit childish to them and the timeframe was too tight,

- Student 15: As has been said previously, it didn’t work. We had a very limited amount of time, and of course we’re a lot older.
- Student 12: It was a bit stressful and it was also a bit silly.

However, these students could see that the role play might work for children who are more playful and who have more imagination and are able to enter into the spirit of the fiction. They also believe that the pupils would find it rewarding to do something completely different from ‘just sitting and writing, or sitting and reading’. They believe it is important for children to use their imagination and that they have scope to develop themselves at school, partly because many children also spend a lot of time in front of screens.

However, the students are unsure about the specific learning outcomes associated with using Storyline in the teaching of mathematics, as they had difficulty seeing the mathematical content within this Storyline. For example, when they had to make the map, they enjoyed painting and playing with glitter, but they ‘couldn’t understand why exactly’. They also explained that it was difficult to prepare mathematical stories, because when ‘the houses became two kilometres long, it was obviously completely wrong’, which might help them to realise the importance of correct scale. They thought that the activities would have worked better ‘without the subjects, or if only pure imagination were involved’. They were aware of the mathematics during the guidance but

did not think it was an effective way of learning mathematics. They thought perhaps it might have worked better if they had more time, a more detailed subject loop or more individual guidance in the group. For example, they were unsure what benefits there would have been for grade 1 students. General remarks,

... it was difficult to see the mathematics within this Storyline [...], and I think in a way nobody thought about the subject, and therefore we didn't learn anything about it either. Mathematics was excluded in a way. Not until the mathematics in this Storyline was explained to me, I could not see it.

They explained that there was a lot of silliness in their group and that they could not take the activities seriously, and that 'those who took it seriously certainly enjoyed themselves, [...] it was just that Storyline didn't quite work in our group and it wasn't enjoyable'.

### **Narrative E**

The five students comprising this group, considered Storyline to be a good experience. They liked the creative aspects the best, and spending 'a little time away from pen and paper and PCs and being able to talk together', but the timeframe was too tight. The role plays were thought to be unpleasant, but they still learned a lot from them, which they would not have picked up otherwise. They felt TSA offers good variation in the teaching of mathematics, and they recognised the mathematics such as scales, shapes, sizes, mathematical stories and how they had to work with area to customise the map to a limited area of the distributed cartons. They also explained that TSA offers the potential for discussion and cooperation relating to mathematics. The pupils benefited from working together and there was a strong element of social learning, and they thought pupils would like Storyline and that it was exciting. When teaching is cross-disciplinary, the pupils have to combine knowledge and skills from different subjects, which, in the opinion of the students, promotes motivation and interest,

In cases where there is someone who is struggling with maths, then Storyline might be an option, and they might then consider that it is not so bad. They might perhaps see a subject they do not like in a different light.

They feel that they have learnt a new approach for teaching mathematics. They feel that they might use TSA in future. They are pleased to have experienced Storyline for themselves because it means they will remember the approach better.

### **Narrative F**

The four students in this interview, explained that they were left with a good impression of Storyline, and they liked the fact that they could participate in a Storyline themselves. They like the creative aspects where they could 'do something with their hands'. They could imagine using TSA in their future teaching, and thought it was 'very nice



to have such a *very* specific approach that you can incorporate in a school context'. They could also imagine participating in further Storylines during teacher education, but for other topics and subjects, because 'Storyline isn't simply a fairy tale, it's much more than that'. The students could immediately see that the Fairy-tale theme involved imagination and exploration, but they explained that they could not entirely *see* how other, more theoretical topics, could be brought alive through a Storyline. The students generally lacked more information concerning TSA and the justification for the various events in the learning process. They also called for a more specific presentation of how a teacher can plan a Storyline,

Student 22: I think perhaps we should have had a little more information beforehand about Storyline itself, for example, what type of approach is it? Because we weren't particularly aware of it, our main focus was on *exactly* what it was we were supposed to do; make the doll and the house, without spending time observing

Student 23: Yes, a little, why

Student 21: There was a lot to consider when you had to think 'OK, what are we doing now purely in terms of approach, while at the same time having to make the doll, which would have been fine with more information.

