The influence of national curricula and national assessments on teachers’ beliefs about the goals of school mathematics

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Abstract

What students should learn in school and therefore also what teachers should teach is an important issue worldwide. Mathematics teaching (and teaching in other subjects) is often regulated by some form of governing text in a written curriculum communicating a set of standards. Another common mean through which policy is communicated is assessments, which for example can convey policy by communicating desirable outcomes in student learning. A common problem with regulating what teachers do through policy means is that it often is difficult to achieve intended changes.

This study investigates the impact of a national reform in Sweden initiated in 1994, introducing mathematical competency goals by communicating them through the national curriculum and national assessments. The study is based on analysis of data obtained from the Swedish Schools Inspectorate (SSI), which conducted a quality review of upper secondary school mathematics teaching. During this quality review, the SSI collected data on a representative sample of 145 upper secondary mathematics teachers through interviews, observations, and surveys. This was done in 2009 and 2010, which means that the reform from a time perspective has had ample time to exert influence on teachers. In the study the data obtained from the SSI was analyzed in order to answer two questions:

1) have teachers changed their beliefs about the goals of upper secondary school mathematics in line with the intentions of the reform, and
2) why have, or have they not, changed their beliefs about the goals of upper secondary school mathematics in line with the intentions of the reform?

In research on teachers’ reception of policy messages, similar to the one introduced in Sweden, it has been found that a common response to these messages is that teachers are positive to the message. However, although positive, teachers have often been found to only adopt superficial properties of the reform while still maintaining a highly traditional view of teaching and the goals of teaching, not consistent with the intentions of the reform. Therefore, the questions in this study were examined by using a model that can explain why teachers, when confronted with a reform message, change their beliefs in profound or superficial ways, or not at all. Through analysis of the SSI-data, measures on constructs of the model were obtained, and with statistical means it was examined whether the
model can account for the changes in teachers’ beliefs about the goals of upper secondary school mathematics.

The results of the study suggest that the Swedish reform has had a relatively small impact, and that the model can give an explanation to why some Swedish upper secondary teachers of mathematics have changed their beliefs in line with the reform, some have changed them in superficial ways, and some have not changed them in any discernable way. Whether teachers perceive the reform as entailing an important and non-trivial change for them seems to be of utmost importance. The results of this study suggest that if teachers do not perceive this, they will not process the message deeply, which by the results of this study suggest that there is little chance for them to change their beliefs in a profound way. If they however do perceive the message as entailing an important and non-trivial change, this study suggests that chances are greater that teachers will change their beliefs in line with the reform. Teachers’ interest in the subject and their perceptions of the usefulness of the documents communicating the message are then in this study suggested to be important factors influencing whether teachers will process the reform message systematically, which in turn heavily influences whether they will change their beliefs in a profound way. One practical implication, suggested by this study is that when policy communicates a new and non-trivial message with the intention of influencing teachers, it is important that the message is communicated clearly. Such clarity makes it more difficult for a teacher to superficially interpret the message as being in accordance with the teacher’s earlier beliefs, and thus not entail any need for change. However, to attain such clarity of a complex message is not an easy task to accomplish.

**Keywords:** Mathematical competence, competency goals, policy, reform, national curriculum, national assessment, teachers’ goals, teachers’ belief change
1 Introduction

Mathematics teaching, and teaching in other subjects, is often regulated by some form of governing text in a written curriculum communicating a set of standards. Also assessments of different kinds (e.g. national assessments) can function as a policy mean regulating mathematics teaching by communicating desirable outcomes in student learning. Because ideas about mathematics education (or other subjects) are affected by educational, philosophical, and political positions, standards and curricula are changed over time (Ernest, 1991; Niss, 1981). Naturally, stakeholders in this process have great interest in seeing the intentions behind the standards or curricula influence the educational outcome (Ellsworth, 2000). The U.S. is implementing the Common Core State Standards (www.corestandards.org). Australia is in a similar position, and recently, India implemented their National Curriculum Framework in mathematics (Australian Curriculum Assessment and Reporting Authority, 2011; National Council of Educational Research and Training, 2005). Additionally, many countries with longer traditions of national standards, including Norway and Sweden, have recently implemented new national standards.

The present study investigates the impact (and the reasons for the impact) of a national reform introducing goals roughly similar to the NCTM process standards (NCTM, 2000). The study focuses on Swedish national curricula documents and national mathematics tests of upper secondary school, belonging to the reform initiated in 1994, as mediating channels for the reform. The analysis is based on data collected in 2009, and 2010 meaning that teachers from a pure time perspective had ample possibility to interpret and implement the goals. The data used in this study, with the permission of the Swedish Schools Inspectorate’s (SSI)2, was collected during the SSI’s quality review of mathematics teaching in upper secondary school. During the SSI’s inspection classroom activities, including each single task performed by any student, were analyzed in terms of their relation to the goals. Further, interviews were conducted with each teacher regarding their goals for student learning and how they viewed the goals expressed in the national curriculum documents and in national tests. The teachers also

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1 The text in Chapter 1 is in parts a verbatim account of the Introduction in Boesen, J., Bergqvist, E., Bergqvist, T., Helenius, O., Lithner, J., Palm, T., and Palmberg, B. (2014).

