Formative assessment and productive pedagogy in Finnish Classroom assessment:

In the lens of curriculum materials

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Abstract

The motivating forces of directing this thesis are: the strong position of curriculum resources for teachers' planning and practice as well as curriculum design matters for classroom instruction and pupils' learning outcomes; potentiality of formative assessment in teaching-learning process to improve students' experience of learning; worldwide recognition of productive pedagogy as a research tool to improve students learning; and the expected benefits through escalating the knowledge in the area of curriculum materials. Therefore, the study aimed to investigate what content of productive pedagogy is represented in Finnish curriculum materials and teacher's practices. It aimed to dig more deeply into the features of the support the curriculum materials offer to design the formative assessment in classroom practice. To do so, the study investigates the features and map the formative assessment and productive pedagogy components for classroom practices as construed in national core curriculum, Finnish teacher guides and teacher practices. The data consist of two Finnish teacher guides in mathematics for Grade vii, national core curriculum and seven teachers from seven comprehensive schools who are responsible for mathematics and science teaching. The analytical tools were developed based on OECD given six key components of formative assessment and Queensland School Reform Longitudinal Study (1998-2001) research team given productive pedagogy components. The study extended also to analyze other issues, i.e. the views of teachers in role of classroom assessment and challenges they faced. As such, the results of this study map the terrain over how formative assessment requirements are described, how components of productive pedagogy merged and how teacher practices both formative assessment and productive pedagogy in classroom assessment. The study provides insights into the strengths and weaknesses in offered for formative assessment environment and nurturing productive pedagogy. However, it was found that peer assessment is deficient in both teacher guides and teachers practices. Teachers could use the study results as insights when making decisions about how to use curriculum materials, and to possibly reconsider how to organize the enactment of the teacher guides and national curriculum in order to develop formative assessment environment and to construct pedagogy productively in their classroom. The analyses could provide authors of teacher guides with appreciated information to consider regarding organization and design.

Keywords: curriculum materials, Finnish comprehensive school, formative assessment, productive pedagogy, and mathematics teachers' guide.

To all of you who were with me …..

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This study process is finally coming to its end and I am going to complete my degree. This has been adventurous journey. Many are those who have been with me on this trip, thank you all. To begin with, my departure on the voyage was not easy, it was so much try and fail story. But I never quite gave up my dream to come to Scandinavia and start higher study with financial support.

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Sharmin Ahmed

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List of Acronyms

AFL	Assessment for learning
FNBE	The Finnish National Board of Education
OECD	Organisation for Economic Co-operation and Development
PISA	Programme for International Student Assessment
QSRLS	Queensland School Reform Longitudinal Study
USA	United States of America

1 Introduction

1.1 Motivation

It took me time before I could finally frame my master thesis topic and clearly define my research problem. First I started another topic area, then I reflected upon myself, what I wanted to be, what I am doing and really what I want to do in my career. But at least I knew that I was going to focus pedagogy perspective, on student learning, and assessment even though I could not yet see myself how I could relate the three concepts, which were related. New ideas kept coming in while doing further readings on those concepts. Therefore, finally I landed on one focus of my thesis, the productive pedagogy perspective (it was always in my mind since I first read about this on one of my course reading) as a concept now widely used in educational and professional settings.

I was always curious about assessment and teaching learning in mathematics and science. My curiosity prompted me to consider another focus area of this thesis, formative assessment. Therefore finally, I decided to study curriculum materials, and how formative assessment and productive pedagogy employed through it. I deduced that by investigating core curriculum, teachers' guide and teacher experience could be good to know about classroom assessment strategies. My interests in the area of classroom assessment in mathematics and science classroom mainly stemmed from my experiences as a university student of teacher education, and then later on, as a teacher within the same academic field.

1.2 Rationale of the study

The recognition/realization and verification of learning outcomes from a particular teaching activity can be performed through proper and relevant assessment. But even with careful and effective instructions, the intended learning outcomes often bear little and the students reach different understandings level. That's why assessment is an important process in effective instruction. Furthermore, the most important factor of influencing learning is that teachers should teach according to what the learner already knows (Ausubel, 1968, cited in Wiliam, 2011) as well as the pedagogy employed to empower students inside and outside the classroom. There is also a very important connection among assessment (learning outcomes), curriculum

(content) and pedagogy (e.g. Black, Wiliam, & Yao, 2011). In this section I am going to focus on the importance of these three aspects in teaching learning process.

Emerging research shows potential of curriculum materials[1] to support pupils' learning as well as to maintenance teachers' teaching (e.g. Ball & Cohen, 1996; Brown, 2009; Davis & Krajnic, 2005; Stein, Remillard, & Smith, 2007). Not only curriculum materials (for example teachers' guides) play a critical role as major resource for teachers' planning and practice (Remillard 2005; Stein et al., 2007), but also curriculum design matters for classroom instruction and pupils' learning outcomes (Remillard, Harris & Agodini, 2014). The relationship between teaching and curriculum materials is a growing area of research, but still indecisive for science and mathematics (e.g. Lloyd, Remillard & Herbel-Eisenmann, 2009; Pepin, Gueudet & Trouche, 2013; Stein et al., 2007) as well as teacher guides have acknowledged minimal consideration (Remillard, 2005). Furthermore, examining and conceptualizing of curriculum materials have not received much research attention (e.g. Pepin et al., 2013; Remillard, 2005; 2013). In recent years, the researchers and school developers have focused on the importance of curriculum materials, especially in the United States of America (USA), for the fruitful reform and development of classroom practice and teaching (e.g. Remillard, 2005). This research has a shift towards the research and development of curriculum materials from the focus on textbook research to deliver support for both teachers' learning and teaching (e.g. Davis & Krajcik, 2005). Therefore, this research field is relatively new and unexplored. Research findings also showed that curriculum materials have the impact on how and what teachers use in their daily practices (Brown 2009; Remillard, 2005) as the curriculum materials used by both teachers and students (Brown, 2009). The same curriculum materials can effect in different ways, due to teachers' experience, intentions and abilities (Brown, 2009). But, there is very little research on the design and character of curriculum materials and teacher experiences as well as in a specific educational context. Therefore, it is important to conduct further studies on how curriculum materials influence classroom assessment to foster productive pedagogy. In this thesis I will focus on curriculum materials as researchers consider them as potentially implemented curriculum in science and mathematics education (e.g. Valverde, Bianchi, Wolfe, Schmidt & Houang, 2002) as well as in a large part of the world (Stein et al., 2007).

[1] Curriculum materials can take a variety of forms. For this study, under the umbrella of curriculum materials include: national core curriculum and teachers' guide.

On the one hand, formative assessment or assessment for learning has a great role in teaching-learning process as several authors advocate this as a way to improve students' experience of learning (e.g. Black & Wiliam 2009; Stiggins 2005; Wiliam, 2011). A worldwide education initiative and a limelight discussion has been taking place regarding formative assessment over the past decade (Stiggins 2005). Formative assessment is meant to obtain information about students' learning process as a part of teachers' teaching-learning process to make decisions on how to design the learning environment so that students' learning can be optimized (Stiggins 2005; Wiliam, 2011). To gather this indispensable information as assessment by teachers in a regular basis is a part of instruction to support and enhance learning (Black & Wiliam, 1998a; Shepard, 2000) draw on cognitive, constructivist, and sociocultural views of learning (Shepard 2000). International studies further have shown that formative use of assessment practices has enhanced considerable improvement in student achievement and creates a classroom culture of success (e.g. Black & Wiliam, 1998a). Important insights have been gained from these studies. But, in terms of understanding different context and impact, there are more studies needed to describe how teachers incorporate formative assessment into their classroom practice (Black & Wiliam 1998a, 1998b; Shepard 2000). Hence, one of the motivations of this study is to offer a comprehensive understanding on teachers' formative assessment practices in mathematics and science classes as well as curriculum materials to support student learning. In other words, "in order to improve understanding both of the forces which shape education systems and processes in different settings and of the impact of education system and processes on social and other development" (Bray, Adamson & Mason 2007, p.16).

On the other hand, the productive pedagogy framework is considered to enhance teaching and learning outcomes, which is emerged from a longitudinal study of classroom practices in work of the Queensland School Reform Longitudinal Study (QSRLS), conducted between 1998 and 2001 by Lingard et al. (2001). The framework is identified of four fundamental principles, namely intellectual quality, relevance, supportive environment, and recognition of difference. Productive pedagogy, as a research tool, has gained worldwide recognition to improve students learning (Hayes, Mills, Christie & Lingard, 2006). Not only that, productive pedagogy is also used as a means for teachers to critically reflect on classroom practices (Mills, et al., 2009). One of the major motives for working with the Productive Pedagogy framework for this study is that it is argued by the scholars to promote the provision of a high quality education for all students (e.g. Lingard et al., 2001). It has been written about extensively of Productive Pedagogies framework (e.g. Lingard, Hayes & Mills, 2003) as well as used in other research

projects (e.g. Allen, 2003; Marsh, 2007). Not only that, it has been adapted as educational policy internationally as well as in different state in Australia, for example, New South Wales (NSW Department of Education and Training, 2003) and in Queensland. Overall, this indicates the importance to investigating the classroom practice. Judgments about curriculum resources and teachers experiences were made against the principles of productive pedagogy (Hayes et al., 2006; Lingard et al., 2003). As the concept itself is too broad, only relevance, supportive environment dimensions are discussed in this study. The bottom line is that the study also focus on the productive pedagogy model that relate to concerns of curriculum materials and teacher practices.

Research in Finland is often cited as an example of an education system. In Finland, teaching and learning is "encouraging teachers and students to try new ideas and methods, learn about and through innovations, and cultivate creativity in schools, while respecting schools' pedagogic legacies" (Sahlberg, 2007, p 152). Finnish teachers use curriculum materials (e.g. textbook) "as a guarantee of a stable quality of teaching" (Pehkonen, 2004, p. 3–514). Pehkonen (2004) studies on Finnish teachers found that the textbook authors are seen as the most competent experts by teachers, and teachers found themselves hesitant to plan the lessons doubting whether they are as competent as the writers. As a result, the textbooks and teacher's guides are extensively use by teachers in Finland (Joutsenlahti & Vainionpää, 2010, cited in Hemmi, Koljonen, Hoelgaard, Ahl, & Ryve, 2013). Indeed, teachers are 'active' users of the curriculum materials and the curriculum as resources shape teachers' work (e.g. Remillard, 2005). Therefore, the overall focus of this study is the ways curriculum materials communicate to help the teachers (Remillard, 2005) in formative assessment and fostering productive pedagogy practices in Finnish context. Considering abovementioned issues altogether, the rationales for this study are:

- ✓ The strong position of curriculum materials in the mathematics classroom in general. The expected benefits of expanding the knowledge base of research, especially in teacher guides and core curriculum, in general the area of curriculum resources as well for mathematics education.

- ✓ In the global context, formative assessment have seen as vigorous significance to improve and accelerate pupils' learning.

- ✓ Productive Pedagogy provides as a framework with potential for enhancing the quality of classroom assessment practices.
- ✓ Finland is often referred as a country that has succeeded with their education system with high and consistent standards.

1.3 Aim and research questions

This thesis builds upon two main focus areas. The first is formative assessment, how it emerges in teachers' daily activities and how teacher guides and national core curriculum have described it. The second focus investigates what content is represented in teacher daily classroom practices, teacher guides and core curriculum in teaching based on productive pedagogy. The other purpose of the study is to explore the barrier encounter by teachers in classroom assessment practices and how have seen their role as a teacher to improve student learning experiences with regard to mathematics and science education. Therefore, the aim of the study is to examine to what extent education policies shape practices of formative assessment and to investigate how formative assessment is remodeled in different contexts (Curriculum, teacher guide books and in classroom practices) to support productive pedagogy in Finish basic education. The following research questions were investigated in this study:

- How do teacher incorporate formative assessment and productive pedagogy's component in their practices to improve their students learning in mathematics and science classroom?
- To what extent do curriculum and mathematics teacher guides convey formative assessment?
- To what extent do national core curriculum and mathematics teacher guides incorporate productive pedagogy components?
- What challenges do teachers find with classroom assessment to ensure formative assessment and productive pedagogy as well as how they see their role in classroom assessment?

1.4 Contextual background

Finland, which situated on the Nordic region and rank highly in many international comparisons of national performance [e.g., PISA (Programme for International Student Assessment) test] as well as currently undergoing through change and reform for better education systems (The Organisation for Economic Co-operation and Development [OECD], 2010). Classroom-based assessment is a strong focus on Finish education system as well as teachers is expected to assess their own students on an ongoing basis (OECD, 2010). Furthermore, contemporaneously, the central bureaus in Finland emphasis teachers to employ professional development to interactive classroom practices perspective. Therefore, the motive of this study is to provide a better understanding about the experiences of classroom based assessment within Finnish contexts from policy to practices.

The school system (see appendix A) in Finland is compulsory nine year basic education where Finnish children begin school only the year they turn seven. The teachers are well educated with a master degree both classroom and subject teachers. The continuous popularity of teaching profession in Finland may one of the main contribution of the academic status of classroom teacher education, and to the trust parents feel towards their children's teachers as well as the school in general (Kupiainen, Hautamäki & Karjalainen, 2009). The government determines the general objectives of education and the National Board of Education sets out the concrete objectives and core contents of instruction in the different subjects as the Finnish education system is a mixture of state steered and relatively autonomous elements. Since the beginning of the 1980s in Finland, there is no state control over curricular materials (Pehkonen, 2004). Local authorities (generally municipalities) are responsible for combining the municipal curriculum based on the national core curriculum, also the practical arrangement of schooling. School compose its own curriculum based on both the national core curriculum and the municipal document, and free to choose what curriculum materials to use. But the new core curriculum of 2004 reinforced a new state control by narrowing the licence of municipalities and schools in planning their respective curricula (Kupiainen et al., 2009). In addidtion to that, since the 1980s, Finland has a rather long tradition to produce of commercial curriculum materials by teams of teachers and other experts (Niemi, 2012). The national core curriculum provides an overall outline for school education (Finnish National Board of Education [FNBE], 2004), which the locally designed curriculum at municipality level defines. It is important to know that there are emphasized on both formative–summative assessment systems in the

Finnish core curriculum for pupil assessment. The task of assessment is to guide and encourage student learning and to help pupils in for their learning during the course of studies where continuous feedback from the teacher seems very important. There are also separate sections about pupil assessment (FNBE, 2004, p. 260–265).

1.5 Limitation of the study

The context of study is Finland as a place where the education regarded as the best education in the world. Only Finnish basic education has been chosen as a focal point for this study, but the issues argued and the outcomes found have implications for other teaching and learning contexts beyond Finland. Research on curriculum materials, especially national core curriculum, teacher guides and teachers' practices can be applied to any educational domain, as well as any discipline. But for the present study, first, it has been limited to mathematics education, especially for mathematics teacher guides. More precisely, to the area of classroom assessment in mathematics. Second, the area of teachers' experiences have seen both science and mathematics teaching as well as in core curriculum.

Another limitation of this study could be that I did this study through teachers' point of views, there are enough room and would be interesting if the based on observation and also large scale. Likewise, only nine of the elements of the productive pedagogy framework have been considered here. Finally, another limitation relates to the generalizability of teacher practices and teachers' guide.

1.6 Contribution of this study

This study will add the contribution to the international research discourse on curriculum materials regarding formative assessment and productive pedagogy. Since the teacher guides and national core curriculum were analyzed with respect to both perspectives on formative assessment and productive pedagogy. The analysis add the value to what kind of resource mathematics teachers guides and national curriculum constitute for the teachers as well as what kind of classroom assessment environment they construct to assist the teachers. The drive of this study will contribute to gain deeper knowledge of curriculum materials and the teacher experiences from their classroom practices that are significant components in the complex teacher-curriculum relationship (Charalambous & Hill, 2012; Remillard, 2005). The study also

contributes to convey the intentions and goals of productive pedagogy in teachers' practices and curriculum materials to presents an important example of the feature of Finnish basic education.

To do so, the first aim with this study is to contribute to the knowledge of how national core curriculum and mathematics teacher guides developed formative assessment criteria. The second aim is to investigate what kind of content is available in respect to productive pedagogy components. The third aim to how teachers' practices in their classroom on both formative assessment and productive pedagogy components. It is highly interesting to broaden the knowledge base of formative assessment and the potential support from both curriculum and teacher guides on teachers' enactment of classroom. The results of this study could be seen as one piece in the building of a theoretical understanding of how curriculum materials are seen the teachers' use of formative assessment tools in planning and enacting teaching as well as the teachers' daily experiences in classroom assessment. The results of this study map the terrain over how national core curriculum and mathematics teacher guidebooks in Finland construct the productive pedagogy in classroom assessment. The result of this study could use by the authors of curriculum materials as one way to develop teachers' most important tools as science and mathematics education relies heavily on curriculum materials. The school, municipal committee involve with local curriculum development as well as teachers could use the results about potential strengths and weaknesses in the support offered by curriculum materials to inform themselves.

1.7 Structure of the thesis

This thesis consists of a total of six chapters (including this introduction chapter), references and appendices.

In Chapter 2, reviews relevant research and the theoretical background is presented under several sub-chapters. A review of relevant literature and previous research is presented on teachers' use of curriculum materials, teacher guides as curriculum materials, assessment as well as formative assessment and productive pedagogy perspectives, in order to portray key components of the thesis. I briefly defined about curriculum materials and then described different perspectives and relation between curriculum materials and classroom assessment practices based on previous research. Then some of the literature review concentrates on

research in formative assessment and classroom assessment perspectives along with the spirit of the adopted perspective, for this thesis. I tried to review the large body of research on formative classroom assessment environment. Formative assessment is clarified under the ensuing subtitle. Then another section deals with research on the productive pedagogy. I briefly described the features of productive pedagogy. Finally, a description of the overall theoretical stances for the studies is provided and specifies the focus of this thesis. I focus my review on definitions and known obstacles of classroom assessment. This picturing is necessary to understand the framework for analysis, used for assessing the potential of Finnish core curriculum, teacher guides and teacher practices to support the student learning and teacher teaching strategies.

Chapter 3 includes methodological discussion of this study. It describes the methodological approaches, how decision was made collection of data, and analytical approaches, which divided into seven main sections. In one section I briefly describe the justification of the selection of the documents. I introduce the tow analytical approaches: the analysis of the formative perspectives and productive pedagogy contents, which I followed to analyses this study. This chapter also discuss of the studies in relation to criteria of quality in research, the trustworthiness and the ethical aspects of the study. In the last section, the research challenges of the entire study are explored as well.

Chapter 4 presents the analyses to answer the research questions. The presentation of the data is presented in three main sections thematically to focus on the main research questions. First I have given very little touch on core curriculum, then the organization of teachers' guide, which were used, then under three broad sections and several subsections I have discussed the perspective of my main research focuses.

In chapter 5, the discussions are presented and discussed in relation to the research questions of the study as well as to previous research outlined. This chapter consists of three sections based on the analysis and the study focus areas.

Chapter 6, finally closes this thesis with a discussion of the contributions of the study, addressing the degree of importance of further studies.

2 Literature Review and Theoretical Background

The main research problem in this thesis is how formative assessment and productive pedagogy dimension employed in Finnish curriculum materials (national core curriculum, teachers' guides and in teachers' practices). In this chapter, I will review relevant and related research and positioned my theoretical standpoint. The aim of this chapter is not to give a broad and extensive overview, as stated earlier, this is a complex and manifold field. Instead, I will delimit and structure the review according to four considerations. Firstly, I include the perspectives of curriculum materials in teaching learning process. Secondly, the relevant studies that I find important and relevant for the present study on formative assessment environment as well as the definition. Thirdly, I include the perspectives that can provide a solid foundation for productive pedagogy as discussing the findings from my research. Fourthly, the positioned of my present study. The overall aim of this literature review is to expand on how different strands of research understand the curriculum materials, formative assessment and productive pedagogy in teachers' practices to contribute on classroom assessment.

2.1 Instructional strategy and curriculum material

In this section, I will briefly present some trends in international research on curriculum materials and their importance that have been influential on teaching and learning process.

2.1.1 Defining curriculum materials

My admission into this section is through the concept of curriculum materials. The term curriculum is used in different ways around the world. Curriculum sketches the why, what, when, where, how, and whom of learning (Braslavsky, 2003). The word curriculum is informed by the original Latin meaning which means the course of a race. In this sense, it includes the path traveled which is more than the end point. Perhaps one of the most comprehensive explanations of curriculum is delivered by Braslavsky (2003):

> The curriculum defines the educational foundations and contents, their sequencing in relation to the amount of time available for the learning experiences, the characteristics of the teaching institutions, the characteristics of the learning experiences, in particular

> from the point of view of methods to be used, the resources for learning and teaching (e.g. textbooks and new technologies), evaluation and teachers' profiles (p. 1).

This definition of curriculum is informed is not specific to a single content area, where the several explanations of curriculum materials are used interchangeably as there is no explicit existing definition in the field of science and mathematics (Stein et al. 2007; Remillard, 2005). In this study purpose, however, the particular focus is the national core curriculum for mathematics and science education, and mathematics teachers' guide in Finnish comprehensive school. Scholars have also conceptualized the use of curriculum materials differently across studies as these notions have different meanings in different contexts (Stein et al. 2007; Remillard, 2005). I use the term curriculum materials to refer to Finnish national core curriculum and mathematics teachers' guides as the most common form of instructional materials used all over the world as well as continue to play a critical role in national education systems (Remillard, 2005).