Student 23 I thought that we didn't learn enough about the template and that there was too much focus on the specific tasks [...] because the point wasn't that we should do it, but that we should learn more about it, so more about it then

Student 20: How would we go about planning an entire Storyline?

Student 23: A little bit more meat on the bones, then

They felt it was difficult to get into the spirit of the fiction; the content passed them by to some extent because they were adults. Playing a role was difficult, artificial and uncomfortable. They pointed out that there was not enough time. They did not prepare themselves properly for these activities (activities 3 and 12), either mentally or physically,

... because we had to race through it and 'we had to get it done in five minutes', and so it felt overwhelming, and people with any form of social anxiety would need more time to prepare themselves mentally. When you also need to take on a role and use a voice that is different from your own, then you need to be a bit more robust and this can be unpleasant.

They thought that the fairy tales they worked with, *West of the Moon* and *Maiden Rosewing of Santavaja Isle*, were not very accessible and made for heavy reading. They lost motivation. The students were generally very focused on what they should do, make and arrange, and did not feel that they learned very much in the way of mathematics. Nevertheless, they felt that Storyline 'was something for the kids' and they were keen to try out this approach with their future pupils. Pupils find it boring just sitting with 'dry' blackboard teaching, which destroys their motivation and interest in subjects. They feel that Storyline will make teaching fun and pleasurable. TSA is a good way for children to learn numbers 'and perhaps it's a good way to get people who are not that interested

in maths to suddenly have a few light bulb moments'. Storyline can give both a sense of mastery and motivation. The students liked the way the subjects were woven together because their pupils would discover and reflect on the links between themes across the skills objectives in the curriculum. They think this is beneficial because it enables pupils to put their learning into context,

... when they put their knowledge into practice, and they had to find information and learn about different things, this gives meaning rather than simply struggling through things. You get to put the learning into a system, which can give them fresh motivation and learning.

According to the students themselves, they felt that they had acquired some tools to make the teaching of mathematics more accessible and fun for the pupils. They also realise that such an approach requires good planning and good cooperation between teachers over time. They feel that it is important that Storyline is well anchored in competency goals for the curriculum and is not something that is simply 'fun'.

## Results and Discussion

In this study, we aimed to explore how student teachers perceive the mathematic knowledge at play in a *Storyline* focusing on fairy tales implemented in teacher education for students preparing to teach grades 1–7. The following themes are analysed and discussed based on the six narratives, i) Playing out the Fairy-tale story; ii) Preparing, exploring and performing the tasks; and iii) Learning through a Meta-Storyline. The three main categories were analysed to investigate the potential of TSA with regard to the development of mathematical pedagogical content knowledge (cf. Ball et al., 2008), viewed in the light of Midtsundstad and Willbergh's (2010a) didactic perspective.

### Playing out the Fairy-tale Story

*The Fairy-tale Forest* invites the students to enter a Fairy-tale universe with figures and creatures that they recognise from child and youth culture, where they meet teacher educators in roles such as 'messengers' and 'fairy queens' (see table 1, activities 5 and 11). The study shows that the students were surprised when their teachers took on roles, dressed up and were *in* fiction. This role play helped to create a good atmosphere and the perception of good cooperation in relation to common learning goals. Through the role play, the students gained a broader understanding of what the role of teacher entails in terms of play and imagination. The study shows that student teachers have a desire to be creative teachers who dare to use different approaches to the teaching of mathematics, and as one student put it, 'that's the kind of teacher I want to be'. We interpret the students as implying that TSA provided useful input in relation to the role of teacher, and that therefore they found the content to be meaningful (cf. Midtsundstad & Willbergh, 2010b). This result can also be interpreted as implying that the students found that mathematics can be placed in a fictional framework, which, according

to Fauskanger (2002), can be challenging. Thus, in this way, the activities promoted the development of knowledge of content and teaching according to Ball et al. (2008, p. 401), where they have experienced how varied pedagogical choices in the design of the teaching have effected and promoted new learning experiences.