2 The Swedish Schools Inspectorate (SSI) is an agency of the government that has three main tasks: asserting the right of each individual to knowledge and personal development in a safe environment in school, asserting national equivalence, and contributing to higher national educational standards. The Inspectorate works in different ways: regular inspections of all schools, thematic quality evaluation within certain areas, investigations of complaints concerning the situation for a specific child/student, and approval of independent schools. The collaboration between SSI and the researchers came about due to SSI having the need for specific mathematics education expertise in this thematic quality evaluation.
completed a survey. The schools chosen for inspection represented large and small schools, rural and city areas, and large and small municipalities. From analyses of these data, it is in this study deduced how teachers have changed their beliefs about the goals of upper secondary school mathematics. The qualitative analyses of data for examining why teachers have changed their beliefs in certain ways were also supported by statistical methods. Based on the sample selection it can be argued that the results of this study represent Swedish upper secondary school teachers in general concerning how a reform message, 15 years after the initiation of the reform, can be said to permeate their beliefs about the goals of school mathematics. Hence, this study presents an important example of the functioning of using national curriculum documents and national tests as carriers for a reform message.
2 Background

2.1 A reform of goals of mathematics education and the Swedish context

A common feature of all the standards or curricula mentioned in the introduction is that they present an enriched view of what it means to know mathematics. However, in what sense is this feature new and can be considered a reform?

Mathematics can be described as an autopoietic system in the sense that it produces the objects it discusses (Maturana & Varela, 1980; Sfard, 2008; Varela, Maturana, & Uribe, 1974), which means that the act of being mathematical (Mason, Burton, & Stacey, 1982) or doing mathematics (Schoenfeld, 1994) is scarcely separable from the act of studying or using mathematical structures. Traditional curriculum messages mainly specified the mathematical structures (notions, concepts, theories, methods, results) that should be studied, with little reference to the practice of mathematics (Hoffmann, 1989). During the 1990s, however, a clear trend emerged: the curricula now aimed to clarify the relationship between mathematical content and practice to make the development of a sound mathematical practice an explicit curricular goal. In Freudenthal’s words,

Every researcher, every producer of mathematics will readily admit that mathematics is an activity. (Freudenthal, 1991, p. 14) [...] the learner should reinvent mathematising rather than mathematics, abstracting rather than abstractions, schematising rather then schemes, formalising rather then formulas, algorithmising rather then algorithms, verbalising rather than language – let us stop here, now that it is obvious what is meant. (Freudenthal, 1991, p. 49)

The influential work Curriculum and Evaluation Standards for School Mathematics, hinges on the principle that “[...] knowing mathematics is ‘doing’ mathematics” (NCTM, 1989, p. 9). The Strands of Mathematical Proficiency and the Process Standards in the two U.S. publications Adding it Up (Kilpatrick, Swafford, & Findell, 2001) and Principles and Standards for School Mathematics (NCTM, 2000), respectively, are two examples of constructs that build on such ideas. Another example is the Danish Mathematical Competency Framework (Niss & Jensen, 2002). Frameworks for international comparative studies, such as TIMSS and PISA, incorporate

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3 The text in 2.1 is essentially a verbatim account of Section 1.2 in Boesen, J., Bergqvist, E., Bergqvist, T., Helenius, O., Lithner, J., Palm, T., and Palmberg, B. (2014).
similar constructs (Mullis et al., 2003; Neubrand et al., 2001; OECD, 1999),
with the latter being a particularly distinct example. The national curricula of
many countries have also picked up on these ideas, with Norway, China, and
Singapore as a few of many examples (Kunskapsdepartementet, 2010;
Ministry of Education of the People’s Republic of China, 2004; Singapore

Retrospectively, these ideas have a certain top-down flavor, with
inspiration perhaps coming from developments in the areas of the ontology
and epistemology of mathematics (Hoffmann, 1989; Lakatos, 1976, 1978;
Pólya, 1954; Schoenfeld, 1994; Steen, 1988) and from social constructivist
ideas of teaching and learning mathematics (Bishop, 1985; Ernest, 1991,
1998; NCTM, 1989; Restivo, 1988), rather than from a grass roots teacher
movement. Moreover, while the motives behind the above referenced
frameworks are often complex, it is clear that they intend to break with a
traditional teaching of mathematics associated with mainly practicing
procedures and instead communicate a richer view of what doing
mathematics means. Hence, it makes sense to assume that for most teachers,
the concept of formulating specific goals about the process of doing
mathematics represents a major shift of attention concerning the intended
focus of the teaching of mathematics in school: a reform. These types of goals
are in this study denoted competency goals.