2.1.2 Role of curriculum materials in teaching-learning process

The curriculum materials is the important content for the progress of classroom practice and teaching (e.g. Ball & Cohen, 1996; Davis & Krajcik; 2005; Remillard, 2005). Curriculum materials require, Ball and Cohen (1996) argued, to be developed to enhance support the teachers in learning about teaching. Consequently, curriculum materials constitute an important source for mathematics education. Ball and Cohen (1996) emphasized how teachers' guides could help teachers "to learn how to listen to and interpret what students say, and to anticipate what learners may think about or do in response to instructional activities" (p. 7). They are typically a main resource for teachers' planning and practice (e.g. Stein et al., 2007), and recent studies focus has been appeared on the influence of the quality of curriculum materials on science and mathematics teaching (Charalambous & Hill, 2012; Davis & Krajcik; 2005).

Rather than simply scripting instruction, Ball and Cohen (1996) argue that, "curriculum materials could contribute to professional practices if they were created with closer attention to processes of curriculum enactment" (p. 7). Building on this idea, Davis and Kajcik (2005) recommend five guidelines for enacted curriculum, in this way might help teachers where they emphasized:

(1) To anticipate and interpret what learners may think about or do in response to instructional activities;

(2) To support teachers' learning of subject matter;

(3) To help teachers consider ways to relate units during the year;

(4) To make visible the developers' pedagogical judgments and

(5) To promote a teacher's pedagogical design capacity.

Curriculum materials have influence on teachers' pedagogical design capacity as an important source for teachers in instructional design (e.g. Stylianides, 2007). A number of scholars have analyzed features of curriculum materials to scrutinize different ways that objectively specified structures link to critical subject schemes, including the mathematical treatment and emphasis as well as discourses (Pepin et al., 2013), and how potentials of the teacher's role are communicated (Remillard, 2012). In this regards, Remillard et al. (2014) formulated a conceptual framework for the assessment of educative features in curriculum materials where they examined four mathematics curricula (the most using curricula in USA) to look the capacity required for teachers to make productive use of the these curricula materials as well as supportive for teachers to design quality instruction. They found that:

> Conventional teacher's guides provide guidance that directs teachers' instructional actions, by providing teachers with tasks to present to students and questions to ask. Some curriculum developers have designed teacher's guides that also speak to teachers about the design of the lessons, the mathematical and pedagogical ideas underlying them, and how students might respond. This latter type of guidance is viewed as especially important for curricula that adopt instructional models and mathematical emphases that are likely to be challenging for teachers to implement (p. 743-744).

Brown (2009) redirects on how different resources can work as indication of different educational opportunities for teachers and pupils. He provided three basic aspects of curriculum resources based on his analysis of science curriculum resources, such as:

(a) Representations of concepts specific to the domain,

(b) Representations of tasks or procedures that students are expected to undertake, and

(c) Physical objects and representations of physical objects that are intended to support students' work on the tasks and understanding of the concepts.

2.1.3 Interactions between teachers and curriculum material

The interactions between teachers and textbooks as a curriculum material have focused on textbook research works (e.g., Remillard 2005; Pepin & Haggarty 2001). Effective designs of curriculum resources are increasing interest for several theoretical as well as empirically driven researches (e.g., Ball & Cohen, 1996; Brown, 2009; Davis & Krajcik, 2005; Remillard, 2012). Studies on development of educative features of curriculum materials have shown how curriculum materials providing an explicit type of support for both teachers' learning and teaching (e.g., Ball & Cohen, 1996; Davis & Krajcik, 2005; Remillard, 2005).

Remillard (2005) examined 'key concepts in research on teachers' use of mathematics curricula' by reviewing the articles which covered 25 years of research on use of mathematics curricula. She found four main conceptualizations of using curriculum. First, she found that many studies are conducted under the presumption that teachers either follow or subvert the text in curriculum material as the starting point. This view is predominant when curriculum resources are seen as a vehicle for change by administrators and policymakers in instructional reform. A presumption is that a close fidelity between the written and enacted curriculum might be achieved under ideal conditions, which is possible and desirable. Second, she found that several studies described the use of curriculum in as ways in which teachers draw upon and incorporate texts into their instruction. This insight leads to that the teacher has agency over the curriculum and view texts as one of the many resources that teachers use in constructing the enacted curriculum. Fidelity between the written and the enacted curriculum is possible, but unlike cultural tools or artifacts. Third, she found that studies conducted on the teacher as interpreter of the written curriculum as well as how those interpretations relates to teachers' beliefs and prior experiences. Fourth, she found the less common perspective taken by researchers studying on participating with the texts, in which both teachers and curriculum materials are seen as participatory influencing the enacted curriculum. In this view, teachers and curriculum materials are engaged in a dynamic interrelationship, in which collaboration on the parts of both the teacher and the text.

Based on her analysis, she offers a framework that highlights relevant dimensions of and interactions within the teacher–curriculum relationship (see figure 1). Remillard indeed sees teachers as 'active' designers and users of the curriculum materials. The figure shows that the collaboration is shaped by what the teacher and the curriculum carry to them. She anticipated;

> It design is grounded in two assumptions central to the previous account of teaching: that teaching involves curriculum design and that it is multifaceted. Together, these stances imply that teachers are engaged in design work throughout the multiple domains of teaching. Emphasizing the relationships among the participatory relationship, the planned curriculum, and the enacted curriculum allows the framework to represent the cycles of design before, during, and after classroom practice (p. 236).

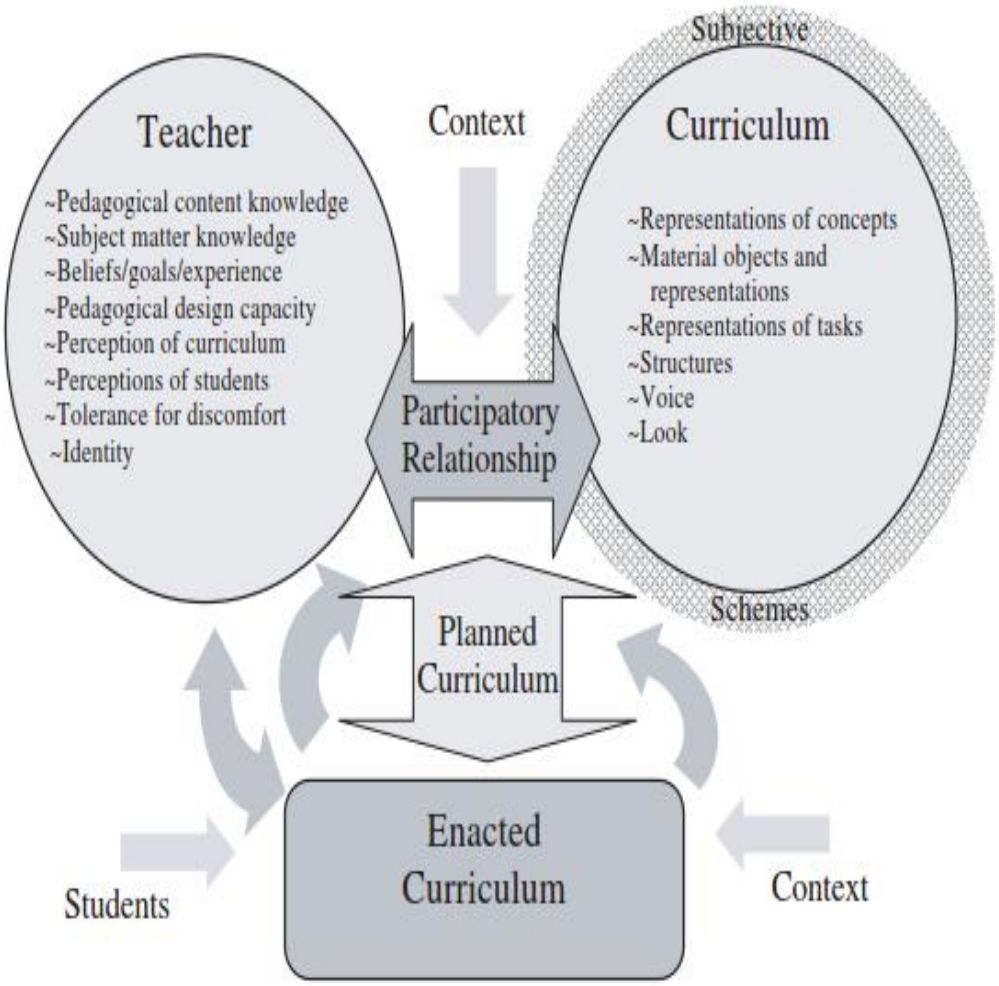

Figure 1: Remillard's (2005) Framework of components of teacher–curriculum relationship.

In her later work, Remillard (2012) argued that "teachers are positioned by and through their encounters with curriculum materials as particular kinds of users of them" (p. 106). She explained this positioning happened through 'modes of address' in curriculum resources and "modes of engagement" taken up by teachers with curriculum resources. She addressed structure, look, voice, medium, and genre are forms of 'Modes of address' in curriculum resource. 'Modes of engagement' refer to how a teacher interacts with the forms of address of the text including "what the teacher reads for, which parts she reads, when she reads, and who she is as a reader" (Remillard, 2012, p. 115).

The concept of teachers participate with curriculum resources includes "how teachers engage or interact with these resources as well as how and the extent to which they rely on them in planning and enacting instruction, and the role resources play in teachers' practice" (Lloyd et al., 2009, p. 7). Recently, researchers have begun to show that the teaching and learning supported by curriculum materials as a useful resources for teachers. Teachers and curriculum material has a collaborative relationship together in enacted curriculum (Brown, 2009) to provide pupils opportunities to acquire knowledge as the configuration of social, political and pedagogical conditions (Valverde et al. 2002).

Brown (2009) and Brown and Edelson, (2003) have explained on the teacher-curriculum resources relationship. Offloading, adapting and improvising are the three basic forms of how teachers participate with curriculum resources (Brown & Edelsson, 2003). Adaptation are when teachers adopt certain elements of the curriculum design with the contribution of their own design elements, offloading is where teachers rely significantly on the curriculum resources to support instruction, and improvising when teachers follow instructional tracks of their own strategy. Teachers' use of curriculum resources can contrast in these three process of offloads, adaptations and improvisations which provides, Brown and Edelsson (2003) argued, a means "to classify the nature of the teachers' partnerships with curriculum materials by identifying differential contributions of instructional resources and distributions of design responsibility" (p. 7).

Furthermore, the process of enacting the curriculum materials could contribute for teacher own learning (Remillard, 2005; Davis & Krajcik, 2005). Stein et al. (2007) presented findings on the influence of curriculum on student learning from a review of research. Curriculum materials use "to communicate concepts and actions, being attentive to the ways in which teachers perceive and interpret these representations and understanding how these representations can

constrain and afford teacher practice" (Brown, 2009, p. 18). In this regards, Valverde et al. (2002) emphasized that textbooks work as the link between intended curriculum and the classroom practices to serve teachers and students. Brown (2009) identified three ways communication between teachers and curriculum artifact, such as:

1) Curriculum resources play an important role in affording and constraining teachers' actions,

2) Teachers notice and use such artifacts differently given their experience, intentions, and abilities and

3) 'Teaching by design' is not so much a conscious inevitable reality.

These three facets, according to Brown (2009), "encompass the most fundamental aspects of the curriculum's content and structure: its core ideas, the activities undertaken in their explorations, and the objects that support such activities" (p. 27).

2.2 Assessment in teaching learning process

The word 'assessment' was used primarily to describe the processes as when the instructional cycle was completed, after that to evaluate the effectiveness of instructional activities. The actions were not generally regarded as kinds of assessments that guided learning processes before the end of the instructional activities cycle (Wiliam, 2011). In her book Beyond Testing: towards a theory of educational assessment, Gipps (1994) pointed out that assessment is "a wide range of methods for evaluating pupil performance and attainment" (p. vii). She also emphasized that 'assessment does not stand outside teaching, but stands in direct interaction with it' (Gipps 1994, 261).

In the following sub sections, I will briefly define the formative assessment and the role of classroom culture, feedback and student engagement in classroom assessment. In the next two sections, I will focus more particularly on assessment as well as formative assessment criteria.

2.2.1 What is Formative assessment

"What is assessment for learning", the paper written by Wiliam (2011) where he reviewed to clarify the development and meanings of the terms 'assessment for learning (AFL)' and

‘formative assessment’ as well as numerous research and pedagogical activities have paid attention in this regard. Although ‘assessment for learning’ and ‘formative assessment’ do share many common features, these two terms are not essentially synonymous to each other. Formative assessment mainly the teacher’s perspective towards assessment, “to provide feedback to the teacher to assess the quality of instruction or to improve teaching behaviors, or to provide feedback to the student to assess the quality of learning and to improve learning behaviors” while ‘assessment for learning’ give emphasis to pupils’ viewpoints, “to provide feedback to students to assess the quality of learning and to improve learning behaviors” (Frey & Schmitt, 2007, p. 417). Therefore, in this study I was focusing on formative assessment to see teacher perspective.

Furthermore, Black and Wiliam (1998a) defined formative assessment as “encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged” (p. 7-8). Moreover Black and Wiliam (1998b) point out clearly in their other writing on 'Inside the Black Box” that “assessment becomes formative assessment when the evidence is actually used to adapt the teaching to meet student needs’’ (p.140). Despite the widespread acknowledgement of formative assessment, Kahl (2005) defined formative assessment as a tool that teachers use in the purpose of measuring student grasp of specific topics and skills of what they are teaching. He stated, “It’s a ‘midstream’ tool to identify specific student misconceptions and mistakes while the material is being taught’’ (p. 11). However, formative assessment is neither just a tool nor a measurement instrument, rather a process to continuously support teaching and learning which is carry out during the instructional process (Shepard, 2000). Formative assessment is concerned “with the creation of, and capitalization upon, “moments of contingency” in instruction for the purpose of the regulation of learning processes” (Black & Wiliam, 2009, p. 10).

Considering the role of the teacher, the learners, and their peers, Black and Wiliam (2009) developed the theory of formative assessment based on the framework given by Wiliam and Thompson (2008) (see figure 2), indicating that formative assessment can be conceptualized as comprising of five key strategies:

(a) Clarifying and sharing learning intentions and criteria for success;

(b) Engineering effective classroom discussions and other learning tasks that elicit evidence of student understanding;

(c) Providing feedback that moves learners forward;

(d) Activating students as instructional resources for one another; and

(e) Activating students as the owners of their own learning.

<table>
<tr><th></th><th>Where the learner is going</th><th>Where the learner is right now</th><th>How to get there</th></tr>
<tr><td>Teacher</td><td rowspan="3">Clarifying learning intentions and sharing and criteria for success (1)</td><td>Engineering effective classroom discussions, activities and tasks that elicit evidence of learning (2)</td><td>Providing feedback that moves learners forward (3)</td></tr>
<tr><td>Peer</td><td colspan="2">Activating students as instructional resources for one another (4)</td></tr>
<tr><td>Learner</td><td colspan="2">Activating students as the owners of their own learning (5)</td></tr>
<tr><td colspan="4">Understanding and sharing learning intentions and criteria for success (1)
Understanding learning intentions and criteria for success (1)</td></tr>
</table>

Figure 2. Aspects of formative assessment

The pedagogical potential of classroom assessment is demonstrated by lot of empirical studies (e.g., Black & Harrison, 2001; Orsmond, Merry & Reiling, 2002). Hargreaves et al. (2002) illustrated and exemplified teachers' ideas about assessment from four perspectives: the technological, cultural, political, and postmodern. In the global context formative assessment have seen as vigorous significance (OECD/CERI 2005, 2008; Black & Wiliam, 2005). The extensive international case studies across eight nations including Canada, Denmark, England, Finland, Italy, New Zealand, Queensland in Australia, and Scotland conducted by OECD's

(2005) Centre for Educational Research and Innovation (CERI) had incorporated formative assessments into their national policy frameworks. Study constantly finds that students participate actively in learning progression via monitoring and regulating product-oriented learning processes when they are effectively formatively assessed (Black & Wiliam 1998a, 1998b, 2009; Black & Jones, 2006; Kirton et al., 2007). The evaluation study on using formative assessment project conducted in 16 primary and 2 junior high schools in Scotland which provides some evidence that using formative assessment led to pupils taking more responsibility, boost confidence and contributing to improve motivation for their learning, especially for lower attainers (Kirton et al., 2007). The OECD/CERI case study approach provides a broad spectrum on developing teachers' conceptual understanding of formative assessment which illuminates current understandings of how practitioners may use formative assessment in practical contexts (e.g., Babaci-Wilhite, 2014). Employing such strategies help to move from teacher-centered pedagogy to place pupils learning needs at the heart of teaching (Kirton et al., 2007). Furthermore OECD (2008) provided the key six elements of formative assessment in classroom that have emerged from the case studies and related researches are given below which is one of the main focus area for this study:

1. Establishment of a classroom culture that encourages interaction and the use of assessment tools.

2. Establishment of learning goals, and tracking of individual student progress toward those goals.

3. Use of varied instruction methods to meet diverse student needs.

4. Use of varied approaches to assessing student understanding.

5. Feedback on student performance and adaptation of instruction to meet identified needs.

6. Active involvement of students in the learning process.

In this study these six key elements were chosen as one of the analytical framework (see methodology chapter). The interrelationships among curriculum, assessment and pedagogy have seen an accepted feature by Black et al. (2011) in analyses of teaching and learning. They have shown a formative approach to the learning triangle where emphasized the issue to address

interaction between curriculum and assessment driven by theories of student learning (e.g., Black et al., 2011b, p 79-83).

2.2.2 Convenient Classroom culture for formative assessment

The role of school culture is evident in the literature on classroom assessment (e.g. Stiggins, 2005). The effectiveness of formative assessment in supporting learning has been maintenance by many organizations and key researchers in this field. Cowie & Bell (1999) have as well proposed about requiring the changes to instruction during the teaching learning process, as illustrate: ‘‘the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning’’ (p. 32). It is one of the key concerns of formative assessment to adjust and adapt the instructional strategies with the explicit goal of meeting the needs of the students learning (Black & Wiliam, 1998a, 1998b, 2009). It’s not a matter of “looking at test data and deciding to try a new approach next time; it’s a matter of doing something different (or differently) now” (Popham, 2008, p.8).

The classroom culture also plays a vital role of chasing better marks rather than better learning can result in competition and de-motivation amongst lower-achievers. Black and Wiliam (1998a) argued:

> Pupils who encounter difficulties and poor results are led to believe that they lack ability, and this belief leads them to attribute their difficulties to a defect in themselves about which they cannot do a great deal. So they ‘retire hurt’, avoid investing effort in learning which could only lead to disappointment…What is needed is a culture of success, backed by a belief that all can achieve (p. 9).

Classroom talk and questioning are powerful learning activities in formative classroom culture, which is recognizes by researcher as a very good methods for teachers to elicit evidence of pupils’ understanding and misunderstandings in order to inform the learning and teaching (Black, 2003; Swaffield, 2011). Swaffield (2011) stated that “engaging in dialogue and listening to the flow of arguments are learning activities for the students through which they construct their knowledge and understanding – irrespective of whether the teacher uses the information gleaned formatively (p.443). Black and Wiliam (1998b) recommended about key components of formative assessment, “Opportunities for students to express their understandings should be designed into any piece of teaching, for this will initiate the interaction through which formative

assessment aids learning" (p. 143). They also emphasized that thoughtful, reflective, focused to evoke and explore understanding, and conducted dialogue between pupils and teachers in order to get pupils the opportunity to think and to express their ideas. In his book called "Transformative assessment", Popham (2008) shows how formative assessment calls for a fundamental change in three dimensions of the class-room: learning expectations, responsibility for learning, and the perceived role of classroom assessment (see Figure 3).