The events in Storyline furthermore suggested that the students should themselves take roles and play along with the fiction (activities 3, 6 and 12). The study illustrates that the students found this both challenging and daunting. Nevertheless, some students could see the value of this, because Storyline provides training in standing in front of a group of people, something they realise they will have to master as teachers. We understand this to mean that the students associate the content of the activities with a skill they must develop as future teachers, and TSA would appear to be relevant to them (see Midtsundstad & Willbergh, 2010b, p. 11). However, other students found the role play activities to be of little value. Besides finding it challenging and daunting, they also thought it was embarrassing and uncomfortable. The justification for this was that they are adults and that using a voice which was different from their own did not come as naturally to them as it would for a child. This is a result that is confirmed by Karlsen et al. (2019a), where students were 'refusing to join the fictional in-role activities' (p. 156). In our study, the students stated that the timeframe was inadequate to allow thorough preparation, either physically or mentally. They felt that a demonstration would have adequately enabled them to get the point that children think *this* is fun.

Fiction and the ability to live in a fictitious universe are entirely pivotal elements in Storyline (see Bell & Harkness, 2013; Omand, 2014). When the teaching does not invite immersion in the story itself, the students lose the potential that is afforded by such activities for learning, exploration and sharing perspectives. However, although the study demonstrates that the students did not master the role play, this does not necessarily mean that the instruction is of low quality (cf. Hopmann, 2010). It could mean that the Storyline fell outside *the student teachers'* area of interest and had a demotivating effect. Because individual student teachers felt that the learning in mathematics was *too simple*, although this formed a basis for a critical view of the choice of events and activities facilitated by this Storyline, one has to remember that the topic in first grade seems simple for adults. This could be interpreted as expression that this particular Storyline did not take into account that student teachers are adults; not taking seriously the corresponding model of Ball et al. (2008) in line with Valenta and Enge (2015), who claim that teacher educators must use *their knowledge within the field of mathematics and students* to plan for and develop high quality teaching for the student teachers. Nevertheless, *The Fairy-tale Forest* was designed in such a way that the students could ultimately implement it with minor adjustments in schools. The limitation of this, was that the students found it unnatural to enter into roles such as Cinderella or the Beast, and thus the choice of fairy-tale fiction was a limiting factor that made little sense to these students (cf. Willbergh, 2010, p. 49).

The challenge within the teacher education context is designing a Storyline that appeals to the student teachers and creates a desire and motivation to explore the fictitious universe (e.g. Valenta and Enge, 2015). One possible option could be to use an adult fairy tale such as the fantasy genre, which most students will be familiar with from

series and books such as *Game of Thrones*, *Lord of the Rings* and *The Walking Dead*. The limitation with such fiction is that the Storyline requires more adaptation to work in primary school. It is also likely to be more difficult for the students to see the relevance of such a Storyline to pupils, particularly primary school pupils, and therefore also limits the potential for the students to acknowledging in line with Ball et al. (2008) the pedagogical knowledge relating to the content and the pupils. We feel there is a need for more research into how the elements in the Storyline role play can be designed in such a way that student teachers can see participation in the fiction as being meaningful (cf. Midtsundstad & Willbergh, 2010b).