As mentioned in the introduction, what students are supposed to learn
in school is often specified explicitly in a national curriculum (or similarly on
another level, e.g. through a state standard in the American context) and
implicitly (or explicitly) in externally imposed assessments. In Sweden, it
was in 1994, introduced new national curriculum documents for primary
school and upper secondary school with the documents relevant to upper
secondary school revised in 2000 (Swedish National Agency for Education,
2001a, 2001b). The writing of the mathematical parts of these documents
was influenced by the NCTM Standards (Emanuelsson, Johansson, &
Lingefjärd, 1992), and references to competency goals can be found
throughout the national curriculum documents (Palm, Eriksson, Bergqvist,
Hellström, & Häggström, 2004). Although previous curriculum documents
also mentioned problem solving, the documents from 1994 still represented
a reform in terms of broader competency goals. However, the curriculum
documents are intentionally designed to leave scope for local school and
professional interpretation of the aims and content of the subject. For
example, the central notions of the competencies (problem, reasoning,
communication and so on) are included but not defined, explained, or
exemplified. The intention is that the participants working in the education
system should thoroughly analyze the curriculum documents by interpreting
and discussing them and that this process should increase the quality of the
teaching and learning in the schools. The national tests measure all the competencies, and each competency is required in several tasks (Boesen, 2006). Based on their results from the national tests, students receive a test grade. The teachers assign the final course grade, which is based on both the national test result and other achievements made during the course, such as the performance on teacher-made classroom tests. However, the national tests are often considered as the main foundation for teachers’ grading since it covers the whole course. The course grades from upper-secondary school are used for admission to the university. There are no direct sanctions or rewards for the teachers or schools as a direct consequence of the students’ national test results, but teachers’ salaries may be based on their general performance and the schools may benefit from good test results when recruiting new students. The reform described above, is hereafter referred to as the competence reform, and the message communicated in this competence reform is referred to as the competence message.

2.2 Policy implementation

In Fullan’s (2001) book on educational change there are examples of studies demonstrating successful implementation as well as studies revealing what hinders educational change. It is made clear that the success of educational change depends on many factors besides those relating to policy documents or assessments (e.g. textbooks, students, colleagues, pre- and in-service training, teachers’ beliefs etc.). In the review of literature here, some of the aspects pertaining to these issues are brought to light, but because the number of factors possibly influencing change are great, the review cannot aim to be comprehensive, so instead a selection of studies delimited by the following considerations are reviewed. This section reviews research on the influence of curriculum, in the form of policy documents, and assessments, on teachers. The type of policy documents of foremost interest are documents that govern the goals for student learning in some form, whereas the type of assessments of interest are ones which are imposed on teachers from outside (for example by a state or a nation). Since, as mentioned, there are a lot of different factors that might influence teachers, the studies reviewed sometimes examine the effect from several sources at once (see e.g. Taylor et al., 2003; Stecher et al., 2000). A reason for this, besides the obvious one that different factors might influence teachers, is sometimes found in the notion that alignment between for example state standards, textbooks, and assessments, is beneficial when it comes to exerting an influence on teachers (Webb, N., 1997). Furthermore, reasons for studies examining the effects from several sources at once can be attributed to that many studies have been made in the American context where the standards based reform in mathematics oftentimes both includes an explicit state
policy and also an implicit communication of the standards through, for example, assessments (Wilson, S. M., and Floden, R. E., 2001). The type of reform that happened here in Sweden with the introduction of competency goals in the 1994 national curriculum, revised in 2000, (Swedish National Agency for Education, 2001a, 2001b) and assessments (described in the section before this one) is similar to the movements in America precluding and following the release of the NCTM standards (1989). Therefore it is in the review below included studies that do not have an explicit focus on policy documents or assessments, but rather as in Sztajn's (2003) study, have the general movement of reform (as represented by the NCTM standards) as a source of influence on teachers. The type of influence on teachers that are of interest is foremost, changes in teachers’ beliefs, but due to the interrelatedness of beliefs and teachers’ practice (Cross, 2009; Thompson, 1992; Richardson, 1996; Haney et al., 2002), and beliefs relations to values and emotions (Philipp, 2007), this review also includes these studies of these types of influences in addition to studies of influence on teachers beliefs. Also, because the question of influence from policy documents and assessments on teachers can have similar features across subjects, and because it is not a phenomenon exclusive to mathematics education, but also relates to general themes in educational research (Niss, 2007), studies not focused on mathematics are included. In the first section that follows, influence on teachers from policy documents or from policy documents in interplay with for example assessments are considered whereas in the second section focus is directed towards assessments influence on teachers.