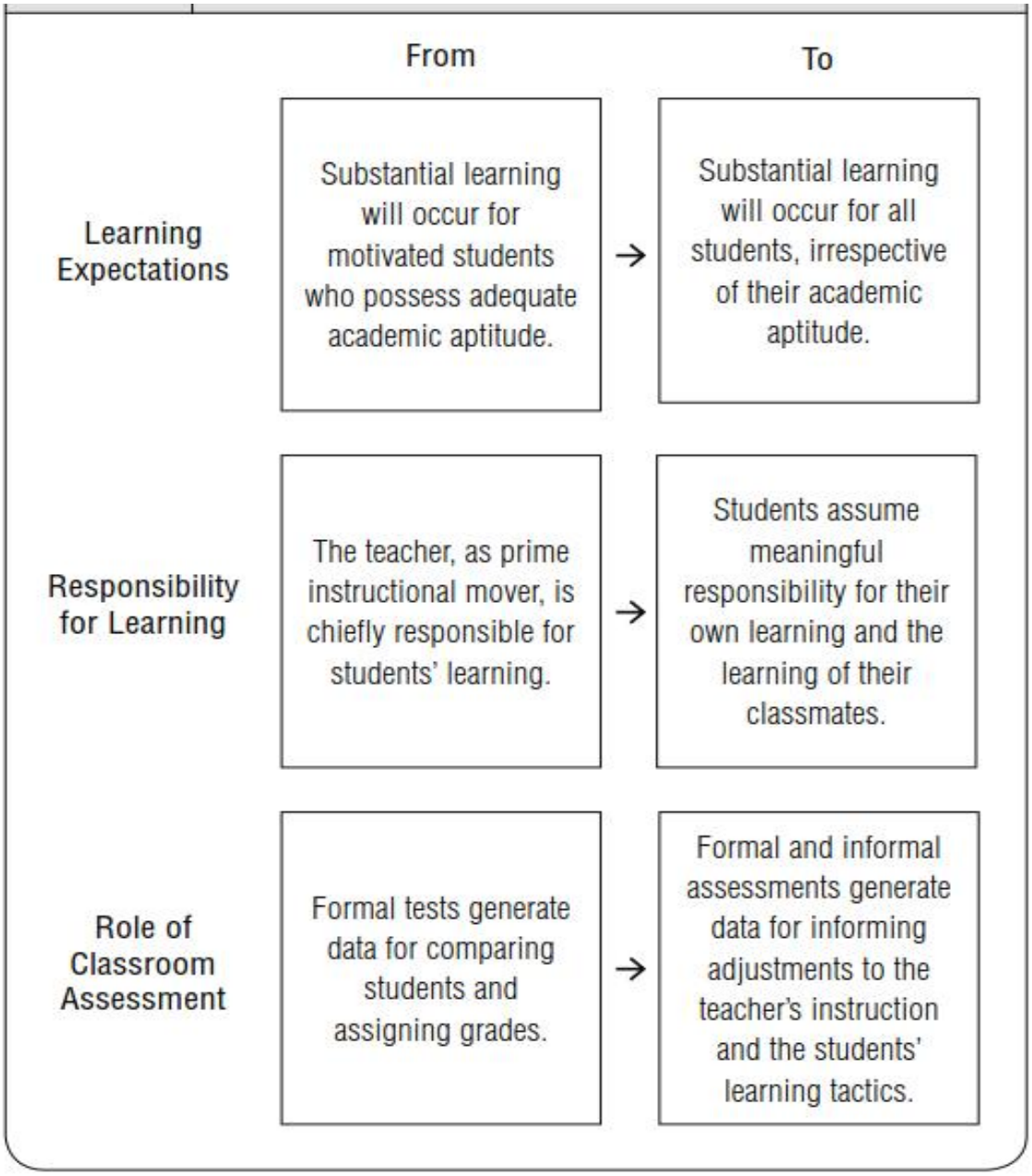

Figure 3: The Key Classroom Climate Shifts in Formative Assessment (Popham, 2008)

> Teachers need to clarify learning goals and task criteria, Torrance and Pryor (2001) argued that not only by making clear the purpose of and criteria for judgment of any individual task, but also by making clear the relationship of particular tasks to the overall management of the classroom-i.e. making the 'social rules' of the classroom as transparent as possible, in addition to the purpose and criteria of individual tasks (p. 628).

Sadler (1989) outlined knowing the desired goal as key elements of effective learning. He emphasized how to close the gap between pupil's present positions in relation to the desire goal and in order to reach in that goal. Based on Sadler's three conditions, phrased as questions from the pupil's point of view, "Where am I going?", "Where am I now?", and "How can I close the gap?", Stiggins et al. (2007, cited in Chappuis, 2009) developed 'Seven strategies of Assessment for Learning' to reflect teachers' practices in classroom in order to create convenient classroom culture for formative assessment (see figure 4).

Figure 4: Seven Strategies of Assessment for Learning (Stiggins et al., 2007).

2.2.3 Role of Feedback in supportive learning environment

Feedback lies at the core of the formative assessment. Feedback indicates "the existence of a 'gap' between the actual level of the work being assessed and the required standard" (Taras, 2005, p. 468). Formative assessment, which help to indicate, how the work can be improved to reach the goal. Therefore, it is far too infrequent and broadly focused to be supportive to deliver feedback through standardized assessments once in a year (Stiggins & Chappuis, 2005). Stiggins and Chappuis (2005) perceived that it is crucial for learners to get continuous access to constructive feedback on strengths and weaknesses as well as suggestions where improvements might be required in the future, not merely occasional judgmental feedback in their work. More specifically, feedback should be delivered with instruction and thoughtful

questioning for further inquiry to close the gap between their current level of understanding and the desired learning goal which is then turn out to be formative feedback as the indication of learning is used to adapt instruction to meet student needs (Black, 2003; Black & Wiliam, 1998a, 1998b, 2009; Sadler 1989).

Black and Wiliam (1998a) reviewed research articles which carried out from 1988 to 1998 where they sought out that providing feedback on student performance can improve and accelerate learning. Most important thing about feedback is quality, not just about the quantity. Quality of feedback means, "not just the technical structure of the feedback (such as its accuracy, comprehensiveness and appropriateness) but also its accessibility to the learners (as a communication), its catalytic and coaching value, and its ability to inspire confidence and hope" (Sadler, 1998, p. 84). In this regards, Black et al. (2011) specified three important implications of feedback in formative assessment:

> First of all, feedback should follow a three way path: from students to teacher so that the teacher can understand the students' level of understanding; from teacher to students, whereby the teacher responds to challenge or to extend the students' ideas; and from student to student, in as much as students can help and be helped by mutual dialogue. A second implication is that the definition includes feedback by students in assessing themselves and each other. A third is that feedback can be enacted both through oral and written exchanges, and over various time scales. (p. 74).

A model of feedback principles (see figure 5) has provided by Nicol and Macfarlane-Dick (2006) that support and develop self-regulation in students, based on a model by Butler and Winne (1995). Seven key principles of good feedback practice were developed in this model synthesis of the research literature:

1. helps clarify what good performance is (goals, criteria, expected standards);

2. facilitates the development of self-assessment (reflection) in learning;

3. delivers high quality information to students about their learning;

4. encourages teacher and peer dialogue around learning;

5. encourages positive motivational beliefs and self-esteem;

6. provides opportunities to close the gap between current and desired performance;

7. provides information to teachers that can be used to help shape teaching.

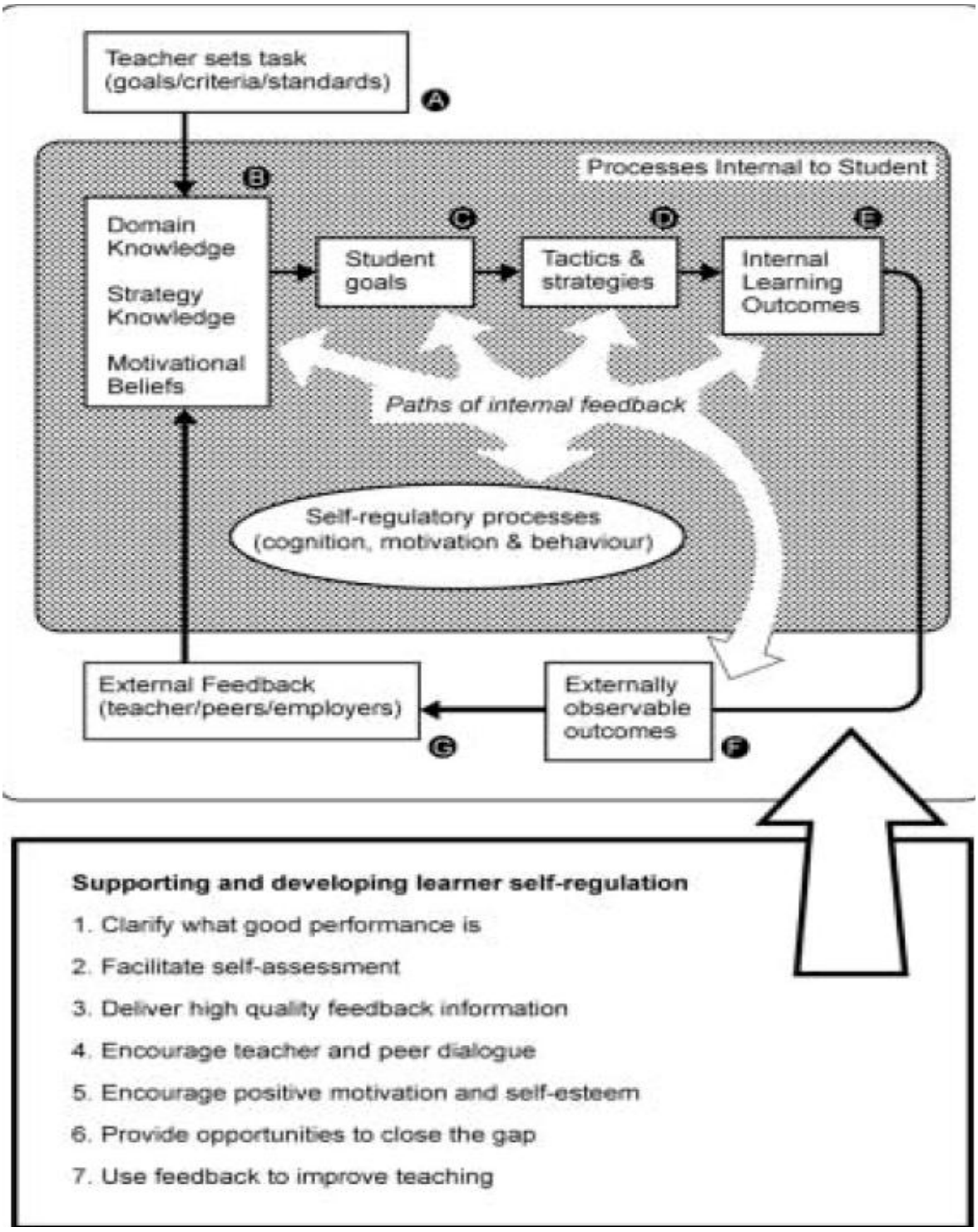

Figure 5. A model of self-regulated learning and the feedback principles that support and develop self-regulation in students (Nicol & Macfarlane-Dick, 2006).

2.2.4 ‘Pupils’ engagement in assessment processes

Student involvement in assessment, particularly self and peer assessments by and between students are an inevitable feature in assessment process for continuous improvement and lifelong learning (e.g., Sadler, 1989; Black & Wiliam, 1998, Shepard, 2000, Kirton et al., 2007; Wiliam, 2011). Wiliam and Thompson (2008) incorporated explicitly learner involvement and their peers in formative assessment which could be considered of as concerning three main practices “identifying where learners are in their learning”, “where they are going” and “how to get there” work out by teacher, learner, peer. Thus self-assessment can be a powerful confidence builder for students (Stiggins & Chappuis, 2005). Learners’ partnership in the assessment process associate to build self-regulation learning (Voogt & Kasurien, 2005; Black & Wiliam, 2009). In the developmental study conducted by Kirton et al. (2007) found that peer assessment helps the pupils “to acquire the skills to self-assess their own work more effectively” (p. 618), as well as to understand the benefits of collaboration with peers. Also, that their contribution leads to developed knowledge for their peers as pupils are able to demonstrate their ability to carry on a professional conversation Through peer assessment (Davis, Kumtepe & Aydeniz, 2007)

Peer assessment allows pupils to participate in the process of assessment. Distributing some of the teacher’s responsibility can taking place in the form of peer assessment. However, giving ownership as well as the responsibility of learning to pupils does not correspond to less responsibility for teachers (Gipps, 1994). Scholars also argued that:

> Sharing criteria with learners enables them to develop a clear sense of what they are aiming at and the meaning of quality in any particular endeavor, which coupled with self and peer assessment helps students learn not only the matter in hand but also to develop metacognition (Swaffield, 2011, p. 443).

By providing concrete pieces of work for pupils to discuss through formal and informal conversations about their learning, pupils get the opportunity to develop more collaborative relationships with their fellow peers and teachers. Peer assessment by no means indicates “what students have learned; instead it helps students realize what they have not learned and how their peers and teacher can help them develop more critical-thinking skills (Davis et al., 2007, p. 125).

Evidence gathered over decades from around the world reveals that when teachers implement pupils' engagement in assessment process, it helps to reduce achievement score gaps and gains achievement. Pupil involvement in the assessment process is productive way to turn their thinking in more positive directions by encouraging pupils' confidence in their learning. In this regard, Stiggins and Chappuis (2005) affirmed, "student-involved classroom assessment opens the assessment process and invites students in as partners, monitoring their own levels of achievement" (p. 13). Therefore, pupils' meta-cognitive strategies such as individual goal-planning, monitoring, and reflection on their learning could be achieved through deep involvement of learners by giving "the power to oversee and steer one's own learning so that one can become a more committed, responsible and effective learner" (Black & Jones, 2006, p. 8). Student self-assessment assists to increase students' responsibility for their own learning where the relationship between teachers and students become more collaborative (Shepard, 2000). Hence, peer assessment allows mutual understanding through a collaborative process about the progress that pupils make, they get the opportunity to demonstrate what they are capable of doing.

2.3 Productive Pedagogies

The productive pedagogy, developed by the Queensland School Reform Longitudinal Study (QSRLS) research team (Lingard et al, 2001) which derived from authentic instruction of previous studies (Newmann & Wehlage, 1993). The Newmann research identified the concept of 'authentic pedagogy' which has been offered significant general insights into how teaching practice might be improved that to promote students learning Outcomes and boosted achievements for all students (Newmann, Marks & Gamoran, 1996) including math and science. The five standards (higher order thinking; depth of knowledge; connectedness to the world beyond the classroom; substantive conversation; and social support for student achievement) of authentic pedagogy were incorporated into the productive pedagogy framework, which consists a total of 20 items to make up four dimensions (see figure 6) which involve "heightened intellectual demand on students, connectedness to the students' lives outside the school, a supportive classroom environment and the recognition of difference" (Allan, 2003, p. 175).

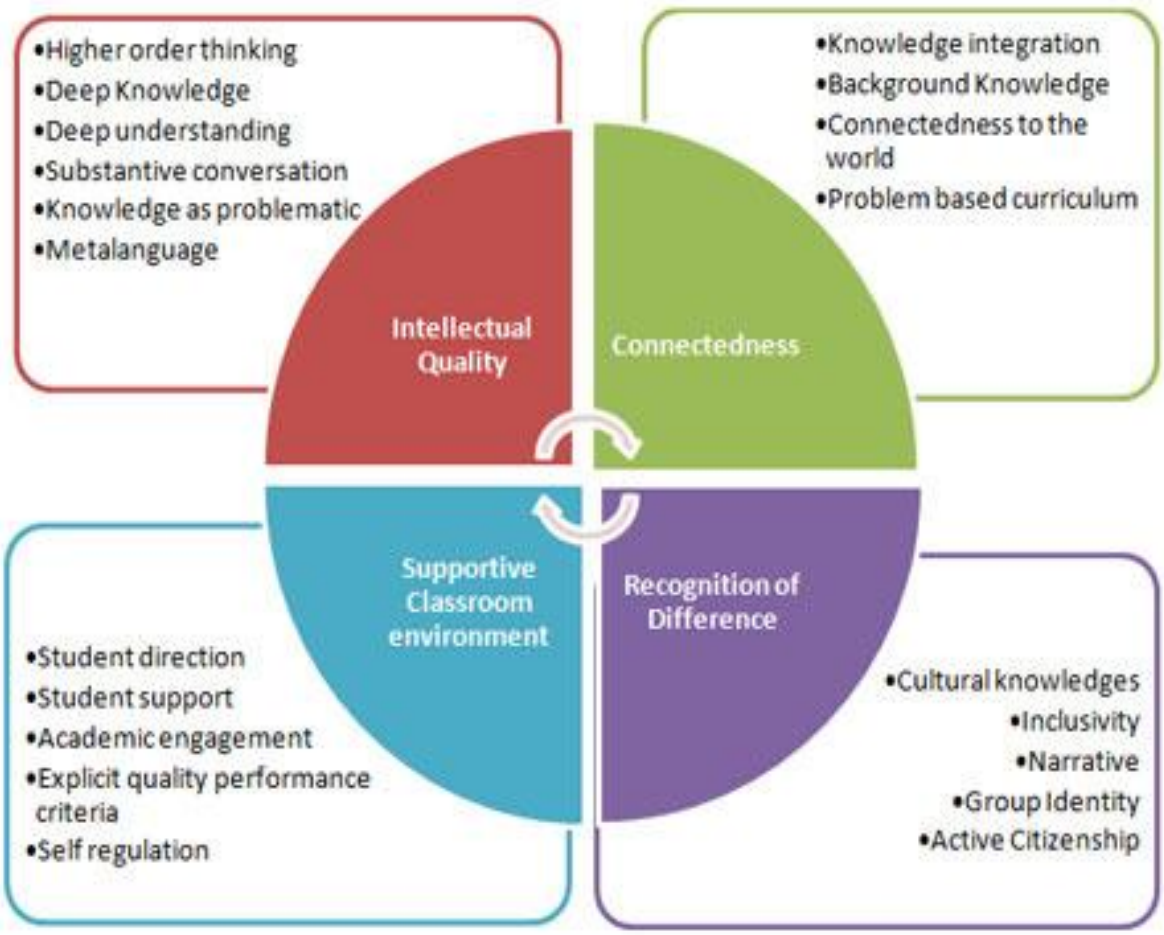

Figure 6: Productive pedagogy dimensions

The intellectual quality dimension of the Productive Pedagogy model stresses the importance of all students to perform well academically and being presented with intellectually challenging work regardless of background and perceived academic ability in teaching and learning process (Hayes et al., 2006; Newmann et al., 1996). Connectedness attempt to connect students' lives with curriculum and its contents that will provide them with more meaningful experiences to be more 'relevant'. In respect to connectedness dimension, Mills et al. (2009) stated:

> Concerns have been expressed that new forms of curricula and pedagogy that appear to focus on making classes relevant for students often reflect a dumbing down of lessons and also do not extend students' access to cultural capital by relying upon what they already know and on their own cultures (p. 72).

The supportive classroom dimension is needed to ensure that students are competent to achieve the learning objectives. Providing all students with intellectually challenging classrooms is seen

as critical for improving academic outcomes (Mills et al., 2009). Furthermore, teachers need to recognize the diversity exists among students with different cultural backgrounds and beliefs (Hayes et al., 2006) in order to achieve better outcomes. The framework is based on the premise derived from a substantial literature review which included work from:

> the sociology of education, school effectiveness and school improvement research, socio-linguistic studies of classrooms, social psychology including socio-cultural approaches, social cognition, learning communities and constructivism, along with work on Indigenous and feminist pedagogies, research on direct instruction and so on (Lingard, Mills & Hayes, 2000, p. 105).

The widely documented effective teaching and learning has close correspondence between the pedagogy associated with authentic instruction as well as thinking skills that enable teachers to effect real change in their classrooms as these approaches function as powerful pedagogical strategies (Leat & Higgins, 2002). Lingard et al. (2000) also stated that "we have developed the concept of 'productive pedagogies' as a way to reflect upon which pedagogies might make a difference for different groups of students" (p. 100). The more "comprehensive and multi-dimensional construct of 'Productive Pedagogy' provides an analytical framework for more descriptive models of teaching practice that can be developed theoretically and applied in the professional development of pre- (and in-) service teachers" (Gore et al., 2001). Studies suggested that the adoption of Productive pedagogy framework has helped to improve the teaching and learning as well as has contributed to the increase of the students' engagement in classes (e.g., Tanko & Atweh, 2012). Though Hayes et al. (2006) recommended that "at least one item from all 4 dimensions should be present to ensure that the academic and social outcomes of all students are maximized" (p. 77), but for the research limitation of my study, I have examined only two dimensions of proposed framework.

2.4 Theoretical standpoint

My position is influenced by sociocultural theory, in which, it has been explained how artifacts mediate human activity (e.g., Vygotsky, 1978). In socio-cultural theory, the curriculum materials are regarded as cultural tools, artefacts that are shaped by human actions, on both the social and individual planes (Wertsch, 1998) where context-dependent teacher curriculum interplay is grounded (Brown, 2009; Vygotsky, 1978). The teachers' guides and national core

curriculum are the artefacts that refer to the cultural tools which produced by humans. These cultural tools have influence on their capacity to mediate actions, which includes tension between the tools and the actor in a cultural context. The mediate actions gives this act meaning (Wertsch, 1998) and thus have the potential to affect human activity (Vygotsky, 1978). Here teachers as agents appropriate the tools (curriculum materials) and its mediating potential.

Teachers' instructional strategies is a process of social participation in communities of practices. Therefore, the artefact of the curriculum materials is used by the teachers in classroom practices. In line with Brown (2009), I emphasize that there is a collaborative relation between teachers and curriculum material which participate together in a collaborative way, whereby teachers are viewed as active agents for enacted curriculum materials. My analysis stretch out in an adaptive view of curriculum use, which holds the perspective that teachers actively interpret and construct curriculum in their practices (Remillard, 2005). This viewpoint raises questions about the type of guidance curriculum materials might provide regarding formative assessment and productive pedagogy. As explained earlier section (2.2.3), Remillard (2005) distinguishes four conceptions of curriculum use, such as, curriculum materials use as

(a) following or subverting the text,

(b) drawing on the text,

(c) interpretation of text and

(d) participation with the text.