### Preparing, Exploring and Performing the Tasks

The study proves that the students consistently enjoyed the activities where they could be active and make things (i.e. activities 2, 8 and 9). Apart from the timeframe, which created unnecessary stress, the students were able to experience new ways of learning mathematics through practical activities involving the body and emotions. In order to complete the tasks, the students found that they had used mathematics almost without realising it, and that this had ‘sneaked its way in’. With guidance, they recognised that themes such as geometry, numeracy and numerical systems, maps and scales, were involved in the events, and had to be interpreted correctly, in line with Ball et al. (2008, p. 403) domain ‘common content knowledge’. Once they discovered the mathematics, several students expressed a positive ‘Aha!’ moment, where they could see links which they had previously been unable to see. This discovery enabled them to gain a greater understanding of what mathematics *can* be in primary school. And when they started out with the maps and wrote mathematical problems in their own words (activities 8 and 9), making mathematical stories, they got a glimpse into the domain ‘specialised content knowledge’ (a skill unique to teaching), in line with Ball et al. (2008). The students had to use mathematics in order to perform the tasks, e.g. counting the number of roses in the meadow<sup>5</sup>. The students felt that such tasks can be a good method, for example in learning to count, which is a skills goal above grade 2 in the mathematics curriculum in primary and lower secondary school for grades 1 to 10, in The Norwegian curriculum Knowledge Promotion (Directorate for Education and Training, n.d.). The students feel that such tasks help to develop an understanding of numbers (Skills goal above grade 2, Directorate for Education and Training, s.a.a), something which confirms previous studies. For example, Solstad (2009) considered TSA to be ideal for developing an understanding of numbers (p. 101), while Fauskanger (2002) argues that Storyline is a good arena for working with counting, because counting ‘is an important activity in the teaching of mathematics to beginners’ (p. 318).

During the task, the students found that they built up cross-curricular knowledge, in which mathematics played a major role, in accordance with Fauskanger (2002, p. 308). The study shows that the students believe that they have a good tool to facilitate learning in mathematics in ways that promote imagination, play and exploration. It

5 The example is taken from the group that worked with *Beauty and the Beast*.

appears that the students can see the relevance of Storyline in the future teaching of mathematics, and that Storyline is considered to be meaningful (cf. Willbergh, 2010, p. 49). We interpret this as indicating that the students have developed a knowledge of content and teaching (e.g. Ball et al., 2008). In line with Christensen (2007), who claims that pupils who immediately perceive the instruction as meaningful, will be more easily engaged and thus take responsibility for their own learning (p. 21), these students experience a cohesion between learning in mathematics and perceived relevance. This result confirms Solstad (2009), who reported that “more than 80% of the students and about 75% of the teachers agreed that the approach is very well, or well, suited for the basic teaching of numeracy” (p. 101).

The study shows that the students believe the activities characterised by play and exploration will create engagement amongst pupils, particularly amongst pupils who do not like mathematics or who have learning difficulties. This is in line with Fagernæs (2003a), who claims that especially in subjects like mathematics, it is important to allow for pupils to be explorative, and when using The Storyline Approach, the pupils are given time for curiosity and reflection (p. 25). Further, the students also believe that such an approach to learning will help pupils to see the links between different subject areas. When the pupils combine knowledge and skills from diverse subject fields, they believe this creates an engagement and interest in mathematics. The fact that the student teachers believe that Storyline will help to create pupil engagement confirms the results found by Murray (2016). In her study, one of the students stated, ‘I loved learning about the approach as a way of engaging [pupils] in what they are learning’ (p. 269). When the students in our study consider the diversity of pupils at the school in relation to the variation in interests, motivation and subject level, they can see that they can *reach* more pupils through Storyline specifically because they have this knowledge of the pupils in line with the domain, ‘knowledge of content and students’ in Ball et al. (2008, p. 401). This could mean that the teaching content chosen in *The Fairy-tale Forest* was defined in a way which enabled the students to see the content as being meaningful and relevant (cf. Midtsundstad & Willbergh, 2010b). That Storyline can contribute to good experiences and learning for student teachers confirms previous research (for example, Karlsen et al., 2019a).