2.2.1 Policy documents’ influence on teachers
In Ferrini-Mundy and Floden’s (2007) review of the influence of policy one conclusion is that:

Research about implementation and effects of the policies embodied in standards and frameworks is relatively sparse, and does not provide compelling evidence about the impact of standards in mathematics on teachers’ classroom practice. (p.1254)

Knapp’s (1997), review of research on systemic reform of mathematics and science education, where policy documents often are a part of systemic reform, comes to similar conclusions, and especially notes a lack of studies with large samples. In Knapp’s review it is highlighted that what counts as successful implementation is an important aspect when evaluating reform efforts. The review also concludes that many teachers are affected by the reform initiatives and respond to them, but that the differences in responses
is great, and that implementation where teachers fully understand the reform seldom is found (and perhaps should not be expected). Relating to the question of what should count as successful implementation, the review by Ross et al. (2002), which in part focus on evidence of non-implementation and what hinders implementation of reform ideas, concludes that there are difficulties in how degree of implementation should be measured. In a review from the early nineties Cohen and Spillane (1992) concluded that little research had been made on the effects of instructional guidance (through e.g. policy documents or assessments). Even though Stevenson and Baker (1991) found differences between different school systems that indicated that the degree of instructional guidance exerted some influence on what teacher choose to teach, these effects could perhaps be explained (as suggested by Cohen, and Spillane, 1992, p.26) by teachers’ own experiences of teaching as students perhaps being the most guiding thing for what a teachers do when they themselves have become teachers. On the related topic of school reform Desimone (2002) reviewed studies of Comprehensive school reform implementation with the help of Porter and colleagues’ (1988) policy attribute theory. She found that all policy attributes (specificity, consistency, authority, power, and stability) contributes to implementation and that “specificity is related to implementation fidelity, power to immediate implementation effects, and consistency, authority, and stability to long-lasting change.” (p.433).

Because most studies reviewed in Sections 2.2.1.1-2.2.1.6 below have focused on (or connects to the question of) whether the intended influence from policy documents (sometimes in combination with other policy means) on teachers have been realized, and because full embodiment of policy ideas seldom are found, the first sub-section of Section 2.2.1.1 gives three often cited studies, and one recent study, as examples of the general conclusion of this review. Thereafter the rest of the section is loosely arranged around what factors facilitate or impede influence, or explanations of why influence from policy has been limited or as intended. An exception to this structure is Section 2.2.1.6 in which studies that have found adversary effects from policy are reviewed.

### 2.2.1.1 Studies exemplifying the general conclusion regarding policy documents’ influence on teachers

Both Ball’s (1990) case study of Carol Turner and Cohen's (1990) case study of Ms. Oublier were set in California, where a new curriculum framework had been introduced in the mid eighties. Each of their cases showed similar responses to the curriculum framework introduced in that both teachers
adopted properties of the reform in a way that did not change their teaching the intended way. Even though for example Ball’s teacher followed the textbook that was supposed to be reflective of the curriculum framework, and even though Cohen’s teacher had adopted for example innovative instructional material, both teachers’ teaching remained very traditional. Explanations given for this were in the case of Carol Turner (Ball’s study), that the teacher interpreted the reform as being consistent with what she already had done, and therefore did not see the need for change. Hence no substantial change of teaching ensued. Cohen’s teacher, Ms. Oublier, who were very willing to change her practice in accordance with the framework and also experienced that she had made many changes had not really had the opportunity to learn about the deeper meaning of the message of the curriculum framework, and therefore the changes experienced by the teacher were not reflective of the deeper meanings of the framework.

Another study displaying little impact of a reform message was Spillane and Zeuli’s (1999). They observed 25 teachers who reported that they taught in accordance with reformers’ proposals, and were familiar with the NCTM standards and with state mathematics goals and assessments. In the light of this, the results are striking. Although reform oriented mathematics was observed in each teacher’s classroom, only 4 out of 25 teachers displayed a close alignment to the intended instruction. 10 out of 25 teachers displayed some features of reform orientation but the attention of students was directed at procedural content. In 11 of 25 classrooms both tasks and discourse norms were grounded in a focus on procedures and computation. A caveat to the results given by the authors is that even though the study in one sense reiterate findings that policy have limited influence on teachers’ practice (in the sense that the core ideas of reforms seldom seem to permeate teachers’ instruction), their study suggests that some dimensions of instruction are easier to influence than others. Reminiscing Cohen’s (1990) and Ball’s (1990) observations are the suggestion that (what the authors label) behavior regularities are easier to change (e.g. to include manipulatives in the teaching or to encourage student-student interaction) than epistemological regularities (such as conceptions of knowledge and knowing). The reform in Sweden (see above) can be viewed as belonging to the latter category, with new specification of what it is to know mathematics. A conclusion drawn by the authors is that a key challenge for policy makers is how teachers are supposed to be enabled to understand reform ideas (i.e. how will opportunities to learn about reform ideas be arranged).

A final and more recent example is the study by Mayrowetz (2009). He studied teachers’ instruction in relation to two policies that were supposed to influence the teachers’ instruction. The New Jersey state standards communicated similar ideas as NCTM’s standards, which in some cases were in accordance with and in some cases in conflict with the ideas of
individualization of the Individuals with Disabilities Education Act. He found that teachers approved of the New Jersey state standards, but that few took them into consideration while planning their lessons and that the instruction observed mostly showed evidence of superficial properties of the ideas of the standards. Teachers’ handling of having to cater to two messages elicited three different responses according to the author: “skimming the surface of both policies without engaging the ideological core of either, finding the common ground while remaining true to the spirit of both policies, and privileging one policy at the expense of the other.” (Mayrowetz, 2009, p.554). The first response was found to be the most common. As will be seen below the phenomenon that teachers believe to have adopted a reform while still not actually enacting it is common, and has also been observed in other subjects than mathematics as well.