I align with the fourth conception of the ways to use curriculum materials for this study, participation with the text, in which teacher-curriculum relationship is considered "as collaboration with the materials" (Remillard, 2005, p. 221). Taking this stance has several consequences for what teachers and the features of curriculum resources can bring to the collaborative relationship in classroom assessment as well as foster productive pedagogy. The socio-cultural theoretical viewpoint makes it possible to understand the act in a social practice where curriculum resources are seen as tools as participating with the text to shape human activity (Brown, 2009). In line with Brown (2009), the relationship between teacher and the use of curricular materials (in this study core curriculum and teacher guides) is seen as both complex and dynamic as it is connected to a specific socio-cultural context. The view that the features of core curriculum and the teacher guides matter as much as the teachers'

characteristics in which teachers use their resources in a participatory relationship (Pepin et al., 2013) as learning is thought to occur through interaction, negotiation, and collaboration informed by a sociocultural perspective.

In addition to that, I have positioned this study in the same vein with Black et al. (2011) explained of a formative approach to the learning triangle (see Figure 7). they have explained the triangle in developing a set of learning practices (e.g., combinations of curriculum, pedagogic, and assessment practices) based on the formative learning triangle, in which, "the results of the pedagogy will reflect back, via the assessment, to the curriculum, and, thus, the arrowheads will point both ways from pedagogy to curriculum and back via assessment" (Black et al, 2011, p. 82).

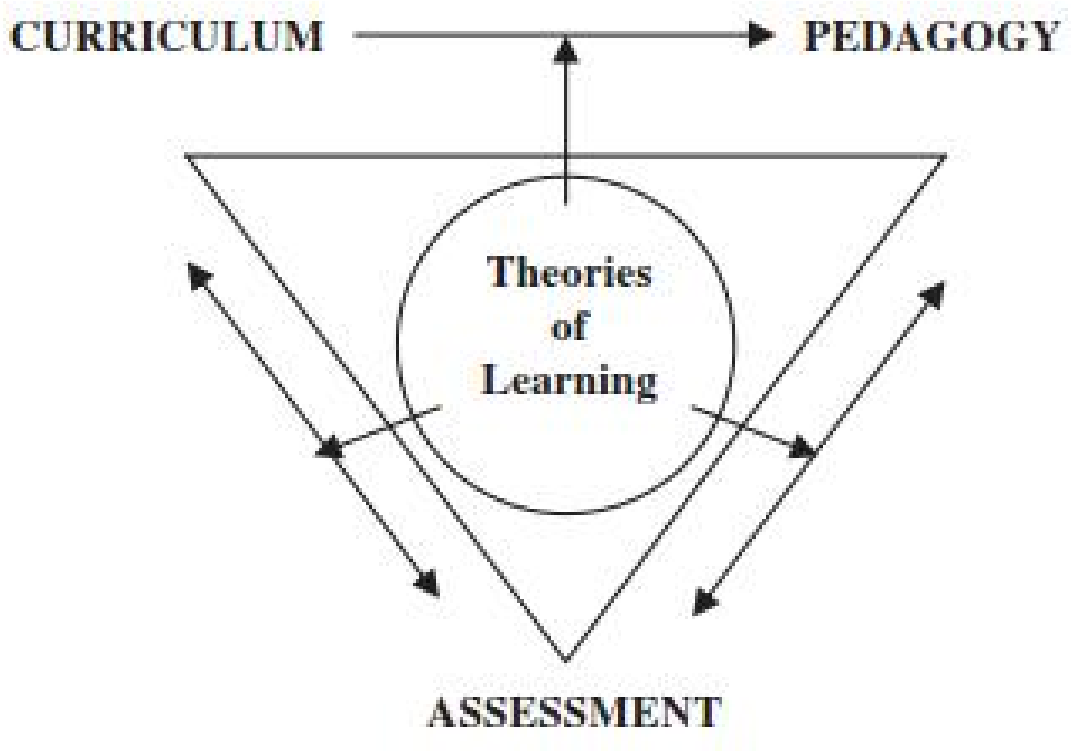

Figure 7: a formative approach to the learning triangle.

In her study, Remillard (2005) also highlights that the teacher-curriculum relationship has four components, such as: (1) the teacher, (2) the curriculum, (3) the participatory relationship between teacher and curriculum and (4) the resulting planned and enacted curriculum. In this study, I emphasized the first and the second components, the curriculum materials and teachers. In line with Brown (2009), teaching is consider as a design activity. Teachers are viewed as

active agents, in which teachers evaluate their resources and make decisions to develop and enacted curriculum.

In summary, the teacher guides and Finnish national core curriculum are considered as tools, artefacts used by teachers to mediate potential in and for teaching to support, guide and enhance instructional design as well as student learning. In this theoretical perspective, teachers and the tools (the teacher guides and national core curriculum) are active participants in planning, enacting and evaluating teacher's instructional strategies. The teacher, teachers' guides and national core curriculum are the components in the teacher-curriculum relationship. I examine those components (the Finnish national core curriculum, teacher guides in mathematics for Grades VII and teachers of grade VII-IX) through different analytical approaches (see further in methodology chapter).

3 Methodological Approaches

This chapter methodological framework gives an overview and rationale about how I made decisions during data collection period and rationales for the selection of documents, the teachers' guides and teachers. Furthermore, it provides a detailed description of the issues of quality within qualitative comparative research. Finally, I will give a brief highlight the analyses separately and connect them to the specific aims and research questions. I am interested in classroom assessment strategies in curriculum materials to teacher experiences from Finnish perspectives, a topic which still remains marginalized in educational research. I end this chapter by discussing the trustworthiness and ethical aspects applicable to the methodology.

3.1 Research strategy

The methodological framework is qualitative method as it's appropriate to get a "clear and accurate picture of the nature of each culture" (Drew, Hardman & Hosp, 2008, p.185) that makes the world visible (Denzin & Lincon, 2011). Since my further aim to identify how collaboration construct with the text and teacher practices which considered qualitative approach help to understand cultural context as well as how people make sense of their circumstances (Denzin & Lincon, 2011). Another reason to position the study within the field of qualitative research for exploring in-depth and individual information as it has own sets of philosophical assumptions and principles (Bryman, 2012; Creswell, 2008).

Qualitative researchers define a paradigm as "a basic set of beliefs that guide action" (Denzin & Lincoln, 2011, p.91) and this is the way in which researcher views the world (Denzin & Lincoln, 2008). Ontology (the nature of reality) and epistemology (Nature of knowledge) is the philosophical assumptions which shape how researcher sees the world and act in it ((Denzin & Lincoln, 2008). A sociocultural understanding of the social world is a departure point of this study based on an ontological position. In the same vein, the ontological aspects of the study reflect the nature of reality (Creswell, 2012). This implies that individuals construct the phenomena of the social world through their interactions, and there is no objective world, which can be measured (Bryman, 2012). There are multiple realities that exist about a phenomenon which experienced by people (Krauss, 2005), therefore, individuals point view can only be understood when they are directly involved in the activities. This position becomes self-evident

to look at the influence which discursively constructed individuals act in relation to curriculum materials and teachers experiences as a central part of the study.

In continuation of this ontological position, the study is interpretive on the aspect of epistemological position as the analysis on the basis of the involved actors' perception of the phenomena (Bryman, 2012). Then assumptions from epistemological and ontological point of views are decoded into distinct methodological tactics (Krauss, 2005), which assist researchers in dealing with the world under investigation. In general, qualitative research is based on natural settings under interpretive paradigm (Denzin & Lincoln, 2011). To be more specific, the study has been influenced by social constructions as a methodological approach. Ontologically, social constructions dimension dominate interpretive paradigm where the qualitative approach is embedded (Denzin & Lincoln, 2008).

To study phenomena like this one qualitative research is suited to understand the meaning, interpretations and subjective experiences of examining contemporary social processes (Creswell, 2008). Qualitative research can be described as exploring phenomena in natural settings (Denzin & Lincoln, 2011) or as choreography where "at various stage in the design process in terms of situating and recontextualizing the research project within the shared experience of the researcher and the participants in the study" (Janesick, 2000, p. 380). In addition to, qualitative inquiry stresses that people must be researched in their cultural and social framework as human activities cannot be identified separately from context (Kvale, 2007).

As curriculum materials and classroom assessment is complicated issue to identify, subjective in nature, in this regard qualitative method is emphasizes for researching this study under qualitative manner (Creswell, 2008) in order to capture the underlining social thoughts and perceptions. Therefore, it triggers the need to closely examine the study subject to in-depth, contextual nature of qualitative approach (Creswell, 2008; Robson, 2002). The study involved collecting variety of empirical materials that portray "routine and problematic moments and meanings in individuals' lives" (Denzin & Lincoln, 2008, p. 4). This would, for instance, help to understand the curriculum materials, teacher's guides and teachers' experience in order to achieve the goals of this study by drawing a wider picture of the formative assessment and productive pedagogy.

3.2 Research Design

The research design is a logical sequence for getting a study from initial research questions to its conclusions (Yin, 2009). In other words, research design enables researchers to draw a framework to collect and analyze data (Bryman, 2012). It is an important part in research process as "research design relates to the criteria that are employed when evaluating social research" (Bryman, 2012, p. 45). The selection of a particular design depends on the purpose of the study as well as the interest/ability/biases of the researchers (Patton, 2002).

To conduct this study, I chose a case study design because I wanted to understand Finnish context in depth, which encompasses with contextual condition (Yin, 2009). A case study design is to explore an issue through one or more cases within a context or setting (Creswell, 2007). Moreover case study is the appropriate research design when 'how' and 'why' questions are being asked (Yin, 2009) though the selection of a certain research approaches often not straightforward (Patton, 2002). Yin (2009) also defined twofold technical definition of case study as an all-encompassing method. First he shows the scope of a case study, "An empirical inquiry that investigate a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context not clearly evident" (Yin, 2009, p. 18). Second he gives other technical characteristics including data collection and analysis strategies regarding case study method:

> *"The inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis" (Yin, 2009, p. 18).*

Case studies can be both as a single-case or multiple-case application. In this study, I studied in curriculum materials (national core curriculum and teachers guides and teachers) to formulate a comparative case study design where 'Finland' is unit of case for being analyzed regarding curriculum materials and teachers experiences from classroom, which are independent but comparable cases. The case of this study constitutes the curriculum materials and how teachers' experiences at classroom reality to provide in depth understanding of the Finnish case (Creswell, 2007). So, the design is a single case (embedded) design in the sense that: "the objective is to capture the circumstances and conditions of an everyday or commonplace

situation" (Yin, 2009 p. 48). Under this design, documents and teachers were included as informants to provide a more holistic picture for looking at how various factors create and sustain the phenomena.

3.3 Unit of Comparison

The study is an attempt at doing comparative study as "comparative inquiry affords can prompt deeper examination of the tensions among society, development, and education" (Kubow & Fossum, 2007, p. 6). The nature of comparative study depends on the purposes for which it is undertaken. Bray et al. (2007) sketched different kind of purposes about why person(s) conduct a comparative inquiry. He points out that "academic undertake comparisons in order to improve understanding both of the forces which shape education systems and processes in different settings, and of the impact of education system and processes on social and other development" (Bray et al, 2007, p. 16). In addition to that, according to Bryman (2012) the comparative design "embodies the logic of comparison in that it implies that we can understand social phenomena better when they are compared in relation to two meaningfully contrasting cases or situations" (Bryman, 2012, p. 72).

Bray and Thomas (1995, cited in Bray et al., 2007) presented a framework for comparative study analysis (e.g., Bray et al., 2007). The framework is a cube model where seven geographic/locational levels for comparison on the front face of the cube. The second dimension contains non locational demographic groups and, aspects of education and of society is the third phase of the cube. I have placed my study in all three dimensions, which can be mapped in the corresponding cells followed by the diagram (see figure 8) where the shaded cell represents a comparative study of 'aspects of education and of society' for the Finnish perspectives.

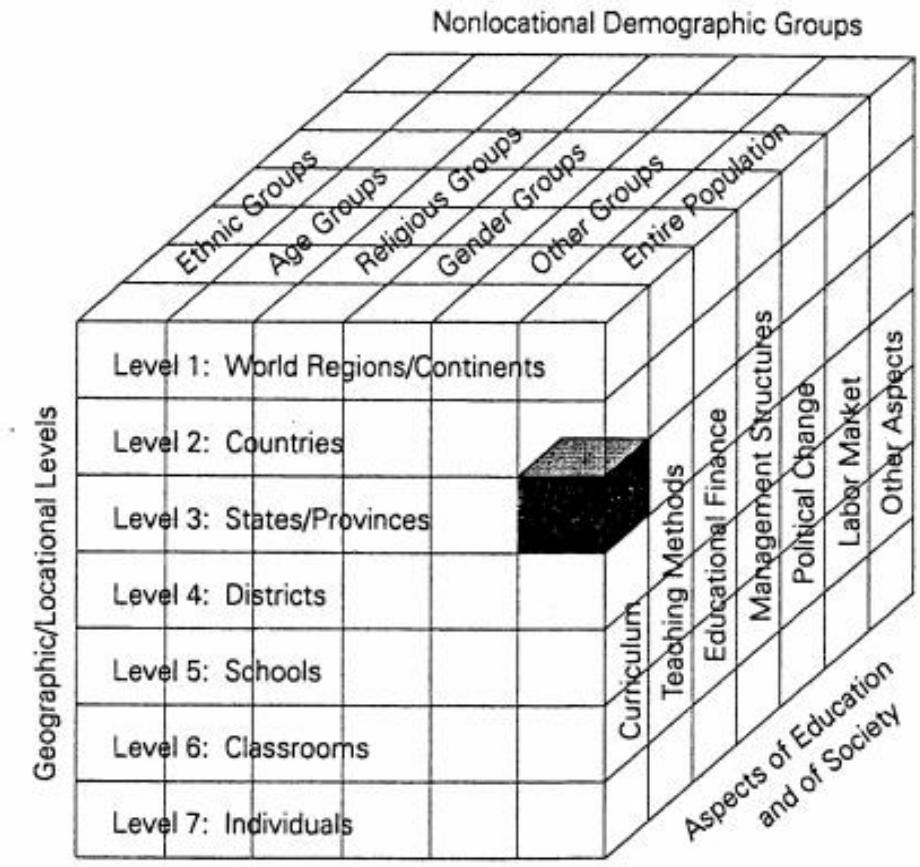

Figure 8: Bray and Thomas's (1995) Framework for Comparative Education Analyses

It is comparative in the sense that I investigated empirical data from schools' teachers, to be compared with curriculum materials in reference to their similarities and differences to arrive at explanations and understandings. The comparison that carried out throughout the study served to identify explanatory components that shape curriculum materials and teacher experiences regarding formative assessment and productive pedagogy.

3.4 Data Collection procedures

In order to answer the formulated research questions, different data collecting methods were employed due to the variety of informants as well as to get in depth understanding of the phenomena, which is subject to the research (Yin, 2009). Data were collected from a range of sources using a combination of data generating instruments such as open-ended questionnaire and document analysis. The selection of each of these techniques was concluded by the purpose of the research, and such limitations as time and cost. The questionnaire questions were adorned to get qualitative data. Research tools were developed after reviewing the prior research papers including existing studies. Moreover pilot testing of the focuses of questionnaire schedule were

conducted and modified accordingly to measure the reliability of the research tools. In the following the sample selection and sources of used to collect data are elaborated on.

3.4.1 Sample selection

Data were collected from randomly chosen one big city of Finland and analysis of national core curriculum and, two teacher guide books in mathematics teaching. First, I chose seven schools from that city. Next, in each school I concentrated on the seven to nine graders teachers who were responsible for science and mathematics teaching. Teachers were selected purposively as purposive sample relevant to seek out the answer of research questions (Bryman, 2012; Creswell, 2008). Seven teachers from seven different comprehensive schools were given their consent for the study, for the purpose of homogeneity sample (Bryman, 2012). The assumption behind this decision was to shorten my sample size as well as time bound.

The national core curriculum was collected from Finnish National Board of Education. I chose two sample teachers' guides for Grades VII which provides an opportunity to investigate teacher guides and reveal patterns associated with the curriculum materials in regards to formative assessment and productive pedagogy. There were two criteria employed of selection in teachers' guides. First, I wanted to investigate in mathematics teacher's guide for the grade VII to IX. Second one was I sought to cover those two guides which are used by most of the Finnish teachers corresponding as closely as possible to the current situation. Therefore, I have chosen two teacher guides, Pii and Laukistatalo where Laukistaatlo covers 57.5 percent of the Finnish market in 2008 (Joutsenlahti and Vainionpää, 2010). The grade seven teachers used frequently the two guides which was also another purpose of why they were chosen. Overall the sample for this study is presented in figure 9.

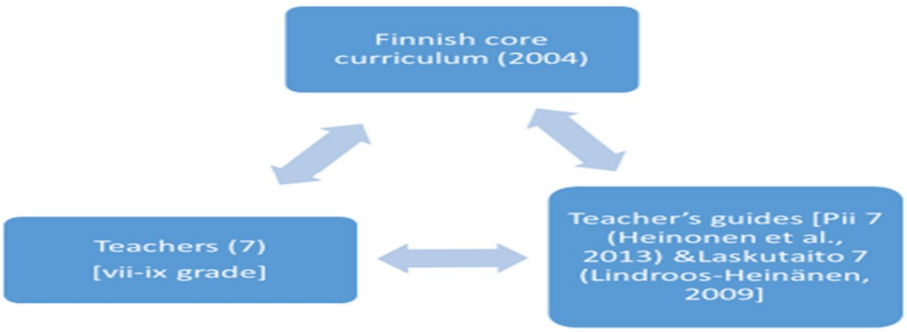

Figure 9: data sources

3.4.2 Open-ended Questionnaire

First I had collected data from teachers through open-ended questionnaire where I had provided open questions for the purpose of giving space to themselves own answer (See Appendix B). In the questionnaire, questions schedule were followed to allow the participants to create the options for responding without being forced into response possibilities as well as to supply answers in their own words (Creswell, 2008) in order to address more specific issues (Bryman, 2012). It also assists to understand peoples' point of view and to uncover the meaning of their experiences (Kvale, 2007). The questionnaire schedule comprised of questions on teachers' own understanding and experiences of formative assessment and productive pedagogy features on classroom assessment in science and mathematics teaching. The languages used were both English and Finnish. The teachers were free to write which language they felt comfortable with. The development of the questionnaire for the teachers and text analyses are all based on the research questions and the frameworks presented above.

3.4.3 Document analysis

Document analysis is a way of qualitative research in which documents are taken to deduce by the researcher to stretch voice and meaning. A document review is important because literature, reports, written policies can contribute to the scrutiny as it's "simply 'out there' waiting to be assembled and analyzed" (Bryman 2012, p. 543) and by augmenting evidence from other sources (Yin, 2009). It is advantage of using documents as a source of information in research as documents contain potentially interesting information. A document according to Scott (1990) is defined as a written text which is "an artifact which has as its central feature an inscribed text" (p. 5). Scott (1990, p. 6) also introduces four quality criteria, what followed an assessment of the documents analyzed in this thesis (see table 1) according to four criteria suggested:

Criteria	Judging points
Authenticity	Is the evidence genuine and of unquestionable origin?
Credibility	Is the evidence free from error and distortion?
Representativeness	Is the evidence typical of its kind, and, if not, is the extent of its untypically known?
Meaning	Is the evidence clear and comprehensible?

Table 1: Scott's (1990) quality criteria for assessment of the documents

One of the documents analyzed in this study is purposively sampled policy documents of national core curriculum from Ministry of Education in Finland. The reason for looking at National Core Curriculum document in this regard is that such document is a single, comprehensive, and concise policy document which contain information about policy priorities for the basic education states, thus providing a fruitful point of departure to explore who formative assessment and productive pedagogy embedded in Finnish education policy. The policies analyzed here fall into the category of "official documents derived from the state" following Bryman's (2012) classification of documents (p. 549). The documents used in this case study and chosen to be analyzed were mainly (table 1):

type of document	document name	sources
Official	Core curriculum for basic education (2004)	The Finnish National Board of Education (FNBE)
Public	Laskutaito 7.(Lindroos-Heinänen, 2009)-Mathematics teacher guide	Commercially produced for teachers
Public	Pii 7. (Heinonen, Luoma, Mannila, & Tikka, 2013)-Mathematics teacher guide	Commercially produced for teachers

Table 2: source of documents

3.5 Data analysis

Collecting data from the respondents have been analyzed using content analysis approach. Gathering data were read, analyzed and decoded repeatedly in order to interpret the expressions of the participants, which reflect the scenario and reason behind. Description and explanation of themes and concepts were presented in the narrative format. The categories derived from the theoretical background and research questions following content analytical rules (Mayring, 2000). Qualitative data were analyzed with quoted voice of the research participants, which also added the strength of data as what they experience has taken seriously for ethical consideration (Bryman, 2012).