Although the main trend in the material is that the students perceive Storyline to be a good approach for teaching mathematics, we must stress that the students in interview D represent an alternative view. These students are unsure of the learning outcomes in mathematics when using Storyline in school. They justify this by claiming that they struggled to discover the mathematics and that they believe that pupils would do the same. We interpret this to mean that the selected activities did not adequately enable these students to see the potential for gaining knowledge within the ‘content and student’ domain as defined by Ball et al. (2008). More detailed subject loops and more supervision during the tasks may have resulted in better learning for these students and could reflect the fact that the learning within this Storyline did not relate to these student teachers in line with Valenta and Enge (2015).

## Learning Through a Meta Storyline

*The Fairy-tale Forest* was a 'Meta Storyline', where the students would learn *about* TSA through their own participation in a Storyline. *The Fairy-tale Forest* had three subject loops relating to Storyline as an approach to teaching and learning (activities 4a, 4b and 10). The study shows that the students found transitioning in and out of fiction to be challenging; i.e. being *in* Storyline and simultaneously learning *about* Storyline. They felt that the subject loops should have been covered in greater detail. In general, they felt they needed further information on TSA itself. However, the study also shows that the students believe it was important that they could *experience* a Storyline for themselves, so that they could see how this approach works in practice (not just receiving the theory). They thus felt that a lecture on TSA would not have resulted in the same learning outcome. This finding confirms Falkenberg (2016), who explains that the best way to learn about TSA is to actually participate in a Storyline (p. 220).

The fact that the students experienced challenges with the Meta Storyline confirms the results of the study conducted by Karlsen, Bjørnstad, and Lockhart-Pedersen (2019b). The findings show that the student teachers had problems in understanding the difference between a Meta Storyline and an ordinary Storyline, which caused frustration and uncertainty. The fact that the student teachers wanted more theory on TSA might suggest that they feel unsure how Storyline can be used when teaching mathematics in schools. In such cases, the potential of the Storyline may be weakened as regards the development of knowledge of content and teaching (e.g. Ball et al., 2008). One solution to improving the Storyline would be to strengthen the theoretical subject loops. However, such a change would take the students out of the fiction for a longer period of time, which would not be desirable as part of a Storyline. Although the subject loops represent an important tool in TSA (Eik, 2000), they must be used with caution for the reasons described above. Another solution would be to facilitate a two-part teaching approach, such as that proposed by Murray (2018), where the students first participate in an ordinary Storyline (without the Meta perspective), and then in the following, they learn the theory of TSA where their experiences are linked to curriculum matters, and to the content of students (pupils) and teaching. When the students worked with the curriculum to find the topics related to the activities in the Storyline, they recognised most of the topics highlighted in mathematics, thus they increased their knowledge of content and curriculum, in line with Ball et al. (2008). Future research is required to identify the best approach for students to perceive the content of Storyline as being relevant (cf. Midsundstad & Willbergh, 2010b; Hopmann, 2010) in order to develop a pedagogical content knowledge within the field of mathematics.

## Conclusion

This study demonstrates that through *The Fairy-tale Forest*, students have found a specific approach which will enable them as future teachers to organise and adapt the teaching of mathematics in primary school to create engagement and a desire to learn amongst their pupils. They believe that TSA has helped them on the way to become the

teachers they want to be – people who facilitate exploration and creativity while at the same time having a good knowledge of their subject. And as previously mentioned Ball et al. (2008) encompasses the knowledge a pre-trained teacher should have, but it is not possible for them to acquire all these six parts of the knowledge during this Storyline. Still in summary, the study demonstrates that *The Fairy-tale Forest* offers potential for the development of pedagogical content knowledge within the domains of *knowledge of content and curriculum*, *content and students*, and relating to *content and teaching*. The Storyline was designed in such a way that student teachers should ultimately be able to implement an adapted approach in primary schools. The study illustrates that this has provided opportunities for consideration in relation to pupil diversity, learning and motivation in the lower school grades. The practical activities where the students could work with mathematics like number, number system, geometric shapes, scale, units of measurement, symmetry, formulas and mathematical stories in an exploratory way was something they believed would create considerable engagement, both with respect to school as a whole and in connection with pupils who struggled with mathematics. With this in mind, we will argue for the possibility to design Storylines, which address and go in depth into other domains of the framework for mathematical knowledge for teaching in Ball et al. (2008).