### 2.2.1.2 Teachers’ opportunities to learn as a factor mediating influence from policy documents

Turning now to factors suggested to mediate influence from policy documents and (other sources) on teachers, several studies suggest teachers’ opportunities to learn as one important factor. Cohen’s (1990) case study of Ms. Oublier, and Spillane and Zeuli’s (1999) study, both mentioned above, serves as the first examples of this. A further example of this is Cohen and Hill’s (2000) study where almost 1000 Californian teachers were surveyed, and where data from the survey was coupled with data on student outcomes. It was found that instructional policy can influence teaching and that teachers’ opportunities to learn are a very important link between the two. Difficulties in influencing instruction with policy tools is acknowledged in the study and it was found that even when both state and professional agencies worked together and supported the reform in different ways over years, “coherent relationships among teachers’ opportunities to learn, their practice, school curriculum and assessments, and student achievement” (Cohen & Hill, 2000, p. 331) was only found for 15 to 20% of the teachers. This suggests that expectations on the possibilities of reforming classrooms through policy should be modest, in line with for example Knapp’s (1997) suggestions mentioned above.

In the country Jordan, Innabi and Sheik (2006) studied the impact of a reform promoting critical thinking in secondary school mathematics fifteen years after it’s implementation. Interview data was collected fifteen years apart at the same twelve secondary schools. Questions asked were ones eliciting teachers’ understanding of critical thinking and it’s role in mathematics learning, and questions on what type of instruction might improve students’ critical thinking skills. The authors found essentially no differences between the 24 teachers interviewed in 1988 and the 23
interviewed 2004. Neither of the groups of teachers had a comprehensive view of critical thinking. Furthermore they posit that based on their findings: “one could assert in general that teachers’ conceptions of critical thinking were narrow in scope, fragmented in structure and lacking clarity and consistency” (p.65). A conclusion is that the reform has failed to influence the teachers. A possible reason discussed by the authors, which relates to opportunities to learn, is that the teachers themselves have had little schooling in the ideas of critical thinking and that the documents prompting teachers to teach this did not explain the concept explicitly or with examples.

Coburn (2001) also (as e.g. Ball (1990) among others did) studied Californian teachers’ responses to reform through policy. In this study however the subject was reading instruction and not mathematics. The reform at hand was communicated both through state policy and assessment, pre-service training was aligned with the policy, and resources to buy instructional materials were provided; the reform was thus both comprehensive and supported with extensive resources. Through sustained observation and in-depth interviews at a school in the process of improving reading instruction Coburn found that collective sensemaking was an important factor when policy messages were to be reinterpreted by the teachers. The teachers did not always interpret policy in the way that policy makers would have hoped for, but that the sensemaking was collective rather than individual enabled teachers “more readily to integrate new ideas into the highly situated context of their classrooms” (Coburn, 2001, p.162). The intended influence could be found in teachers’ practice but it was incremental rather than profound. Coburn concludes that if conversation among colleagues was not structured around activities with connections to the classroom or that time was insufficient, then the collective sensemaking did not give any benefits as to teachers’ opportunities to learn and change. As seen below, for example Borko et al. (2003), Swanson and Stevenson (2002), Lefstein (2008), and Spillane (1999) also suggest that teachers’ opportunities to learn are an important factor mediating influence from policy. In Borko and colleagues’ (2003) study this is for example included in the construct of school capacity.

2.2.1.3 School capacity, and teachers’ knowledge and beliefs as factors mediating the influence of policy documents

Some of the studies reviewed here suggest factors such as school capacity, and teacher knowledge and attitudes as mediating policy influence on teachers. Borko et al. (2003) studied the influence of educational reform, communicated through state standards and assessments coupled with accountability systems, in the state of Washington. In case studies of two exemplary elementary schools responding to state policy in the form of
standards and assessments, they used the concept of school capacity to better understand what promotes goal attainment in relation to the reform efforts. Their study lends support to the claims that large-scale reforms take time and that one cannot expect “full embodiment of reform visions” (Knapp, 1997, p. 228) in the early stages. Furthermore their study suggests that school capacity, especially the dimensions (of school capacity) labeled instructional leadership, teachers’ opportunities to learn, and professional community, was an important factor in determining how successful the schools were in their efforts to improve.