The process of data analyzing started during the fieldwork, which is "the beginning of qualitative analysis" (Patton, 2002, p. 436). Coding is a key process in approaches to qualitative data analysis (Bryman, 2012) whereby data are broken down into component parts, which are given names and categories are generated from the participants' context bound information in the process (Bryman, 2012). Participants' own words and experience were used under this category to expose the practices (Bryman, 2012; Patton, 2002) and by drawing a wider picture of the curriculum materials and teachers practices.

I moved toward to the data coding process by applying an inductive method after completing the transcribing. Although my purpose was not to give theoretical explanation or grounded a theory, but I chose this approach, because I believed that an open category of coding could outcome new insights. First, I analyzed open-ended questionnaires. To analyze the questionnaire, I had to translate those answers. One Finnish person translated the Finnish data to English, and then cross-checked by two other university teachers who are also Finnish. The coding process consisted of itemization, conceptualization and categorization. In this study, different analytical approaches were followed (see Figure 9, below highlights the studies' aims and research questions (RQ) in relation to which analysis techniques was conducted).

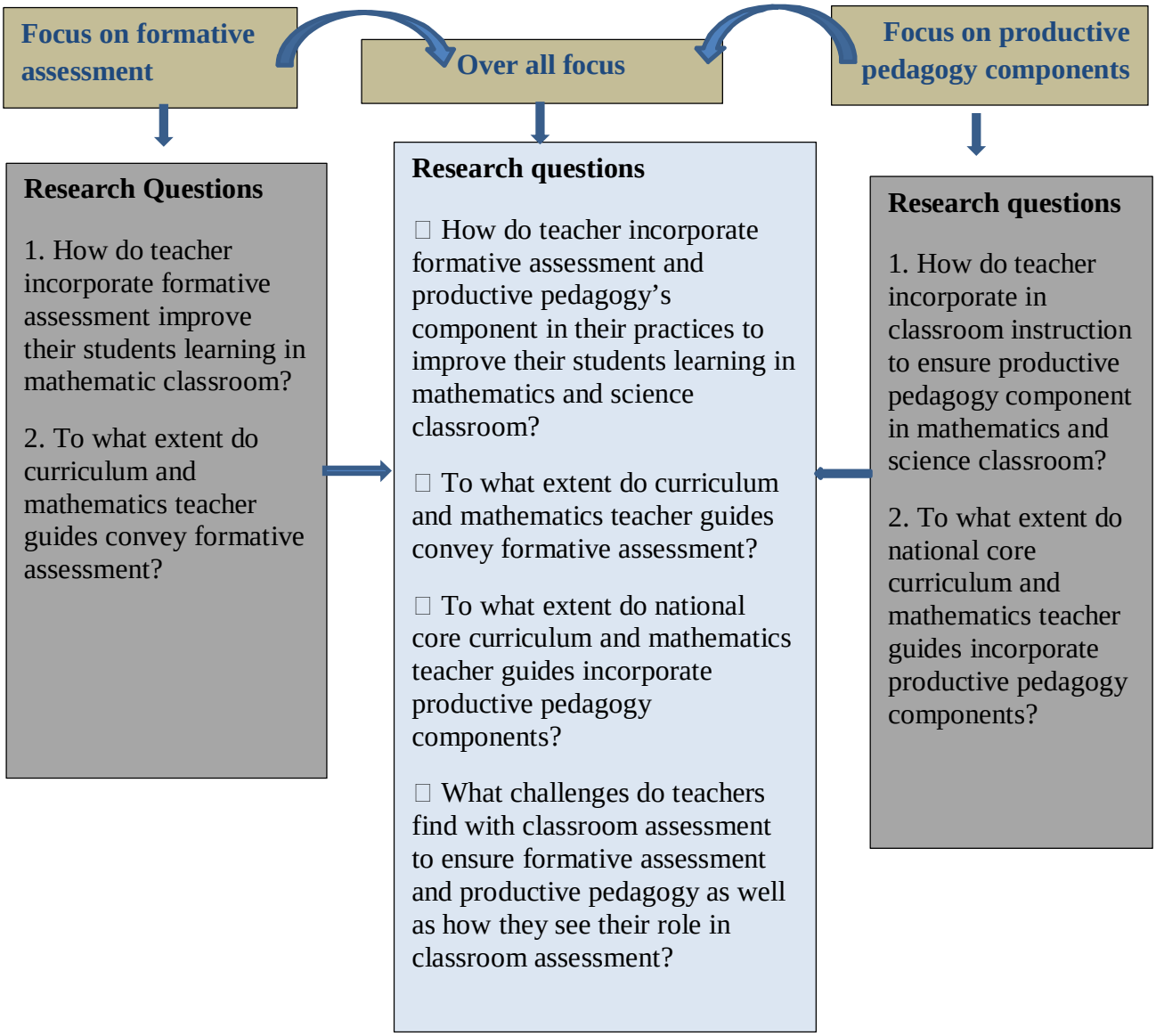

Figure 11: analysis focuses

To answer in the first focus of this study, a framework to fit was constructed based on OECD (2008) provided the key six elements of formative assessment in classroom that have emerged from the case studies and related researches. Those six predetermined categories were converted into an analytical tool (see table 3) where I separate peer and self-assessment, therefore I followed seven category though they all are interrelated.

Category
Classroom culture that encourages interaction and the use of assessment tools
Establishment of learning goals and tracking of individual student progress toward those goals
Use of varied instruction methods to meet diverse student needs
Varied approaches to assessing student understanding
Feedback on student performance
Active involvement of students in the learning process
Self and peer assessment

Table 3: category for analysis on formative assessment

In the second focus of this study, the analytical tool developed and evaluated based on productive pedagogy dimension given by the Queensland School Reform Longitudinal Study (QSRLS) research team (e.g. Lingard et al, 2001). The productive pedagogy is made up of four main dimensions, such as: (i) intellectual quality; (ii) connectedness (relevance); (iii) socially supportive classroom environment; and (iv) recognition of difference. These four dimensions are further subdivided into twenty components as discussed in earlier chapter. Among the four dimensions on two dimensions (connectedness/relevance and socially supportive classroom environment) were examined in this study which utilized by nine components out of twenty elements (see figure 13). The nine elements of productive pedagogy utilized in this study are: (1) Knowledge integration, (2) Background knowledge, (3) Connectedness to the world, (4) Problem based curriculum, (5) Student control, (6) Student support, (7) Academic engagement, (8) Explicit criteria, and (9) Self-regulation.

no	items	key questions addressed
		Relevance dimensions
1	Knowledge integration	Does the lesson range across diverse fields, disciplines and paradigms?
2	Background knowledge	Is there an attempt to connect with students' background knowledge?
3	Connectedness to the world	Do lessons and the assigned work have any resemblance or connection to real life contexts?
4	Problem based curriculum	Is there a focus on identifying and solving intellectual and/or real-world problems?
		Supportive classroom environment dimensions
5	Student control	Do students have any say in the pace, direction or outcome of the lesson?
6	Social support	Is the classroom a socially supportive, positive environment?
7	Engagement	Are students engaged and on-task?
8	Explicit criteria	Are criteria for student performance made explicit?
9	Self-regulation	Is the direction of student behavior implicit and self-regulatory or explicit?

Table 4: Productive pedagogy dimensions and key questions addressed

3.6 Validity and Reliability

In the context of doing social research, validity and reliability is the prominent criteria to evaluate the study (Bryman, 2012). There are many perspectives, which exist when it comes to assessing qualitative research strategy. Trustworthiness and authenticity are two criteria for qualifying qualitative study (Bryman, 2012). Trustworthiness is about explaining how a researcher conducts research and its legitimate (Lincoln & Guba, 1985, as cited in Creswell, 2012). Creswell (2012) goes a step further by replacing the terms trustworthiness and authenticity with using the term validation. He considers "validation" in qualitative research as "to be an attempt to assess the "accuracy" of the findings, as best described by the researcher and the participants" (Creswell, 2012, P.206).

Building trust with participant and learning the culture is one of the major issues in validation strategy (Creswell, 2008). I had capable to manage the trust that my study would not going to do harm to them, and might have some influence of being stay to the area of study to enhance the chance of trust and openness. Rather, I witnessed much praise and admiration from the teachers, for the fact that I came to understand their situation. I have to admit that, there were intimacy and good relationships with the participants as Creswell (2012) argued that "extensive time spent in the field, the detailed thick description, and the closeness of the researcher to participants in the study all add to the value or accuracy of the study" (P. 207).

Reliability on the other hand refers to the operations of the study (Yin, 2009) to minimize error and bias. I have also kept the records of all data that I had gathered for approaching the reliability of the research findings (Bryman, 2012; Yin, 2009).

3.7 Ethical Considerations

I received an introductory letter from the University of Oslo, Norway, which helps to obtain a research permit (see Appendix C). I introduced myself and informed about the purpose of the research to the administration head at the demonstration schools and also asked for cooperation. Issues concerning risk and harm, confidentiality and informed consent are important ethical issues (Bryman, 2012). In order to correct these issues, all participants were informed about the intentions of my study prior to their involvement and also ensured their rights to withdraw from participation at any time, even after the interview was finished. Furthermore, with the aim of

ensure privacy and anonymity I have been careful about not mentioning their names (Kvale & Brinkmann 2009).

All of the participants who were participating in the study did so in their free consent. I gave a short introduction about my study prior to conduct the study that the participants can understand (Kvale & Brinkmann, 2009). In addition to, I informed the teachers about the research and its aims prior to distribute questionnaire. I also emphasized the teacher's importance and independence in the study, which empowered them to open up, and sharing more. I notified for teachers that everybody's own voice is important, and that my study will help to understand and also contribute to explore teacher's experiences in classroom assessment. Ethical considerations were occupied fully and also to understand the cultural context. Qualitative analysis strategy is challenging for making sense of the massive amounts of data (Patton, 2002), which I experienced through this research project.

4 Analysis

This chapter represents and discusses the data derived from teachers and the analysis of core curriculum and two mathematics teacher guides. By comparing different data I will attempt to show similarities and differences by highlighting quotes from the teacher's experiences and curriculum materials. The presentation of the data is thematic to focus on the main research questions and focus areas. By organizing and put together thematically, to contrast and to compare, the chapter seeks to provide an understanding of Finnish basic education system in lenses of formative assessment criteria and productive pedagogy components. First I have given very little touch on core curriculum, then the organization of teachers' guide which were used, then under three broad sections I have discussed the perspective of my main research focuses. In order to maintain the anonymity of the participating teachers, comments from each teacher are labelled as Teacher 1, teacher 2 and so on.

4.1 General organization of the national core curriculum and teacher's guides

It is important to know that there are emphasized on both formative–summative assessment systems in the Finnish core curriculum for pupil assessment. The task of assessment is to guide and encourage student learning and to help pupils in for their learning during the course of studies where continuous feedback from the teacher seems very important. There are also separate sections about pupil assessment (FNBE, 2004, p. 260–265).

Two teacher's guides Laskutaito 7 (Lindroos-Heinänen, 2009) and Pii 7 (Heinonen et al., 2013) were analyzed. Both books include several topics but the larger topics have similar assessment schemes so only the chapters about whole numbers and rational numbers were analyzed. Laskutaito 7 has a separate book for tests but it only includes summative tests, so it was not used in this study. In this analysis only formative assessment are taken into consideration.

Laskutaito 7 (Lindroos-Heinänen, 2009) has a short introduction on one page about the topics of the chapters, the structure of the pupils' textbook and its own structure. On this last section there is a very short general introduction to how assessment can be done and it is very much emphasizing the forms, quizzes and exams that can be found later in the book. Next chapter is the main chapter of the book. For every lesson it introduces in two pages the pupils' textbook

sets goals for the lesson and tells if there are some additional handouts and gives hints to some additional exercises. Each lesson two-pages also includes mental arithmetic exercises and gives the correct answers to the exercises. There are very little hints or advices for the teachers and the main thing on the pages is the picture of the pupils' textbook and the correct answers. After this main chapter there are guides to some games then handouts for copying. They include the preliminary tests, extra exercises, different cutouts (number cards, etc.) and the self-assessment forms. The book ends with the correct answers to the handout exercises.

Pii 7 (Heinonen et al., 2013) on the other hand is formed in different way. It starts with an introduction but it is not about organization of the guide but "Additional information and hints for the lessons". The chapter includes something about the assessment too but there is a separate chapter for assessment later in the guide. Next chapter goes through every chapter in the pupils' text book. This differs from the Laskutaito book so that the pupils' textbook picture is not copied. There is always at least one page long chapter with including the goals and then a section about teaching it and hints for the teaching. After that there are the answers to the pupils' textbook problems and some mental calculation exercises. Compared to Laskutaito book Pii has much more ideas for the teacher for actual teaching. This chapter does not, however, talk about assessment.

After the pupils' textbook chapters have all been handled. Compared to the Laskutaito book Pii does not have any handouts or extra exercises to copy. It has the summative exams and answers to them. After that there is a chapter about mathematics in the national core curriculum (which is an exact copy of the text from the core curriculum), the criteria for final evaluation (which again is a copy from the Core Curriculum). After those there is a one and a third page chapter about assessment in mathematics. This chapter is analyzed in this work and forms for self-assessment and teacher assessment. The book ends with a table of suggested grade for summative exams compared to different maximum points.

The teacher's guides are very different. Where Laskutaito concentrates on answers to the exercises and additional handouts Pii gives teacher more actual teaching hints and background information. Also assessment is much more discussed in the Pii book.

4.2 Formative assessment perspectives

4.2.1 Classroom culture that encourages interaction and the use of assessment tools

This part is how the classroom culture is established to encourage interaction in the classroom and, as a bigger whole, the school environment. The National Core Curriculum talks about possibilities for individual work and interaction between the pupils and the pupils and the teachers to support as well as guide the learning. The curriculum indicates to create situation for interactive learning and working together and individually as well as teacher working approaches must support the classroom environment. As there state:

> *The objective is an open, encouraging, unhurried, positive atmosphere, for whose maintenance the teacher and the pupils share responsibility (Core Curriculum, p. 17)*
>
> *Methods and working approaches should be chosen so as to create situation for interactive learning and working together and individually (Core Curriculum, p. 5 in amendments).*

The teachers' guides do have some hints for the teacher on what comes to the interaction. This comes in a form of encouraging the teachers to use games and plays as social ways to learn but usually the books seem to think that these are for special occasions only, the normal lesson being very traditional: teacher teaching, pupils doing exercises. As there state:

> *Games and plays are good for active mathematics studying for example for a games lesson. (Laskutaito, p. 5)*

The other teachers' guide book "Pii" also mentions assessment's social aspect. As there state:

> *Assessment is social interaction* (Pii, p. 200)

The teachers think that the class is socially encouraging and positive environment for assessment. Interaction is also seen as learning from the peers in one teacher's answer. Teachers pointed out how they have put emphasize on supporting students for creation of the positive and encouraging classroom atmosphere. In other words, established the culture of their classroom where students feel safe to take risks and make mistakes. This is where the collective

effort played a crucial role in creating and enabling the learning environment that both students and teachers would get benefit as the classroom environment depends on also the group and single students. Here is one teacher statement how he is helping students to feel safe to take risks and make mistakes in classroom:

> *I do not tolerate laughing at other people's answers. One should give only positive feedback or ideas on how you'd have done the assignment yourself. This is how you learn from others. (Teacher 6)*

4.2.2 Establishment of learning goals and tracking of individual student progress toward those goals

In core curriculum to track individual pupil's progress towards learning goal has emphasized on learning plan what must have to have for every pupils and in which the study plan of implementation would be mentioned. It is the learning plan which describes how the curriculum's objectives are to be achieved and can also be used as a basis for assessing pupil's progress (Core Curriculum, p. 21). The main purpose of the learning plan is to learn to take more responsibility for pupil's own studies as well as to be committed with more purpose for learning (Core Curriculum, p. 20).

Though in this two teachers' guides, there are not mentioned learning plan, but teacher used them in their practice in general for student progress and to meet their learning objectives. This can also be seen from one teacher's answer. Teachers also agree with the class about the assessment criteria and this is a social aspect as well. As teacher mentioned:

> *At the beginning of a course I ask the pupils about their aims and preferred ways of studying and showing their skills. After written exams (there are 2) I ask how the pupil has been working, and how s/he is going to improve, and what wishes does s/he have for the teacher. (Teacher 7)*

> *Assessment criteria are agreed on together at the start of a course. (Teacher 1)*

The chapter about "pupil assessment during the course of studies" in core national curriculum clearly has mentioned about the task of assessment during the course of studies, which are to illustrate how well the pupil has met the objectives established for growth and learning as well as to guide and encourage studying (p. 260). Through ongoing classroom assessment teacher

get to know how the student progress in their learning objectives and also the teacher guides the pupils. As stated in core curriculum:

> *In becoming aware of their thinking and action and helps them understand what they are learning (Core Curriculum, p. 260)*

The task of assessment during the studies is mentioned in the core curriculum as guiding and encouraging study, then to depict how well the pupil has met the objectives established for growth and learning (p. 260). Both teacher guides also has indicated that assessment during the studies is targeted towards the learning and improvement in the different areas of learning. Assessment is connected to the description of good performance, which is totally linked from the core Curriculum (Pii, p. 200). In the same vein, teacher also does the same practice in their everyday teaching. Teachers think that they assess the student's progress and ability level which could help them to assess their students without an exam. Like one teacher wrote:

> *In classroom assessment I see the pupil's development and skill level well (I could, in principle, assess my pupils without an exam as well) (Teacher 5)*

Assessment criteria are agreed on both teacher and student together at the start of a course. Learning objectives also reflects on pupils work as how the pupil wants to get their outcomes. As another teacher mentioned:

> *Most have aims for each course when they attend the first time. Some only want to pass, others want an A. This is reflected in their work. (Teacher 1)*

The core curriculum lay attention to that learning environment which must guide pupils in setting their own objectives and evaluating their own actions (p. 16, chap learning environment). The teacher guide Pii also copies the Criteria for Good learning from the National Core curriculum in its entirety (Pii, p. 198–199). From the teacher opinion it's also came out that they takes into account their pupils' wishes about learning outcomes as well as learning objectives. From their answer, it is quite clear that they tell the students which things will be assessing as well as the requirement to get a specific grade, and they guide the pupils during the learning process to organize their learning. For example one teacher statement is given here:

> *I take into account my pupils' wishes on ways of working beforehand. At the beginning of class I rarely change my plan. I tell the students which things I'll*

*be assessing, for example in longer projects what's required for a specific grade, and guide the pupils during the process to do it as well as they can. (*Teacher *5)*

4.2.3 Use of varied instruction methods to meet diverse student needs

The instruction methods are discussed somewhat in the National Core Curriculum. It says that diverse methods must be used for instruction to help the pupils' learning process. It is also mentioned that the teacher selects the teaching methods (p.17). The pupil's different needs must be taken into consideration when selecting the methods. The curriculum emphasized that the learning tools and facilities must be designed and organized in a way that it allows the service of diverse study methods and working tactics (p. 16). This actually also suggests very strongly that the pupils' background knowledge should be tested or otherwise known. As stated there:

> *instruction is to be provided making use of diverse working approaches and teaching methods sensitive to pupils' abilities and suitable for different ages and various learning assignments and situation ----------Differentiation of instruction makes it possible to provide pupils with suitable challenges and experiences of success and offer them opportunities to develop and learn according to their own strengths (Core Curriculum, p. 5 of Addentum)*

The Pii teacher's guide mentions legislation (not specific part), this reference actually seems to point out to the National Core Curriculum.