In this study, the fact that *The Fairy-tale Forest* invites reflection in relation to the teaching of mathematics and pupils at school must be interpreted as an opportunity for the content to contribute to the development of knowledge in the domain *content and students*. Furthermore, the study illustrates that role play conducted by teachers helped to broaden the views of the students in relation to what the role of teacher entails. The students discovered new opportunities to create variation in the teaching of mathematics. Through the approach, the students discovered practical mathematics and ways in which a cross-curricular framework can be applied where mathematics has a natural place. The fact that the students could themselves participate in a Storyline creates motivation for testing the approach as future teachers. They found that they had acquired a new approach they could take with them into schools, and that they have developed their knowledge of teaching mathematics through this approach. Overall, this could be interpreted as an opportunity for the content to contribute to the development of knowledge in the domain *content and teaching*. The following elements of TSA may have had a limiting effect on the students' development pedagogical content knowledge: The students were uncomfortable about having to adopt roles in the fiction. Because the fictional element is an important instrument in Storyline, there will be a need in future for expanded and detailed research into how the fictional aspect of Storyline can be made to appear attractive, relevant and immediately engaging to student teachers. Furthermore, the students did not believe they were given sufficient theory regarding TSA and that this led to uncertainty in relation to implementation. This demonstrates a need for more knowledge of the ways in which Meta Storylines can be used in teacher education in general, and how Meta Storylines can facilitate and captivate students learning and development of mathematical pedagogical content knowledge, in particular. More research within this field is needed in the future.

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## References

- Ahlquist, S. (2015). The Storyline approach: promoting learning through cooperation in the second language classroom. *Education 3-13*, 43(1), 40–54. doi: 10.1080/03004279.2015.961692
- Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5), 389–407. doi: 10.1177/0022487108324554
- Bell, S. & Harkness, S. (2013). *Storyline – Promoting Language Across the Curriculum*. UK: The United Kingdom Literacy Association (UKLA).
- Blömeke, S., Suhl, U., & Kaiser, G. (2011). Teacher education effectiveness: Quality and equity of future primary teachers' mathematics and mathematics pedagogical content knowledge. *Journal of Teacher Education*, 62(2), 154–171. doi: 10.1177/0022487110386798
- Brinkmann, S., & Kvale, S. (2015). *Interviews: Learning the craft of qualitative research interviewing* (Vol. 3). Thousand Oaks, CA: Sage.
- Bryman, A. (2016). *Social Research Methods*. United Kingdom, Oxford: Oxford University Press.
- Corbin, J. & Strauss, A. (2015). *Basics of Qualitative Research. Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks, California: Sage.
- Christensen, A., Børnebyen, L., & Christensen, O. H. (2011). *Danske dyr – faglig storylieundervisning 2.-6. klasse*. Danmark, Mårslet: Hauboundervisning.
- Christensen, O. H. (2007). Storyline i matematik og naturfagene *Pædagogisk orientering*, 2, 20–23.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: qualitative, quantitative, and mixed methods approaches*. Los Angeles: Sage.
- Depaepe, F., Torbeyns, J., Vermeersch, N., Janssens, D., Janssen, R., Kelchtermans, G., ... Van Dooren, W. (2015). Teachers' content and pedagogical content knowledge on rational numbers: A comparison of prospective elementary and lower secondary school teachers. *Teaching and teacher education*, 47, 82–92. doi: 10.1016/j.tate.2014.12.009
- Directorate for Education and Training (n.d.). Kunnskapsløftet [The Knowledge Promotion]. Retrieved from, <https://www.udir.no/klo6/MAT1-04>.
- East of the Sun and West of the Moon*: a translation of this Fairytale can be found here: <http://nordlandsnatt.blogspot.com/2016/06/the-maiden-rosenwing-of-santavaja-isle.html>