In contrast to the many case studies reviewed here, Swanson and Stevenson (2002) utilized statistical techniques on a large sample. They coupled data on (teachers’ self reported) instructional practice (from the National Assessment of Educational Progress State Assessments) with data on policy activity at the state level and a range of contextual factors on state, school and classroom level. Also a factor of pre-existing instructional practices was included, which made the analysis (in their terms) quasi-longitudinal. Their notion of local receptivity does in some ways resemble the concept of school capacity used by Borko et al. (2003) and similarly Swanson and Stevenson’s study suggest professional development to be important for reform to reach the classrooms (which also can be seen as an aspect of teachers’ opportunities to learn). The largest part of the variation in teaching was explained by factors residing at the school and classroom level, with the teachers’ knowledge about and attitudes toward the NCTM’s standards as especially important factors predicting level of standards-based practices in the classroom. Although most variation in teaching was explained by factors at the school, and classroom level, they found that the “use of standards-based instruction within individual math classrooms is more prevalent in states that vigorously pursue standards-based reform” (Swanson and Stevenson, 2002, p.17).

Lefstein (2008) studied the influence of the English National Literacy Strategy by observing and interviewing teachers at a school during a school year. By doing this he demonstrated how the teacher on one level adopts the policy, by for example relying on provided material and supporting the objectives of the policy, but on the level of interaction between teacher and student the innovative ideas of the policy are missing. The innovative ideas are assimilated into the regular classroom practice. The study suggests (among other things as seen below) teacher knowledge and policy support as important factors explaining the results of teachers not implementing the NLS in the way intended. Policy support is in this study conceived as what support there is for teachers to make sense of the policy; i.e. it is related to teachers’ opportunities to learn. The knowledge aspect, suggested as a factor important for what influence policy might have, is somewhat differently conceived in Lefstein’s study than in Swanson and Stevenson’s (2002) study.
It is not only a question of knowledge about the reform, subject matter, or pedagogic content knowledge, but “successfully shifting one's pupils and oneself into a new interactional genre undoubtedly requires teacher capabilities, including, for example, tacit understanding and awareness of social dynamics, self-knowledge, and control” (p.731). In Pang’s (2011) study, described below, teachers’ intrinsic willingness to change is suggested as mediating influence from policy, but as the case of Ms. Oublier (Cohen, 1990) shows, this certainly does not seem to be a sufficient condition.

Another perspective on how teachers’ knowledge might affect implementation, or rather the reception of a policy message, is given by Spillane et al. (2002). Based on their review of research on one aspect of policy implementation: “agents’ sense-making with regard to reform initiatives” (p.388), they (in their words) sketches a Cognitive Framework of Implementation. This framework includes factors relating to individual cognition, as well as values, and emotions, but also factors relating to the social nature of sense making. On the cognitive side, they put forth how knowledge and prior beliefs influence the interpretation of a message. Also how messages can be misunderstood as familiar, as well as that one's knowledge and experiences might lead one to focus on superficial features on a message, are suggested as factors hindering change. Relating to values and emotions they conclude that persons are biased to interpret messages as consistent with prior beliefs and values (because the opposite would be emotionally taxing), and also that the costs to one’s self image might hinder change. The social aspect of their framework highlights both that sense making is made in a social context (e.g. organizational or informal communities) and that social interactions shape sense making.

Senger (1999) studied American K-5 teachers’ at one school who had displayed an interest in educational innovation in relation to the release of the NCTM standards (1989). Thus the focus in Senger’s study is not on policy influence by means of state standards or assessments, but rather the policy influence can be thought of as coming from another source (in this case the National Council of Teachers of Mathematics). She however, in contrast to many other studies reviewed here, has a direct focus on teachers’ beliefs. In Senger’s study it is discovered that the beliefs of the teachers studied changed in some ways although not drastically. While deeply held values (such as the good of the child, or the value of education) of the teachers did not change, instrumental beliefs (e.g. what good teaching is) actually underwent changes. Based on the processes of belief change observed, Senger suggests a model describing how belief change come about:

Newly gained awareness, pooled from various sources, was initially held without commitment in a tentative questioning mode. If not rejected, this new information, with time and
reflection, produced mental images of new forms of teaching practice (pre-images). The pre-images inspired a double-faceted experimentation, both verbal and classroom practice. Verbal experimentation involved the teachers using expressions and descriptions of their pre-images as a mean of expressing and assessing several aspects. (Senger, 1999, p.211)

The experimentation mentioned with verbalization and practice then sometimes resulted in changes in beliefs, which in turn resulted in more permanent changes in practice and verbalization.

Charalambous, and Phillipou (2010), who studied teachers’ concerns about the Cypriote reform in which problem solving had a primary role, found through a quantitative analysis of 167 teachers that teachers’ concerns about the reform mostly were first-level concerns, indicating that teachers mostly had concerns related to how the reform was supposed to be understood (in contrast to e.g. second-level concerns, which can be thought of as concerns of how the reform can be implemented, and third-level concerns, which can be thought of as concerns about the consequences of the reform). They also showed how concerns of earlier stages inform concerns on later stages, and that efficacy beliefs both inform concerns (on the second and third level) and are informed by concerns (at the first level). Their qualitative analysis of 53 teachers corroborated aspects of the findings from the qualitative analysis, i.e. also revealed a low awareness of the Cypriot reform. Furthermore the qualitative analysis suggested that some teachers shallowly and wrongly interpreted key aspects of the reform. They suggest that the reason for teachers’ low awareness of the reform was due to that only limited support regarding the reform had been given to the teachers, and that this could be remediated by directing support that focus on the first level concerns.