> *The legislation states that the learning situations and exams must be organized taking into consideration the individual needs (Pii, p. 7)*

The teachers too tell that they use various methods of instruction but they also say they do have a usual way of teaching. The following statements are also showing that the teachers do choose their own working methods:

> *In class I use varying amounts of different ways of working (theory, experimental work, independent assignments) and different teaching methods (conversation, teaching theory or checking homework in a teacher-led way, outlining an experimental work by drawing a "comic" on the board, asking questions from students, problem-solving, group work, information retrieval and independent*

work). I choose the ways my pupils will be working based on the topic, time available and the pupils. (Teacher 5)

My basic routine is: checking assignments, going through a new topic, demonstrations/student works/measurements, and exercises. (Teacher 1)

The teachers are expected to fit their lessons into diverse students need and to follow them according to the curriculum expectations. There found somewhat different answers when question about how often do they adjust instruction whenever notice that students do not understand a topic. Quite often, teachers explain new things in different ways to make sure everyone understand as teacher ask students to seek help from their working group, or check the instructions from the blackboard. Here is some answer from teachers:

As soon as I notice the subject has not been understood. (Teacher 1)

……..but sometimes it's OK if everything doesn't go the way you'd expect. (Teacher 3)

Usually once, and this doesn't happen very often. (Teacher 4)

Enough times I hope. Or I ask them to seek help from their working group, or check the instructions from the blackboard. (Teacher 6)

In the same way, teachers also explained that they organize their lectures in the best possible way so that the students could benefit from them to understand the thing for themselves and progress in their work. Teacher also try to change both the way of teaching and the way the pupils work so that pupils have a chance to find the best ways to work and a chance to learn to work in different ways both alone and in a group. The teacher also make clear how the diverse students also have an important role if it's necessary take into account learning difficulties to the best of teacher's ability in this process. Teachers generally guide the pupils forward with questions, so that they'd understand the thing for themselves and progress in their work. The following statements make it clear:

I try to explain the subject in many different ways, so that as many as possible would understand what we're talking about. During experiments I guide the pupils forward with questions, so that they'd understand the thing for themselves and progress in their work. (Teacher 1)

With pupils with special needs I can give more weight on some parts of class work, so that all pupils get an assessment that's as good and fair as possible. (Teacher 2)

I change both the way I teach and the way the pupils work so that they have a chance to find the best ways for them to work and a chance to learn to work in different ways both alone and in a group. I take into account learning difficulties to the best of my ability. (Teacher 7)

4.2.4 Varied approaches to assessing student understanding

The section of "pupil assessment during the course of studies" in core national curriculum suggested using methods that enable to demonstrate individual pupil's knowledge and skills as well as possible. There also mentioned that assessment during the course of studies must be truthful and based on a diversity of evidence (p. 260). But in core curriculum has not indicated visibly about what would be the varied approaches to assess student understanding, there has only mentioned to assess pupil progress, work skills, and behavior in relation to the curriculum's objectives and description of good performances. As mentioned:

.....to be guided and encouraged in assessing their learning and performances in a diverse manner (Core Curriculum, p. 262)

Similarly, there are no clear indication of how could be assessed the students in varied approaches in those two teacher guides. The Pii guide book emphasize that assessment supports the individual learning process, strengthening the self-esteem and recognizing individual abilities and skills as well as recommended that different kinds of assessment methods are needed as is producing diverse assessment information (Pii, p. 200). And the other guide book only indicated that the mental calculations [in every chapter] can be used as an exercise for the formative assessment (Laskutaito, p. 5).

On the contrary, from the teachers data it is found that in their everyday teaching they used more or less diverse assessment approaches like group work, exercise, asking question, demonstration, conversation, problem solving, drawing pictures etc. Teachers also pointed out to assess pupils in every class where they take into account their classroom work, for example participating in conversations, following conversations, doing independent exercises

(homework, class assignments), participating in experimental work (following instructions, doing the assignment, working in a group, making conclusions), writing a report and try to assess pupils in as many ways as possible, so that everybody has a chance to show their skills.

Teachers also mentioned that assessing approaches depend on subject. Assignment, homework, exercise are very common assessing approaches. Exams measure what students have actually learned. Homework assignments are a part of the evaluation. Teachers also revealed that classroom activities of students make extra proof for teacher to assess students understanding. As they mentioned:

> *I'll observe how actively they ask questions and how actively they participate to different tasks (*Teacher *2)*

> *I assess activity and try to find things that strengthen them and find out why they do things the way they do (*Teacher 3*)*

Teachers also exposed that classroom activities of students make extra proof for teacher to assess students understanding. As they mentioned that they try to observe how actively students ask questions and how actively participate to different tasks to find out why pupils do things the way they do. It is also revealed from the teachers' writings that their ground rule is to vary between different strategies during each session to keep the students' motivation and concentration. Teacher also use reflective conversations in the whole class or in groups, regular written tasks, group work with both oral and written tasks and also practical tasks both in groups and individually. Teachers pay extra attention to work in group where the students are encouraged to learn from each other's strengths and weaknesses.

Not only that, teachers sees the benefit of diverse assessment methods to assess students understanding and guide them accordingly. Teachers make it clear that this is the process to help them get some kind of picture of different students' skills and performance. Here is one teacher stated like:

> *Otherwise I wouldn't have actual information about the pupils……..have to know their ways of working to be able to guide them (Teacher 3)*

But at a same time, sometimes teachers found it difficult task to imply varied assessment method on some students that don't ask questions or answer to questions stated by a teacher.

Furthermore, teacher found diversify assessment as work load for them along with benefits. As teachers stated:

> *It's difficult to think of a best way to assess, that would give the intended result. It would diversify assessment, but would be too much work for overworked teachers (Teacher 1)*

> *Benefit is that you'll get some kind of picture of different students' skills and performance. But it's difficult to assess students that don't ask questions or answer to questions stated by a teacher (Teacher 2)*

Encouraging the use of assessment tools can also be seen from the Core Curriculum. In the texts many different kinds of assessment tools are mentioned but more in a way of suggestions although strict orders are also given. For instance:

> *The task of assessment during the course of studies are to guide and encourage studying and to depict how well the pupil has met the objectives established for growth and learning (Core Curriculum, p. 260)*

In addition to that, verbal assessment is emphasized in core curriculum during classroom assessment as assessment tools. There also highlights that when using verbal assessment, the school year report is to state whether the pupil has met the objectives for the school year acceptably. The core curriculum seen verbal assessment to help teachers to assess student progress. As mentioned:

> *In verbal assessment, the description helps the teacher assess the pupil progress and the forms the basis of assessment when describing how the pupil has met the objectives (Core Curriculum, p. 260)*

Pii guide mentions using continuous self-assessment which can be seen as a classroom culture to encourage the assessment tools. As there point out:

> *In establishing the teaching it is important that the pupil is guided towards continuous self-assessment. (Pii, p. 200)*

4.2.5 Feedback on student performance

The National Core Curriculum indicates quite a lot of the importance of feedback and particularly the importance of how the pupils reflect on the feedback. The core curriculum emphasis on giving assessment feedback adequately and in a diverse manner to the pupils (p. 261). Continuous feedback is seen as a key element in teaching and learning and in teacher–student relationship for purposes of reflecting on one's own actions (p. 17).

> *Ongoing feedback from the teacher plays an important part (Core Curriculum, p. 260)*

As the feedback is seemed very important in the National Core Curriculum it is very surprising how little it is mentioned in the teachers' guides. Only one mention was found in the Pii book. It might be that the authors of the books see feedback something so everyday practice that it does not deserve more mentioning.

> *Assessment is social interaction in which the pupil both produces and uses multifaceted feedback information. (Pii, p. 200)*

The teachers, on the one hand, see feedback as an important part of the work. Since the curriculum has that well planned and written it is possible to see the reflection on curriculum in teachers' daily activity on the basis of giving feedback. In that way, the teachers have good preference to endow the students learning outcomes and to demonstrate so that the student could be educated in accordance with the approved curriculum. Here is explanations from teachers:

> *Generally I try to guide pupils to do their best by giving positive feedback for jobs well done (Teacher 5)*

> *Pupils remember the situation better, when feedback comes immediately and they can change their behavior right away (Teacher 6)*

> *I always give, when possible, oral feedback immediately or after class, or written feedback through the Wilma system [A web based system for passing messages between the teachers, pupils and homes] (Teacher6)*

On the other hand, the cooperation among the students and the teachers serves as an enabler to possible learning from others as well as incorporation in positive, encouraging feedback. In that

way the lack of cooperation among the group and students create the obstacle for the students to concentrate on receiving feedback. This is how one teacher described how it is important to get the whole cooperation the making of a positive classroom atmosphere for giving and receiving feedback as there are risks about giving negative feedback that the relationship between teacher and pupil starts going to a negative direction:

> *With teenagers there's always a risk that the teacher-pupil -relationship starts going to a negative direction because of, for example, giving negative feedback or correcting bad behavior. (Teacher 6)*

> *Sometimes the presence of others can make it harder to concentrate on receiving feedback. (Teacher 7)*

4.2.6 Active involvement of students in the learning process

In the National Core Curriculum pupils are seen as active learners (p. 16). In that way active participation into the learning process is already in the very foundations of the Finnish Curriculum to reinforce the pupil's self-esteem, favorable self-image as a learner, and sense of involvement (p. 260). There stated:

> *It must promote dialogue and guide the pupils in working as members of a group (p.17)*

Active involvement can be seen in the Pii teacher's guide connected to the assessment. As the guide book provide some indication on the self-assessment that also highlighted in the assessment. It is also pointed in that book as:

> *More than before the continuous assessment and self-assessment are highlighted in the assessment also via them the whole learning process is emphasized (Pii, p. 200)*

> *If the pupil's goal is to have a certain grade it is good to tell in advance what the pupil needs to do to achieve it (Pii, p. 200)*

Also teachers offered similar response to emphasize the pupils' role as active participants in their answers. Teachers consider students' participation in conversations, following conversations, doing independent exercises etc. to develop strong strategies for their own

learning. In addition, another teacher underlined actively asks questions from students and appreciation inside the collective participation in different task. As she explained:

> *After that I ask students to do exercises or a group work. I'll observe how actively they ask questions and how actively they participate to different tasks (*Teacher *2)*

4.2.7 Self and peer assessment

Self and peer assessment is something which is one of the most important parts of formative assessment. There are some differences in the two analyzed teachers' guides. The National Core Curriculum lists Self-assessment as part of the pupil assessment process. It says that actually "one task of basic education is to develop the pupil's capability for self-assessment" (p. 262). The purpose for self-assessment is seen as to develop self-esteem and favorable self-image (p. 262). The Core Curriculum states that the self-assessment skills have to be developed and it states that the pupils "are to be guided in examining their learning processes and assessing their skills in learning and working" (p. 262). In addition to that, core curriculum emphasized that "with the development of self-assessment skills the pupils learn to regulate their learning processes." (p. 262). So there is a heavy emphasis on learning the metacognitive skills.

In the teachers' guides, there are some forms for self-assessment. The self-assessment forms are a somewhat different (see appendices D & E). Both books have forms for them but where the Laskutaito book asks about pupil's knowledge in specific topics (Laskutaito, p. 125, task 1.). The Pii asks only about the easiest and hardest topic of the part in question. Laskutaito book has, as said, questions about the specific topics, questions about how many exercises the pupil has done (separated by exercise type) and how hard the exercises were. It also has questions about the pupil's achievement of his or her own goals and short reflection on that. The last thing asked is what grade the pupil is trying to get (Laskutaito, p. 125).

In the Pii book emphasizes to the pupil is made to reflect on his or her own working. In the questions the pupil is asked about the feeling about studying, activity, diligence, classroom atmosphere as well as the how interesting the topics were, how hard they were, how was the progression speed, how much help did he or she get and if there was enough solitary work. Also Pii book asks about the grade but differently to the Laskutaito book, they ask the pupil to give him or herself a grade and explain it (Pii, p. 202).

Pii has also a feedback form, which is meant to be filled by the teacher and used in the feedback discussion or just given to the pupil. It has questions about the how the pupil has studied and also about the social skills (cooperative working, willingness to work in groups) (Pii, p. 203). Only thing about this is from the book Pii, which has in its self-assessment form questions which can be seen as self-regulatory ("I got help when I needed it from the teacher or peers.", "I needed individual work.") (Pii, p. 202). Pii guide mentions using continuous self-assessment which can be seen as a classroom culture to encourage the assessment tools. As there point out:

> *In establishing the teaching it is important that the pupil is guided towards continuous self-assessment. (Pii, p. 200)*

4.3 Productive pedagogy dimensions

The another purpose of the study was to make judgments about the quality of teaching and learning that had taken place in classroom, from teachers experiences to curriculum materials according to the strategy for productive pedagogy components. The analysis is given here coding of comments, how teacher guides and core curriculum indicates those components as per the two dimensions' elements of productive pedagogy according to my analytical tool.

4.3.1 Knowledge integration

The knowledge integration is one component of relevance dimension which concerned with conceptual and other links that the learner could build with development. In the national core curriculum, it is also refer to that pupils assessment during the study course would be to address the pupil's learning and progress in the different areas of learning (p. 260) where the lesson range across diverse fields, disciplines and paradigm. On the other hand, in teacher guide it's not specifically but this can be seen in the exercises in Laskutaito (Laskutaito, p. 62) and in the introductory chapter in Pii where the connections are made to the history (Pii, p. 6). Also in Pii there are some connections to physics (Pii, p. 59).

All teachers see the knowledge integration is occurring as the different subjects merge in all their teaching. The teachers exemplify the importance of connecting concrete and abstract understandings of children in different subjects. This pattern of thinking also emerged as from the example given by teachers. Teachers mentioned that Mathematics and reading are important parts of science (and in other subjects), and reading is important in any subject. Again they add

that general education on citizenship (also IT-skills and language-awareness), contents of the subject and ways of work, and building a world view for students. When asking about does the lesson range cover across diverse field and pattern, all teachers gave positive opinion about this issue. Here is a response from one teachers about how the lesson could support deep learning through other subjects' integration to one subject:

> *A physics class is not only about physics, there's languages, civics, biology, life, interaction. Of course also motivation, the way things are presented etc. (Teacher 2)*

From the above statements of the teachers, it can be deduced that in mathematics and sciences 'Knowledge integration' occurs across subject areas. Teachers touched the topic of connect aspects of with classroom activities impacted on student learning. Teacher again pointed out that it's hard to come up with practical examples, especially because textbooks don't include too many as well as the teacher guides. But they try to variate different ideas during the lessons.

4.3.2 Background knowledge

The component 'background knowledge' is concerned with learners developing a substantive understanding of new knowledge based on prior knowledge. When it comes about student background knowledge, it is tested in both teacher guide books by preliminary tests (Laskutaito, p. 76; Pii, p. 65).

Similarly, teacher also think that their attitude towards science/mathematics assessment is an attempt to connect with students' background knowledge to get information about the students' actual knowledge. The knowledge, not just what they've learned by heart as well as without necessarily understanding the subject at all. Furthermore they think they need to know background information to aid students, for example if students have dyslexia or other disorders. Otherwise they try to move on the most direct possible route. Teachers mentioned that it is essential to help students make connections between their own knowledge and the messages being conveyed. They also stated that in science and mathematics, this can be done using homework and things we did during the previous lesson to help students make personal connections with a place or an issue, as well as group discussion designed to draw out personal involvements. Though some of them have bit different opinion as they mentioned:

> *Probably not. Deficiencies in former education are often tried to be complemented, if possible. Deficiencies can of course affect adopting new information, and can in that way affect assessment (Teacher 1)*

> *Usually we talk about homework and things we did during the previous lesson. Then we have a session to learn new things. I might carry out a science demonstration (Teacher 2)*

From these statements it is clear that the 'Background knowledge' may embrace links not only with pupils' prior knowledge, but also their past experiences, and their connection with their skills and learning. This is what one teacher said about their attitude towards students' background knowledge:

> *Background in itself doesn't matter, but you have to find the pupil's mental structure, and to which experience the pupil associates his knowledge & skills and possibly describe to the pupil some conflicts that inference can cause, to make the pupil think for himself (Teacher 3)*

4.3.3 Connectedness to the world

The items 'Connectedness to the world' as the issues are related to real world problems, and in science and mathematics explicitly aim to help students 'connect' with these problems as well as explore possible solutions, which is found in line with core curriculum (p. 260). Teacher also think lessons and the assigned work have resemblance and connected to real life contexts in most cases making a connection to the wider social context within which students live. In mathematics, there are plenty of examples from real life all the time as teacher mentioned. They also indicated that in every physics class meant to think of an observation from students own life when teachers describe phenomena. Assignments are always connected to reality most of the cases. In the same way, the core curriculum has support pupils personal growths and development through solving realistic things.

> *.....form a realistic image of his or her learning and development, and thus to support the pupil's personal growth, too (Core Curriculum, p. 260)*

Here is some examples how teachers thought about their lessons and the assigned works have resemblance or connection to real life contexts:

Yes, sometimes. I think students have used a lot of different skills that they learned in the school during their life time. For example, How to work in a group? How to handle stress when studying something new? (Teacher2)

I try to find a connection to real life in class, sometimes it's difficult. For example, when we discuss phase transitions of matter we talk about sauna (how phase transitions and going to the sauna are related). In chemistry when learning about water, we do experiments that everyone could do in their own home (surface tension, solubility etc.) or talk about water purification or water footprints etc. (Teacher 5)

Making hypothesizes and testing them out is something we do all the time in an extended way. Poking at our curiosity for new and unknown aspects of nature and the world around us can be applied to most of our everyday life, as can the basic understanding of numbers in mathematics (Teacher 7)

Yes. For example, what are the costs for an employer to hire someone? What fees is one obligated to pay by law? Or How much YLE-tax (Finnish broadcasting company) must a firm pay when their turnover is x etc. or Value-added tax calculations from the perspective of individual people and companies or How much load can a car's suspension take or index calculations (Teacher 4)

At a same time, they also indicated that as the students have different backgrounds, therefore solving real-world problems takes more time. Moreover, the examples from textbooks aren't often of use to many cases. For example, geometry problems are often only about basic geometry, and don't include specific problems much. But teachers guide do have some indication in this regards and done also via the exercises. Here is one teacher statement regarding this issue:

There are a lot of people from different abilities in math classes, and so it's hard to come up with practical examples, especially because textbooks don't include too many (Teacher 4)

4.3.4 Problem based curriculum

The core national curriculum has stated about the function of the working approaches for developing social, learning, thinking, working, and problem solving skills.

> *The task of instruction in mathematics is.....the most widely used problem solving method (Core Curriculum, p.158)*

In teachers' guides, many of the chapters are definition based which means that they start with the mathematical definition or fact which is then applied but there are some problem based chapters too (for example Laskutaito, p. 40 or Pii, p. 59).

The teachers think as curriculum's requirements support activity-based learning/teaching, and so it is possible. The curriculum has requirements for working skills also. It can feel harder for them to cut back on knowledge requirements than working skill requirements, so they think that they go through knowledge at the expense of working skills. The following comments from teachers indicates the relationship between curriculum and classroom lesson ranges:

> *The curriculum must be kept in mind on every course. Activities (measuring etc.) is in place, if it supports learning according to the curriculum's requirements. (Teacher1)*

> *Maybe a little bit more. Because the final exams are designed so that students are tested about knowledge of the topics mentioned in the syllabus. (Teacher2)*

> *That's a pretty provocative way to put it. The curriculum is a guide, whose checklist we try to go through. Sometimes it's not that easy. (Teacher3)*

> *Yes. In my opinion the curriculum for physics & chemistry should be thought through carefully (the upcoming new curriculum is a little better than the old one), so that teaching could be moved to a more activity-based direction. I think it'd be in place to think about the meaningfulness of eg. Physics calculations for 8th graders, most of whom don't yet have a strong enough basis in mathematics to really understand things. This problem could also be solved by switching the order of mathematics and/or physics courses (Teacher5)*

Teachers usually start with everyday phenomena and continue on via simplifications towards the more general and everyday applications. To imply of problem-based curriculum students are expected to present with specific practical, real or hypothetical problems to solve and in this regard, there found some contradiction in teachers' views when asking about what challenges they find with identifying and solving intellectual and/or real-world problems in classroom. They also think sometimes real-world problems can be too complicated to solve as the natural phenomenon is too complex to be fitted into a simple formula. It's often quite abstract because many students have no experience with the things they teach them, that is a challenge. But, teacher said they try to close that gap, though they face challenges including ethical issues, both teachers and pupils' motivation as well as enough time to solve the problem. Here are some teachers' answers which indicates the challenges for enacting problem based curriculum in classroom:

> *There are lots of challenges in those problems. You always should think about the ethical issues when solving these problems (Teacher2)*

> *Does the pupil want to take up the challenge, am I in the mood to think about this thing here and now (Teacher3)*

> *Sometimes real-world problems are complicated, and can't be simplified enough so that they'd be easy to work through with 7-9th graders (Teacher5)*

> *To find some enough problems to which you can find solution in one hour lesson. Or to find enough time to solve these problems (Teacher6)*

4.3.5 Supportive classroom environment

In earlier section it has been discussed about supportive classroom environment as a formative assessment criteria. Again here it will be analysed little bit more with other issues which foster productive pedagogy. It can be seen in the National Core curriculum. Especially Engagement, Explicit Criteria and Self-regulation can be seen.

> *The instruction is to develop the pupil's creative and precise thinking, and guide the pupil in finding and formulating problems, and in seeking solutions to them (Core Curriculum, p. 158)*

The books do not make the student performance criteria explicit. They give more suggestions for assessment. Pii says that if the pupil's goal is to have a certain grade it is good to tell in advance what the pupil needs to do to achieve it. (Pii, p. 200). This is a bit strange since by the national core curriculum states quite clearly:

> *The pupil and his or her parent or other guardian are to be informed in advance about the grounds of assessment – –* (Core Curriculum, p. 260)
>
> *The pupils will learn to trust themselves, and to take responsibility for their own learning in mathematics* (Core Curriculum, p. 164)
>
> *Assist the pupils in becoming conscious of their learning, and their opportunities for affecting that learning (Core Curriculum, p. 18)*

The supportive classroom environment aspect is not so clearly seen in the teacher's guides. There are some indications in the preliminary tests and self-evaluation forms. In Pii self-evaluation form:

> *Teaching was too fast.*
>
> *I got help from the teacher or the peers.*
>
> *I wanted individual work (Pii, p. 202)*

Laskutaito book asks about good mathematics lesson in the preliminary test: *"What kind of a lesson is a good mathematics lesson? Write a short story or draw a picture"* (Laskutaito, p. 76). This can also be seen as student control in the supportive classroom environment aspect of productive pedagogy. Teachers' comments and deliberations about the supportive classroom environment tended to remain relatively stable.