- Eik, L. T. (2000). *Storyline – tverrfaglig tilnærming til aktiv læring* (2. utgave). Oslo: Tano Aschehoug.
- Fagernæs, M. (2003a). Storyline og problemløsning i matematikkundervisningen på småskoletrinnet. In L. T. Eik, M. Fagernæs, J. Fauskanger, & K.-T. Olsen (Eds.), *Storyline for småskoletrinnet* (pp. 13–26). Oslo: Universitetsforlaget.
- Fagernæs, M. (2003b). Trylletrolla. Plan og lærerveiledning In L. T. Eik, M. Fagernæs, J. Fauskanger, & K.-T. Olsen (Eds.), *Storyline for småskoletrinnet* (pp. 27–48). Oslo: Universitetsforlaget.
- Falkenberg, C. (2016). The applicability of the storyline approach to teaching in adult education. I P. J. Mitchell, & M. J. McNaughton (Eds.) *Storyline. A creative Approach to learning and teaching* (p. 220–240). UK: Cambridge Scholars publishing.
- Fauskanger, J. (2002). Storyline – med matematikk innenfor eller utenfor. *Norsk pedagogisk tidsskrift*, 4, 308–321.
- Fauskanger, J. (2003). Tivoliet – En storyline med matematikk som regifag. In J. Fauskanger & L. T. Eik (Eds.), *Storyline for mellomtrinnet* (pp. 34–60). Oslo: Universitetsforlaget.
- Fauskanger, J., Mosvold, R., & Bjuland, R. (2010). Hva må læreren kunne? *Tangenten*, 21(4), 34–38.
- Hjerm, M., & Lindgren, S. (2010). *Introduksjon til samfunnsvitenskapelig analyse*. Oslo: Gyldendal akademisk.
- Hopmann, S. T. (2010). Undervisningens avgrensning: Didaktikkens kjerne. In J. H. Midtsundstad, & I. Willbergh (Red.) *Didaktikk. Nye teoretiske perspektiver på undervisning* (pp. 19–43). Oslo: Cappelen Damm As.
- Håkonsson, E. (1997). Fantasi og sprog i storyline-metoden. In C. Flakenberg, E. Håkonsson, N. Jægerum, S. Madsbjerg, & F. W. Mosegaard (Eds.), *Storyline-metoden. "Den skotske metode" – undervisningk på fantasiens vinger* (pp. 125–113). Denmark: Kroghs forlag.
- Karlsen, K.H., Lockhart-Pedersen, V., & Bjørnstad, G.B. (2019a). "...but, it's really grown on me, Storyline, as practical as it has been': A critical inquiry of student teachers' experiences of The Scottish Storyline Approach in teacher education. *Teaching and Teacher Education. An International Journal of Research and Studies*, 77, 150–159. doi: 10.1016/j.tate.2018.09.017
- Karlsen, K.H., Lockhart-Pedersen, V. & Bjørnstad, G.B. (2019b). Hva slags lærer vil du bli'a? Grunnskolelærer-studenters opplevelse med Storyline som metode i lærerutdanningen. In K.H. Karlsen & G.B. Bjørnstad (Eds.) *Skaperglede, engasjement og utforskertrang. Nye perspektiver på estetiske- & tverrfaglige undervisningsmetoder i pedagogisk virksomhet*. Oslo: Universitetsforlaget.
- Karlsen, K.H., & Lockhart-Pedersen, V. (2020). Story-based Cross-Curricular Teaching and Learning A systematic mapping of the Research Literature on The Scottish Storyline Approach. In K.H. Karlsen & M. Häggström (Eds.), *Teaching through Stories. Renewing the Scottish Storyline Approach in Teacher Education* (pp. 393–432). Münster: Waxmann.
- Klemp, T., Nilssen, V., Strømman, E., & Dons, C. F. (2016). *På vei til å bli skriveleærer: Lærerstudenten i dialog med teori og praksis*. Oslo: Cappelen Damm Akademisk.
- Krauss, S., Brunner, M., Kunter, M., Baumert, J., Blum, W., Neubrand, M., & Jordan, A. (2008). Pedagogical content knowledge and content knowledge of secondary math-