2.2.1.4 **Features of policy messages and teachers’ interpretations as factors mediating the influence from policy documents**

In relation to the phenomenon of teachers believing to already have implemented a reform Sztajn’s (2003) case study of two teachers serves as a further example. In her study of two elementary teachers’ responses to NCTM’s reform proposals, differences in practice between the two teachers were identified even though both teachers stated that they were teaching in accordance to the ideals of the reform movement and also shared many beliefs regarding learning (e.g. that students only could engage in problem solving if they knew the basics first). This was explained by teachers’ ideological visions of student needs, which differed depending on from which socio-economic background the students came and shaped the
interpretation of the reform message. Furthermore she concluded that the shaping of the message was possible due to the vagueness of the message itself. Also Drake (2002) in a study of Californian teachers found that teachers adapted policy messages to fit perceived student needs.

By interviewing, observing, and surveying around 200 teachers in Sweden, Boesen and colleagues’ (2014), studied the impact of a reform of the goals of compulsory, and upper secondary school mathematics (see Section 2.1), communicated through the national curriculum and national assessments. Their results suggest that the Swedish reform had had little impact on teachers’ instructional practice. Furthermore it is suggested that one of the reasons for this is that the reform was communicated with little clarity, and that it therefore was difficult for teachers to acquire a functional knowledge of the reform message (which is thought to be a necessary condition for teachers to be able to enact the reform in their classrooms). From this finding it is also concluded that high stakes alone will not make the intended changes happen. Similarly to the teacher in Ball’s (1990) study, many of the Swedish teachers appraised the reform message positively, but since many had not acquired a functional knowledge of the message, these positive views of the message did not affect the teaching enacted by the teachers in the intended way. Boesen et al. (2014), in part based their data collection and analysis on a model of belief change developed by Gregoire (2003). In her model the process of how changes in teachers come about when they encounter policy messages is put into the context of belief change. Based on several theories of belief change she creates a model, which among other things, highlights the importance of how messages are interpreted, and also captures the phenomenon observed in many studies reviewed here (see e.g. Ball, [1990], and Boesen et al. [2014]) that although teachers positively appraise the policy message, they do not always act upon it. In her model this is conceived of as teachers having assimilated the policy message: “In other words, the reform message is accepted, but the teachers’ cognitive schema about teaching is not radically altered, and true conceptual change has not occurred.” (Gregoire, 2003, p.166). When policy, that communicates a difficult message such as the competence message, has the intended changing effect on teachers, Gregoire labels this as teachers having accommodated the message. Because this model, by Gregoire (2003), is used in the present study, the specifics of this model are not accounted for here, but instead in Section 4.1.

Further results relating to the suggestions of Sztajn (2003), and others, that vagueness of a message allows teachers to interpret it in many different ways can be found in Graybeal’s (2010) study. She studied five elementary teachers and examined the teachers’ interpretations of messages about mathematics and mathematics teaching that was communicated to them through textbooks, state’s curriculum guides, school district’s curriculum
framework, and other sources. She found that teachers when in agreement with their interpretations of the messages often followed through with them, but that vague, inconsistent or controversial messages could be ignored. When teachers disagreed with the messages, they still sometimes reflected aspect of the messages in their practice, which was attributed to a sense of obligation. When messages were clear and consistent (across sources) teachers’ feeling of obligation was most apparent.

Bottino and Furinghetti (1996) studied Italian teachers’ response to a part of a reformed mathematics curriculum (in this case the inclusion of informatics into the curriculum) in upper secondary school. Informatics was the only part of the curriculum that was accompanied by in service training on a nation wide scale. The case studies of five teachers suggested that the reform did not generate radical changes. On the contrary, small steps that fit with teachers’ existing objectives seem more readily accepted, and “As a consequence the introduction of informatics in mathematics teaching works only when it is perceived as an answer to questions (even though unconscious) already present in teachers’ minds” (p.132). If external sources on the other hand are the only influence, superficial changes to the teaching seem to be the result.

Reminiscing what Bottino and Furinghetti found regarding implied changes having a better chance of happening if already in line with existing objectives, Ferrini-Mundy and Johnson (1997) found that what aspect of the NCTM’s principles and standards that schools focused on first seemed to depend on if it fitted “a salient characteristic of the site’s context” (p.116). Also they found that teachers’ sense of professionalism (e.g. enhanced by teachers being involved in decisions at the school or district level) and confidence was found to affect whether teachers changed their practice, and furthermore collaborations between teachers internally and externally (with e.g. a university) was found important, as was the existence of some sort of leader or specialist.

As mentioned above Spillane (1999) suggests opportunities to learn as an important factor contributing to policy influence and in that context he also notes that how the message is communicated might be an important aspect of this. He suggests that although ambiguity of messages cannot be eradicated, a message can be more or less well suited in aiding the ones receiving it. Also Innabi and Sheik (2006) points to this possibility (as seen above).