4.3.6 Student direction

The teachers' replies are mainly about student direction and social support. Via those the teachers see the supportive classroom environment as integral part of the learning process. Teacher stated about students influence on the classroom activities or tasks, and also how they undertake them. Such activities are group work, or individual project and assignments which likely to be student-centered. The student wishes for the teaching-learning process are taken

into consideration beforehand but not during the lesson. Concern with children's individual differences and learning styles appeared prominently in the teachers' notes. Here are explanations on engaging students by providing alternative support structures:

> *I ask students for feedback at the end of periods and during self-assessment, based on which I improve my way of working* (Teacher 4)

In the following statements it has been shown the teachers suggestions that their teaching take a different entry point for developing and accessing student's understandings:

> *I take into account my pupils' wishes on ways of working beforehand. At the beginning of class I rarely change my plan (*Teacher *5)*

> *At the beginning of a course I ask the pupils about their aims and preferred ways of studying and showing their skills (*Teacher *6)*

4.3.7 Social support

The social support were found in core curriculum for students and how this element of PP might impact on their interpretation of teaching. The curriculum indicates about teacher working approaches must support an environment where influences pupil's learning as encouraging and interactive social learning skills to maintain share responsibilities. As mentioned there:

> – – advances purposeful activity and social interaction on his or her [pupil's] part (Core Curriculum, p. 158)

The teacher guide books called Pii asks about social support in the preliminary tests. The test question like:

> *The atmosphere made* me try my best. (Pii, p. 202)

The teacher also made it clear about the classroom characterised by an atmosphere of mutual respect and support between teacher and students, and among students. The teachers' response to put focus on social support is present in classes where the teacher supports students to take risks as well as an environment of mutual respect among all pupils of the class. One teacher pointed out that he don't tolerate if disagreement or conflict build up in the classroom. Another teacher also pointed out clearly how important classroom environment for assessment in terms

of bullying, dominant personality and very quiet students. For example, comments from other students sometimes belittle a student's efforts. Here is how she mentioned:

> *It depends a lot on the group and single students. The class is a bad place for assessment if there's been bullying (the bullied student is afraid to participate), there are too dominant personalities in the class that take all the attention (interruptions break the teaching in to small fragments, the more quiet ones get less attention), if there are very shy students in the class (assessment is hard, because the student for some reason is afraid to show what he knows in other ways than writing) (Teacher 5)*

Even there can still be both positive and sometimes negative atmosphere could be due to the fact that the learners might bring to understanding a curious outcome here. However, there was recognition of the need to cater for the individual learning styles of individual students, as shown by the following comments from teachers as teachers stated:

> *Working in a classroom might be a positive thing or a negative thing. It depends what you are to trying to learn and how. And different methods of studying might suit better for different students (Teacher 2)*

> *It depends on many things. Sometimes it's very supportive, other times it's the opposite. Heterogeneity is usually a good thing, and good personalities (Teacher 3)*

In a similar manner another teacher described the personal effort and role in enabling the supportive classroom environment. As cited:

> *That depends entirely on the teacher. A good teacher makes the classroom an environment where students can evolve socially (Teacher 7)*

4.4 Other related issues from teachers' point of views

To gain a deeper understanding about the use of formative assessment in the classroom teaching and the opportunities it offers to the student by teachers, it is also important to know how teachers would describe their role in students' daily learning activities as a science/mathematics

teacher, how often teacher share experiences or challenges with other teachers/colleagues and how does this work as well as what are the barriers/difficulties do they face to assess your students' scientific/mathematical learning ability. These issues are given below in more details:

4.4.1 Role in students' daily learning activities

Teachers described their role in students' daily learning activities as a lecturer and explainer, an adviser, a counselor and guidance for them to see how they can acquire knowledge and competence in the most effective way possible. They think their role is keep students active to learn new skills and to be eager to discover new things about everything and also the person who shows students meaning and joy through learning. Here are some instances:

> *I try to be guiding and inspiring and give new perspectives on things. I also try to bring the world of physics closer to the environment experienced by the pupil (Teacher 3)*

> *I teach 7-9 graders physics, chemistry and mathematics. My role is to make them aware of everyday physics and chemistry, as instructed by the curriculum (opetussuunnitelma). Having conversations about everyday physics and chemistry and doing experiments is the best way for me to get pupils interested in the subject at hand (Teacher 5)*

> *I try to guide them into thinking scientifically, that is to notice natural phenomena and patterns in those phenomena, and that it's important to take them into account, and some ways to utilize them in their own environments also. My role is to teach skills and knowledge about the aforementioned and teach how to live in this world and society while respecting and advancing them (Teacher 6)*

4.4.2 Sharing experiences

When it comes to how often teacher share experiences or challenges with other teachers/colleagues and how does this work, though none of the teacher stated that they have routines to share experiences, and use quite some time to advise each other in school, but they did mention that when they have meeting which is also an opportunity to share things with

others. During the break time, teachers talk to other teachers about situations in class and the pupil's studying, normal interaction, conversations, assessments, common exams, common assignments etc. Here are some examples how teacher responded:

> *Yes. In the teachers' room and on the way home to colleagues of the same school. In MAOL-club meetings (The Finnish Association for Teachers of Mathematics, Physics, Chemistry and Informatics) to others attendees (Teacher 1)*

> *Quite often I share the general attitude and performance of the students with other teacher's. Or I might ask question about students that I feel that they are struggling with their studies (Teacher 2)*

> *I talk a lot with other teachers of physics, chemistry and mathematics about assessment and its general guidelines. Good practices are shared with all teachers (Teacher 5)*

4.4.3 Barriers/difficulties

Teacher think in assessing the students' learning skills it's hard to think about the big picture, when the student has interrupted a period in his former place of study, and is now continuing his education. Pupils are very heterogenic when they come to secondary school, both in learning skills and studying skills. Therefore, teachers face some barriers and difficulties to assess students' scientific/mathematical learning ability, like how to make his prior knowledge visible as soon as possible, so that the student doesn't have to do the same things multiple times, but can move forward. In addition, they think sometimes it's difficult to assess a student's practical skills (lab skills) and a written exam doesn't always measure every skill and knowledge that a student has. Besides these they feel difficulties about:

> *Using computers has made it hard to interpret some people's handwriting (Teacher 1)*

> *Getting close to quiet pupils and trying to figure out what they know. To make pupils ask questions from themselves (Teacher 2)*

> *There seems to be too little time to comprehensively assess the work of 16 students in a class, and it feels like there's too little time to give feedback. It is*

hard to remember what subjects each student knows well already, and what should they still practice (Teacher 6)

5 Discussion

The discussion of results is separated into three subsections. I will discuss in first subsection how formative assessment has been described in national core curriculum and teachers' guides and how teachers are using it in their practice. Next subsection discusses how productive pedagogy components are embedded in curriculum materials and teachers daily practices. Finally, the Teacher as a collaborator in classroom assessment is discussed in last section.

5.1 Formative assessment- How is it seen in curriculum materials and teachers daily activities?

Research on formative assessment presents evidence that using formative assessment increases standards where peer assessment is an essential part of it. The peer activities provide the students the opportunity to experience that they are being assisted by teaching that responds to their needs (e.g. Black & Wiliam, 1998a; Wiliam, 2011). However, peer assessment, as such, is not seen in any of the elements analyzed although there are some mentions of working in groups. Atjonena (2014) also found in her data that peer and self-evaluation were an almost tacit topic for Finnish teachers. Hendrickson (2012) states that in formative assessment in Finland pupils' self-evaluation is used but in the material self-assessment was mainly seen in the Core Curriculum with some mentions in the books, including self-assessment forms but in teachers' replies it was almost non-existent. According to presented data in this study it seems that self-assessment is mainly seen in documents and rarely in the actual work of the teachers at grades 7–9 of Finnish basic education.

The National Core Curriculum emphasizes the social aspect of school learning and pupils are seen as active learners. In that way active participation into the learning process is already in the very foundations of the Finnish Curriculum to reinforce the pupil's self-esteem, favorable self-images as learners, and sense of involvement. Active involvement can be seen in the Pii teacher's guide connected to the assessment as the guide book provides some indication on self-assessment. Also teachers offered similar response to emphasize the pupils' role as active participants in their answers, as students' engagement in their learning is an important part in the formative assessment practice (Stiggins & Chappuis, 2005; Wiliam, 2011). In addition, teachers underlined the importance of actively asked questions from students and appreciated the collective participation in different tasks. Hence, it was found quite satisfactory when it

comes to students engagement which found the same result with the study of Kirton et al. (2007, pp. 621–624). One reason is student engagement is significant in the formative assessment practice as its supports the pupils possibility to take co-responsibility for their own learning which is highlighted in the core curriculum.

Feedback is seen as the most important criteria for formative assessment by scholars (e.g. Black & Wiliam, 1998a; Sadler, 1998: Wiliam, 2011). Feedback is also seen as very important in the Finnish National Core Curriculum, but it is very surprising how seldom it is mentioned in both teachers' guides. Only one mentioning was found in the Pii book. It might be that the authors of the books may see feedback in general as self-evident, but feedback connected to formative assessment is is not common in schools (e.g., Black & Wiliam, 2005; Stiggins & Chappuis, 2005).Teachers also mentioned that they try to give oral feedback instantly when possible, or written feedback through the Wilma system which is a web based system for passing messages between the teachers, pupils and homes. But, teachers also mentioned that lack of time is a barrier for giving feedback. Not only that, the cooperation among the students and the teachers serves as an enabler to possible learning from others as well as incorporation in positive, encouraging feedback. In that way the lack of cooperation among the group and students create the obstacle for the students to concentrate on receiving feedback. This is how teachers described that it is important to make the cooperation a part of a positive classroom atmosphere for giving and receiving feedback, as there are risks about giving negative feedback or correcting bad behavior that the relationship between teachers and pupils goes in a negative direction. We can therefore assume that the opportunity offered by the information that pupils do not always receive the feedback they deserve (Atjonena, 2014).

As mentioned in the analysis chapter in details, there is very little about how formatively assessment in general in teacher guides. Though they do not dictate what the teachers must do for assessment, in the last section there is a very short general introduction to how assessment can be done. It is very much emphasizing the forms, quizzes and exams that can be found later in the book but there are very little hints or advices for the teachers, and the main thing on these pages is the picture of the pupils' textbook and the correct answers. In compare to Laskutaito book, formative assessment is more discussed in the Pii book. Pii book has some ideas for the teacher how to assess in classroom practices. In regards to classroom assessment, the both teacher's guides are very different. Laskutaito concentrates on answers to the exercises, where as additional handouts are offered by Pii which gives teacher more actual

hints and background information. However, teachers use formative assessment quite actively in their classroom. They see great value in guiding the students during their working process, as to let them see how they can adjust their work to learn in the most effective way possibly.

Both teachers' guides see classroom assessment very much through testing but there are some differences as can be seen in the analysis. The guides talk about assessment in separate chapters and using test (and exam) forms but the on-going every-lesson formative assessment is discussed only in Pii. The National Core Curriculum sees diverse assessment methods as an important part of assessment and requires the teachers to use them. This does not show in the teacher's guides. Pii lists different things to be assessed, but it does not talk so much about how things should or could be assessed. It can be clearly seen that both guides see the tests and exams as the key assessment methods in classroom. The teachers do not mention it but judging from their comments they do also see assessment to be very much test based. When they talk about various methods they usually talk about various methods of instruction and they can in some cases be seen as assessment methods at the same time.

When the diverse assessment methods are not emphasized in the teacher's guides it is quite clear that the methods are not showing in teachers' everyday work. Research has shown that the general ideas and specific pedagogical support of teaching mathematics about mathematics teaching need to be provided in teachers' guides (Beyer & Davis, 2009) in order to enhance teachers' learning and teaching strategy. Limited support for teachers to deepen their knowledge about assessment criteria in mathematics was offered by the guides which is in line with Ball and Cohen's (1996) statement, "Teachers' guides rarely help teachers to think about the temporal dimensions of curriculum construction".

So it can be seen that there is a gap between the practice of formative assessment methods the National Core Curriculum requires and the classroom reality when seen through these answers and the teacher's guides. This is actually quite easily explainable. It has been shown both in Finland and other places that the textbook is one of the main influences for the instruction in the classroom (Van de Walle, Karp, & Bay-Williams, 2014; Niemi & Metsämuuronen, 2010) and for additional help the teachers use teacher's guides and are quite satisfied with them (Niemi & Metsämuuronen, 2010). This means that the curriculum and the National Core Curriculum are not the main source for planning the instruction.

5.2 Productive pedagogy in teachers' guides, national core curriculum and teachers' practices

One of the study's purposes was to seek how the productive pedagogy's component took place in classroom, from teachers' experiences to curriculum materials. The knowledge integration is one of the components of productive pedagogy that is concerned with pupils' conceptual development. In the core national curriculum, it is also denoted about the lesson range across diverse fields, disciplines and paradigm. On the other hand, in the teacher guide Knowldeg integration not specifically but this can be seen in the exercises in Laskutaito guide book and in the introductory chapter in Pii book where the connections are made to the history and physics. However, teachers see the knowledge integration as occurring when the different subjects merge in all their teaching.

Learners develop a substantive understanding of new knowledge based on prior knowledge. Though it is tested in both teacher guide books by preliminary tests, the core curriculum has not talked much and clearly about assessing students' background knowledge, except mentioning that teacher working approaches should be according to pupils' abilities and suitable for different ages and various learning assignments and situations. From the teachers' opinion, clearly indicated that teachers' think their attitude towards science/mathematics assessment is an attempt to connect with students' background knowledge.

From core curriculum and teachers' voices, it is clear that the strategies for students to reflect on their own learning made assessment criteria explicit. In that way, in Finnish classrooms the assessment and learning is seen to be integrated, which is in line with the argument given for the establishment of a supportive classroom in the productive pedagogies framework, where it is recommended that "students be given a voice in the classroom in order to have some say over the direction that activities take within various units of work, that explicit criteria be provided to students so that expectations are clear, and that a classroom environment is created where students are prepared to take risks with their learning" (Mills et al., 2009, p.72). Therefore, it can be deduced that Finnish education is in a transformation which points "to opportunities to make assessment, learning, and teaching more technologically sophisticated, more critical and empowering, more collaborative and reflective" (Hargreaves et al., 2002, p. 92).

Finnish classroom reality is more positive in regards to "connectedness" perspective which is different from Lingard et al. (2000) study, as they stated in their study, "whilst we have seen

little evidence of connectedness' in most of our research schools, we have been to places where schools, and the work students do in the classroom, are very much part of the local community" (p. 106). As I have shown some examples in analysis from teachers perspective how they connect their lesson with real life examples and the students' assignments are always connected to reality most of the cases. But curriculum materials are not so helpful in this case. Not only have I found from teachers guide the insufficiency of indicating real life problem (done via the exercises), teachers also mentioned that the examples from textbooks aren't often of use to many cases.

In teacher guides, I only found some problem based chapter where most of the chapters are definition based (for example, the start with the mathematical definition or fact which is then applied). It's definitely good for teachers learning that teacher guides provided definitions before starting the applications, but it could be better if guidebooks include more real life example as teachers sometimes found it difficult as the examples from books aren't often of use to many cases.

In addition, the rationales behind the specific tasks were inadequate in both Finnish teacher guides. There was hardly any information on the lesson pages about the rationales for the activities. One reason might be that the Finnish teachers typically are familiar with teacher guides, therefore, teachers are expected to be responsive about the activities which are suggest on guide books as they are part of their teacher education (Krzywacki et al., 2012). That is understandable when we look at other ways, the teachers' guides provide help and ideas for new ways to teach and simultaneously ensure that the children learn what they are supposed to learn according to the state curriculum (Pehkonen, 2004). Hemmi et al. (2013) also found teacher guides in Finland "making visible the demands of the practice concerning the curricular goals".

From the teachers responses it seems that connections between theory and practice is lacking in teacher guides, therefore if authors of teacher guides emphasizes this it could help teacher to better teaching. As Remillard (2012) argued, "Despite the invisibility of the authors, curriculum resources have a voice that is manifested through the way they communicate with the teacher" (p.112). Might it be that the authors of curriculum materials assume teachers know how to engage students with the content, whereas teachers want more guidance?

5.3 Teacher as a collaborator

It is revealed from this study that Teachers' roles in assessment as collaborator in their students' learning. It proved that the quest for deep understanding for their pupils is shared where teachers not only cooperated deeply with their pupils, but also collaborate with one another to build a strong base for their teaching direction and student learning. From my study it is found that teachers have seen their role as a lecturer and explainer, an adviser, a counselor and guide for their students, and also the person who helps them:

- to see how they can acquire knowledge and competence in the most effective way possible,
- to keep students active to learn new skills,
- to be eager to discover new things about everything,
- to show students meaning and joy through learning,
- to utilize them in their own environments
- to teach how to live in this world and society while respecting and advancing them

That teachers shared their learning with other colleagues was found promising, instead of working in isolation. They shared their experiences to learn from each other, and shared their thoughts about teaching and learning as a way of supporting their own reflection and understanding on students' assessment and learning. This result is similar to another study on Finnish "Teachers' views of their assessment practice" conducted by Päivi Atjonena (2014). Included in the difficulties they found in classroom assessment is to remember what each student knows well already and what is needed to practice, plus the relatively limited time to comprehensively assess the work of all students in a class as well as to give feedback. To the implementation of classroom assessment, time has been identified as a hindrance factor. However, in their study, Briscoe and Wells (2002) described how uses of assessment formatively helps teacher to save classroom time.

6 Conclusion

The core question argued in this study is how curriculum materials is seen the formative assessment and productive pedagogy perspectives, and how teachers promote those features in their practices. One of the most powerful ways of improving learning in the mathematics and science classroom is emphasizing on the use of day-to-day formative assessment. Productive pedagogy in the classroom has also proved to enhance the quality of teaching learning by scholars all over the world (e.g., Gore, 2001; Hayes et al., 2006; Marsh, 2007).

The results of this thesis has provided information regarding the state of formative assessment and cultures of productive pedagogy science and mathematics in Finnish education context. The findings indicate that the practice of both formative assessment and components of productive pedagogy is visible in curriculum materials and teacher's everyday practices, though teacher are facing challenges to implement these strategies in classroom, where curriculum materials sometimes are not sufficiently supported by example relating to real life. In general, it can be deduced that Finnish education system transforming supportive classroom culture for formative assessment as well as pupils learning. . From this study result, it is found that Finnish teachers use a non-traditional approach which leads to more interaction between teachers and pupils than a traditional teacher-centred approach would allow for. Therefore, it would be better if Finnish classroom emphasized to increase the practice of adjusting assessment tools and methods in the classroom in line with the needs and abilities of students, and more focus on peer assessment to help pupils learn socially, through and with others (Swaffield, 2011). If we add formative assessment to the question of what curriculum resources need to emphasized more and in teachers daily practices, it would be helpful for student learning.

The study has also outlined and explored a picture of how the development of classroom assessment can be supported by all levels of the education system. Data analysis from this study suggests that the components of productive pedagogy's are embedded in Finnish education system, both in curriculum materials and teachers daily practices, in general. However, some of the productive pedagogy items were found to have marginal uses in both curriculum materials, especially in teachers' guides as well as teacher practices. But, teachers explained that they organize their lectures in the best possible way so that the students could benefit from them. It has been legitimate to assume from the PISA success result in mathematics and science that, Finnish teachers have been successful with grasping curriculum outlined goals and

selecting their own teaching materials and lesson plans, nevertheless, there is still a need to focus on formative assessment, especially on feedback and peer assessment. Through peer assessment, students' involvement in such a way that they could take more ownership and become more accountable for their learning and development.

Voogt and Kasurien (2005) also repeat the way Finnish national philosophy determines educational policy. The focus on self-evaluation also reflects "a more general philosophy in the Finnish educational system that it is more important to focus on development than comparison" (Voogt & Kasurien, 2005, p. 150). Teachers have a mode of engagement with curriculum materials as well as curriculum materials have a mode of addressing the shape of teachers practices (Remillard, 2012). To keep pace with global education development, the study tried to focus on how curriculum materials assist teachers and teacher practices in their daily activities in the current educational system in Finnish basic education. If learning processes and knowledge construction are preferred, it might be useful to look back on the productive pedagogy components in Finnish education policy as well as to strengthen more the formative assessment. Teachers and curriculum materials in a collaboration can create a significant foundation for effective formative assessment and productive pedagogy cultures in classrooms as curriculum materials' have the potential of "representing ideas, conveying practices, reinforcing cultural norms, and influencing teachers" (Brown, 2009, p. 21). Again, it is hard not to draw the parallel among the tow perspectives (formative assessment and productive peadagogy) and notice the same reflection from national core curriculum to teacher activities.

In conclusion, the study reveals a lesson pattern for formative assessment and productive pedagogy, in respect to teachers' practices and curriculum materials, which delivers a joint and relatively strong consensus of formative assessment and productive pedagogy learning cultures in Finnish classroom. As the interactions among curriculum materials, formative assessment and productive pedagogy is obvious, therefore, it can be reiterated that there needs new modes of pedagogy in which pupils actively involved in the assessment process.