- ematics teachers. *Journal of Educational Psychology*, 100(3), 716. doi: 10.1037/0022-0663.100.3.716
- Lysne, D.A., & Postholm, M.B. (2018). En studie av skolebasert kompetanseutvikling i lokale kontekster. *FoU i praksis*, 13(1), 68–86.
- Midtsundstad, J. H., & Willbergh, I. (2010a). *Didaktikk. Nye teoretiske perspektiver på undervisning*. Oslo: Cappelen Damm As.
- Midtsundstad, J. H., & Willbergh, I. (2010b). Introduksjon, i J. H. Midtsundstad, & I. Willbergh (Red.) *Didaktikk. Nye teoretiske perspektiver på undervisning* (p. 10–18). Oslo: Cappelen Damm As.
- Murray, O. (2016). Storyline and pre-Service Teacher Preparation Programmes. In P. J. Mitchell, & M. J. McNaughton (Eds.), *Storyline A Creative Approach to Learning and Teaching* (pp. 263–274). Newcastle upon Tyne, UK: Cambridge Scholars publishing.
- Murray, O. (2018). *Storyline in teacher training*. Presentert på: The International Storyline Conference, Exhibition and Convention Centre in Ljubljana, Slovenia. 29 June to 1 July.
- Niess, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and teacher education*, 21(5), 509–523. doi: 10.1016/j.tate.2005.03.006
- Omand, C. (2014). *Storyline. Creative learning across the curriculum*. Ukla. The United Kingdom Literacy Association. Ideas in practice, 7.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14. doi: 10.3102/0013189X015002004
- Silverman, D. (2014). *Doing qualitative research*. California: Sage Publications.
- Solstad, A. G. (2009). *STORYLINE – a strategy for active learning and adapted education – a partnership project between teacher education and practice schools*. Paper presented at the 31st annual ATEE Conference, Slovenia.
- Storhaug, M. (2009). Storyline. In U. Stålsett, R. Sandal, & M. Storhaug (Eds.), *Veiledning i tilpasset opplæring. Arbeidsmåter: Fra oppskrift til refleksjon* (pp. 113–172). Bergen: Fagbokforlaget.
- Tanggaard, L., & Brinkmann, S. (2010). Intervjuet: Samtalen som forskningsmetode. In S. Brinkmann & L. Tanggaard (Eds), *Kvalitative metoder. Empiri og teoriutvikling* (pp. 17–45) Oslo: Gyldendal Akademisk.
- Thagaard, T. (2009). *Systematikk og innlevelse-en innføring i kvalitativ metode*. Bergen: Fagbokforlaget Vigmostad & Bjørke AS.
- Valenta, A., & Enge, O. (2015). Profesjonskunnskap for matematikklærerutdannere. *Bedre skole*, 4.
- Wie, A.-L. (2007). *Lese og skrive og regne er gøy ... Arbeid med begynneropplæring i lærerutdanningene ved høgskolen i Nesna 2003–2007*. Fredrikke. Organ for FoU-publikasjoner. ISBN 978-82-7569-160-4. 2007, n. 7. Nesna: Høgskolen i Nesna. Retrieved from: [https://brage.bibsys.no/xmlui/bitstream/handle/11250/145499/2007\\_7.pdf?sequence=1](https://brage.bibsys.no/xmlui/bitstream/handle/11250/145499/2007_7.pdf?sequence=1)
- Willbergh, I. (2010). Mimetisk didaktikk: Om undervisning som kunst. In J. H. Midtsundstad & I. Willbergh (Red.), *Didaktikk. Nye teoretiske perspektiver på undervisning*, (pp. 46–62). Oslo: Cappelen Damm As.