6.1 Further research

The study on actual and real teacher-curriculum relationship could be the further research area as well as Finnish context as well as Nordic countries as few studies focusing on teacher-curriculum relationship in this area.

The next level will be to investigate how the teacher guides support the teaching of mathematics and science education as teacher guides have received minimal attention in research (Remillard, 2005).

The another interesting study could be investigated on teachers' PDC – Pedagogical Design Capacity (Brown & Edelson, 2003) as well as how the interaction developed between a teacher and curriculum materials.

Another motivating study would be to examine the way to understand how teachers perceive and mobilize existing resources to design instruction (Remillard, 2005).

My study combined with only two dimensions of productive pedagogy components, therefore, it would be stirring for further research combining all four dimension as well as employing the observation manual in classroom, including surveys and interviews with stakeholders.

As Bennett (2011) argued, formative assessment is both conceptually and practically still a work-in-progress, therefore, need to be more empirical study in this issues and must continue this practices to realize its considerable promise. However, because this study was confined by time and resources to only seven teachers from seven different schools in one region, further larger-scale investigation about how formative assessment practices and how other teacher guides well-embedded assessment would add much to the curriculum resources and assessment literature.

It would also be very useful to have data from students and their families, and Ministry of Education policy and qualifications authority officials to expand our understandings about how to speed up and deepen formative assessment practices in these large scales.

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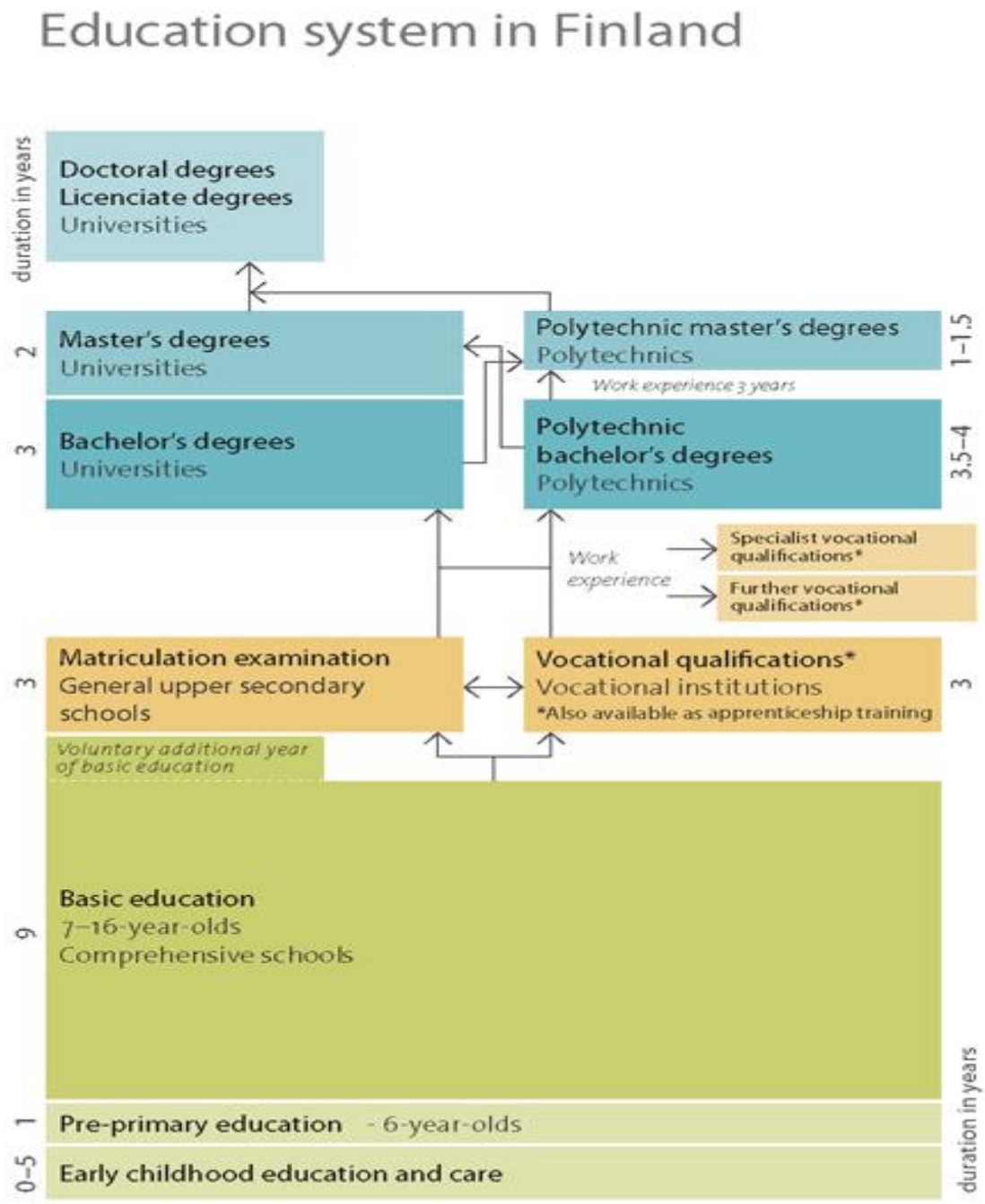
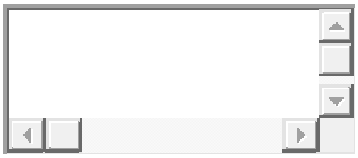
Appendix A: Finnish education system

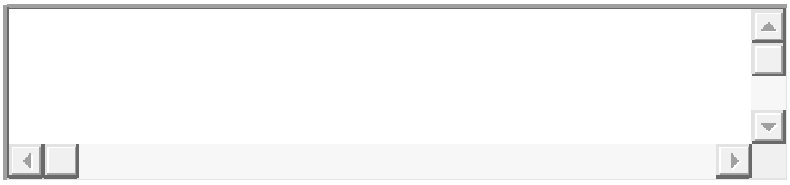


Appendix B: Questionnaire for teachers

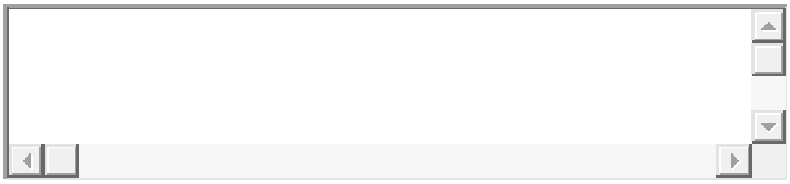
My name is Sharmin Ahmed. I am studying towards a Master of Philosophy in Comparative and International Education at University of Oslo, Norway. Currently, I am doing a thesis about formative assessment in lens of productive pedagogy from teachers' perspective as a part of my degree. I would like you to participate in the study. I will take particular care to ensure what you write in the questionnaire stays confidential and I will also make sure that no one can identify you or your school when I write reports on the study (as you can see I am not asking for your name and also school name).



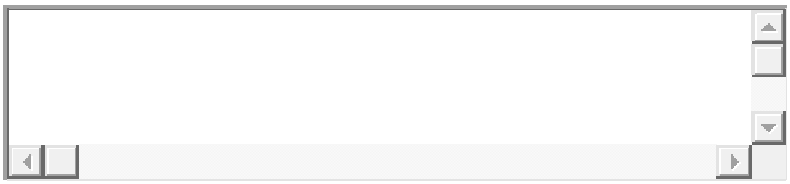
1. Miten kuvailisit roolisi luonnontieteiden/matematiikan opettajana opiskelijoittesi päivittäisissä opiskelussa? (How would you describe your role in students' daily learning activities as a science/mathematics teacher?)



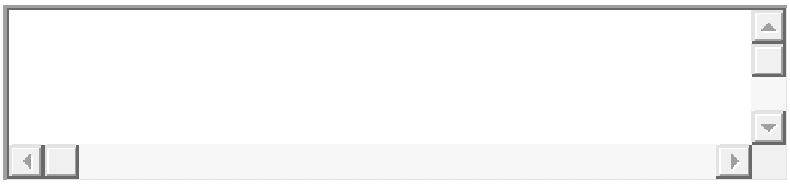
2.Miten arvioit opiskelijasi luokkahuonetilanteissa? Ole hyvä ja kuvaile perusopetusstrategiasi ja selitä miksi käytät niitä? (How do you assess the students in a classroom situation? Would you please describe the principal teaching strategies you use and explain why you use them?)



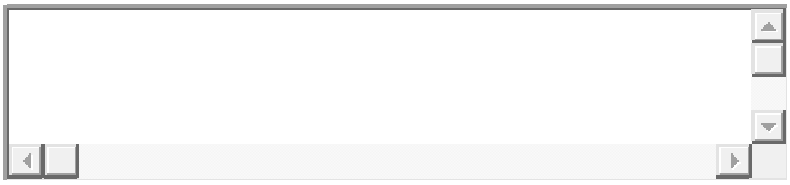
3. Onko luokkahuonearvioinnista etua? Mitä etuja? Miksi? (Do you think there are benefits to using classroom/formative assessment? If so, why and what are the benefits? If not, why not?)



4. Jaatko omat kokemuksesi/haasteesi muiden opettajien kanssa? Miten? (Do you share your experiences or challenges with other teachers/colleagues? If so, how does this work?)



5. Kattaako oppitunti eri alueita/koulukuntia/kaavoja? Kuvaile tarkemmin. (In your opinion does the lesson range across diverse fields, disciplines and pattern? Would you please explain in more sentences?)



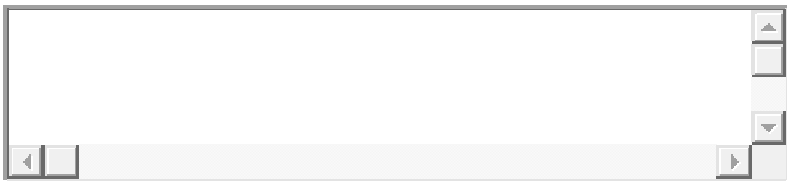
6. Kannustatko opiskelijoita kertomaan suoritustensa parantamisesta sekä päättämään opetuksessa käytetyistä oppimistavoista ja oppimistavoitteista? Kuvaile tarkemmin. (Do you think you get opportunity to encourage your students to reflect upon how they can improve their assignments, to involve about how they want to learn at school or the opportunity to decide on their learning objectives? Would you please explain in more sentences?)

7. Kuinka usein annat uudet ohjeet, jos huomaat, että opiskelijat eivät ymmärrä aihetta? (How often do you adjust your instruction whenever notice that students do not understand a topic?)

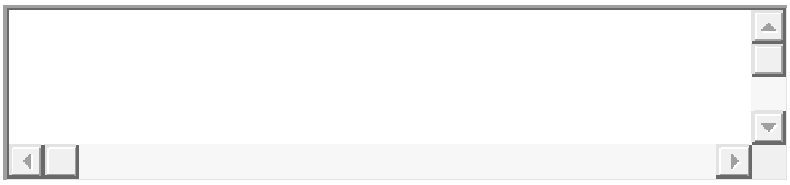
8. Onko opettajan asenne arviointiin yritys saada yhteys opiskelijan taustatietoihin? Miksi/Miksi ei? (Do you think the teachers' attitude towards science/mathematics assessment is an attempt to connect with students' background knowledge? Why and why not?)

9. Onko oppitunneilla ja tehtävillä yhteys todelliseen elämään? Esimerkki? (Do you think lessons and the assigned work have any resemblance or connection to real life contexts? Would you please give some examples?)

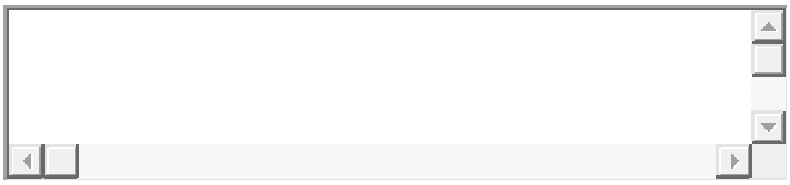
10. Mitä haasteita älyllisten ja tosielämän ongelmien määrittelyssä/ratkaisemisessa on? (What challenges do you find with identifying and solving intellectual and/or real-world problems?)



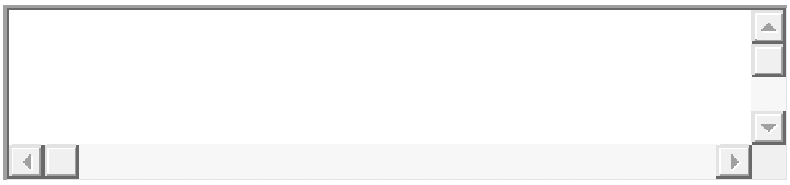
11. Mitä mieltä olet luokkahuonekulttuurista (esim. opettaja-oppilassuhteesta, oppimisympäristöstä)? Onko luokka sosiaalisesti kannustava, positiivinen ympäristö arvioinnille? (What is your opinion about classroom culture and setting in school (Including teacher student relationship, learning environment)? Is the classroom a socially supportive, positive environment for classroom assessment?)



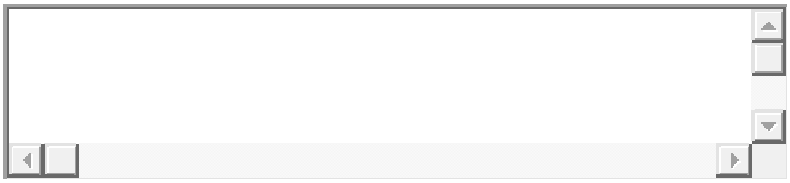
12. Pitävätkö opettajat yleisesti opetussuunnitelmavaatimuksia tärkeämpinä kuin toiminnallista opetusta/oppimista? Selitä tarkemmin. (Do you think in most cases teachers prioritize curriculum requirements rather than activity based teaching-learning? Would you please explain in more sentences?)



13) Mitä esteitä/vaikeuksia kohtaat arvioidessasi opiskelijoittesi luonnontieteen/matematiikan oppimistaitoja? What are the barriers/difficulties do you face to assess your students' scientific/mathematical learning ability?



14. Lisäkommentteja? (Any more comments?)

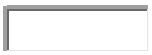


Basic Information

Sex

- Female
- Male

Teaching Experiences (how many years)



Which subject do you teach?

- Mathematics
- Science

Thank you very much for your kind cooperation.

Appendix C: Research Letter

UiO : Department of Education
University of Oslo

To whom it may concern

Date: 13.05.14
Your ref.:
Our ref.: kristi.barcus@iped.uio.no

Letter of Support for conducting field work

I hereby confirm that Sharmin Ahmed, born 11.12.1987, is a full time student in the Master of Philosophy in Comparative and International Education master programme at the Department of Education at the University of Oslo.

In the second year our students are required to write a Master Thesis of 80 to 120 pages. This thesis should preferably be based on field studies conducted in countries outside of Norway. The fieldwork may incorporate interviews with educational practitioners and decision-makers, classroom observation and documentary analysis. The type of data gathered should of course be discussed with the relevant authorities. It is our hope that the work produced by this student will not only benefit him in his academic career but also be of use in the future

Sharmin Ahmed is planning to do her fieldwork in Oulu, Finland; Oslo, Norway: and Dhaka, Bangladesh during the period of May 14th until June 30th 2014.

We kindly ask you to give her all possible assistance during her fieldwork.

Best regards,

Kristi Barcus
Senior Executive Officer
Department of Education

UNIVERSITY OF OSLO
Department of Education
Box 1092 Blindern
N-0317 Oslo

Department of Education
Postal addr.: PO Box 1092, Blindern, 0317 Oslo
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postmottak@uv.uio.no
www.uv.uio.no
Org. no.: 971 035 854

Appendix D: Pii's self-evaluation form

Oppilaan itsearviointilomake

Nimi ja luokka: _____ Jakso: _____

Oman työskentelyn arviointi

Opiskelu tuntui kiinnostavalta	Olin oppitunnilla aktiivinen	Työskentelin huolellisesti	Tein kotitehtäväni tunnollisesti	Ilmapiiri kannusti minua yrittämään parhaani
☐ ei koskaan	☐ ei koskaan	☐ ei koskaan	☐ ei koskaan	☐ ei koskaan
☐ harvoin	☐ harvoin	☐ harvoin	☐ harvoin	☐ harvoin
☐ melko usein	☐ melko usein	☐ melko usein	☐ melko usein	☐ melko usein
☐ usein	☐ usein	☐ usein	☐ usein	☐ usein
☐ aina	☐ aina	☐ aina	☐ aina	☐ aina

Jakson sisällön ja työskentelyn arviointi

Käsiteltävät asiat olivat mielen-kiintoisia	Asiat tuntuivat vaikeilta	Opetus eteni liian nopeasti	Sain tarvitessani apua opettajalta tai oppilastovereilta	Kaipasin itsenäistä työskentelyä ja omatoimista opiskelua
☐ ei koskaan	☐ ei koskaan	☐ ei koskaan	☐ ei koskaan	☐ ei koskaan
☐ harvoin	☐ harvoin	☐ harvoin	☐ harvoin	☐ harvoin
☐ melko usein	☐ melko usein	☐ melko usein	☐ melko usein	☐ melko usein
☐ usein	☐ usein	☐ usein	☐ usein	☐ usein
☐ aina	☐ aina	☐ aina	☐ aina	☐ aina

Jakson helpoin asia oli _____

Jakson vaikein asia oli _____

Jakson kokonaisarvio

Annan itselleni jaksosta numeroarvosanan ____, koska _____

_____

_____

Muita kommentteja: _____

_____

_____

_____

___.___.____ _____

päiväys *allekirjoitus*

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Opettajan antama kirjallinen arviointilomake

Nimi ja luokka: _____ Jakso: _____

Mukanaolo opetustilanteessa
- ☐ aktiivista ja osallistuvaa
- ☐ useimmiten aktiivista ja osallistuvaa
- ☐ taipumusta passiivisuuteen ja vetäytymiseen
- ☐ passiivista ja vetäytyvää

Kirjallinen työskentely
- ☐ vihkotyö siisti ja tehtävät tehty huolellisesti
- ☐ vihkotyö enimmäkseen siisti ja tehtävät tehty melko huolellisesti
- ☐ vihkotyössä ja tehtävien tekemisessä toivomisen varaa
- ☐ vihkotyö epäsiisti ja tehtävien tekeminen laiminlyöty

Kotitehtävien tekeminen
- ☐ aina tai lähes aina tehty
- ☐ useimmiten tehty
- ☐ joskus tehty, joskus tekemättä
- ☐ useimmiten tai aina tekemättä

Asennoituminen opiskeluun
- ☐ erittäin myönteinen
- ☐ melko myönteinen
- ☐ jossain määrin kielteinen
- ☐ kielteinen

Yhteistyöhalukkuus
- ☐ työskentelee mieluiten yhdessä
- ☐ työskentelee mieluummin yhdessä kuin yksin
- ☐ työskentelee mieluummin yksin kuin yhdessä
- ☐ työskentelee mieluiten yksin

Yhteistyökyky
- ☐ hyvät yhteistyötaidot
- ☐ pystyy useimmiten työskentelemään yhdessä
- ☐ yhteistyökyvyssä toivomisen varaa
- ☐ ei pysty yhteistyöhön

Poissaolojen vaikutus opintomenestykseen
- ☐ ei juurikaan poissaoloja
- ☐ ei merkittävää vaikutusta opintomenestykseen
- ☐ heikentävät jonkin verran opintomenestystä
- ☐ heikentävät paljon opintomenestystä

Koearvosana(t): _____

Muita huomioita ja kommentteja:

_____

_____

_____

_____

_____

Nähnyt:

___.___.____ _____

päiväys *allekirjoitus*

Appendix E: Laskutaito's self-evaluation form

49 Itsearviointi

Nimi: _____ Ryhmä: _____

Rastita sopiva vaihtoehto.

1. Arvioi osaamistasi.

Osaan	erittäin hyvin	hyvin	jonkin verran	en lainkaan
murtolukujen laventamisen ja supistamisen				
murtolukujen yhteen- ja vähennyslaskun				
murtolukujen kerto- ja jakolaskut				
murtolukulausekkeet				
jaollisuuden				
desimaaliluvuilla laskemisen				
pyöristämisen				

2. Arvioi, kuinka paljon olet tehnyt tehtäviä.

Olen tehnyt	kaikki tehtävät	suurimman osan	muutaman	en yhtään
Harjoittele-tehtäviä				
Sovella-tehtäviä				
Syvennä-tehtäviä				
monisteita				
kotitehtäviä				

3. Arvioi tehtävien vaikeutta.

Tehtävistä ovat mielestäni	erittäin helppoja	helppoja	vaikeita	en tiedä/ en ole tehnyt
Harjoittele-tehtävät				
Sovella-tehtävät				
Syvennä-tehtävät				
Monisteet				
Kotitehtävät				

Oletko saavuttanut tavoitteesi tässä jaksossa? _____

Jos olet saavuttanut tavoitteesi, vastaa tähän kysymykseen. Miten opiskelit jakson aikana?

_____

Jos et saavuttanut tavoitetta, vastaa tähän kysymykseen. Miksi et saavuttanut tavoitettasi?

_____

Tavoittelen arvosanaa _____.