Relating to the above findings about the importance of certain features of policy messages, Polikoff (2012) studied the relation between degree of alignment, between state policy and practice, and properties of state policy. A large sample of survey data (from teachers in different states) on teachers’ instructional practice and content analysis of state standards and assessments were used to get a measure of alignment between policy and
practice. These data were then studied in relation to the same framework of policy attributes by Porter et al. (1988) that was used in Desimone’s (2002) review of comprehensive school reform (i.e. consistency, specificity (in Polikoff’s study relabeled focus), stability, power, and authority (not measured in Polikoff’s study)). In Polikoff’s study *consistency* was operationalized as alignment between content standards and state assessment, *focus* was about whether the state standard covered many topics shallowly (indicating low *focus*) or few in depth (indicating high *focus*), *stability* was the number of years the policy had been in place, and lastly *power* was the degree of sanctions and rewards (to school, teachers, and students). Descriptive results show great variation between states when it comes to policy attributes, and also that the alignment between standards and assessment overall is low. In mathematics, *instructional alignment to standards* was found to be positively influenced by the attributes *power* and *consistency* whereas *instructional alignment to assessments* only were positively associated with the attribute *consistency*. Across the subjects examined (Mathematics, English, and Science) *stability* did not have an influence on instructional practice, and *focus* was found to be associated negatively with language teaching’s alignment to standards. The author suggests that highly focused standards might be difficult to implement without sufficient support.

In a later study by Coburn (2005), still studying reading reform in California, early grade teachers at two schools were interviewed and observed. Their responses to different policy messages from system (e.g. state frameworks) and non-system actors (e.g. professional development) were studied. Coburn identified five different types of responses: rejection, symbolic response, parallel structures, assimilation, and accommodation. Furthermore, the responses that influenced classroom practice in some way (i.e. parallel structures, assimilation, and accommodation) were more prevalent when the message came form non-system actors. In line with many of the studies reviewed here it can be noted that the response that implied a deeper change with the teacher (i.e. accommodation), only occurred in 9% of the instances.

Not directly in relation to teachers, although by interviewing teachers among others, Spillane (1998) studied how school districts responded to a state’s reformed reading policy. In case studies of two different school districts with sharply contrasting responses to the state’s reform in reading policy he found that because the school district’s response to the state policy was “not internally homogenous, these two school districts sent teachers an array of different, and often conflicting, messages about reforming reading instruction” (p.58). Upon discussing the results of the study he states:
One might also expect the districts’ responses to policies to vary depending on the complexity of the instructional changes pressed for by the policy. For example, the evidence from my study suggests that the urban school district provided much more coherent instructional guidance in response to an earlier wave of reform, the back-to-basics movement. The state-reading policy I studied, however, pressed for much more complex, and not nearly as well elaborated, instructional changes. (p.60)

2.2.1.5 Teacher tradition as a factor mediating the influence from policy documents

Lefstein’s study mentioned above, suggested durability of instructional genres as a factor explaining limited influence of policy, and furthermore suggested that the durability of instructional genres can be attributed to different factors (e.g. teacher’s habitual behavior being comfortable and preferred over a new teaching style, and students being resistant to novel ways of teaching). Where in Lefstein’s (2008) study pupils’ pervasiveness to a certain instructional genre were suggested as a hindrance to teachers who want another discourse in the classroom it is in Pang’s (2012) study suggested that students’ active participation in mathematical activities encouraged change within the teacher. Pang (2012) studied Korean teachers, who were eager to improve their teaching in mathematics in line with the guidelines of the national curriculum, over the course of a year. She reports on one teacher at grade six (and later on grade three) who made substantial changes to her practice. The teachers, besides being willing to improve their teaching also were provided with support to facilitate change. By focusing on the teacher who most evidently went from a teacher centered pedagogy to a student-centered pedagogy (which in this case e.g. included soliciting and using students’ ideas, but also entailed a focus on reasoning and communication) Pang attempts to better understand the process of implementation and discusses the possible factors making the teachers’ change successful. It is suggested that the tradition of teacher telling might be a source of resistance to the reform. Further possible reasons for the change are discussed to pertain from models’ (teacher colleagues) behavior and intrinsic willingness to change.

In Portugal the curriculum is decided upon at a national level, which in contrast to the context of the American studies reviewed here, is more similar to Swedish conditions. There (i.e. Portugal), Ponte et al. (1994) studied teachers and students’ responses to a piloting program of a new mathematics curriculum. Teachers participating in the program got extra time for this and there was also some support in the form of professional development (although this was found to not being very well organized).
Successful change with the teachers was found in some instances, but the program, as mentioned above, also rendered negative feelings in relation to the way the reform was implemented. Teachers were positive to the reform and also tried different aspects of it in their practice (e.g. by employing group work and using real world examples), but the authors point out that: “It is difficult to say how much the changes were merely superficial or apparent and how much they concerned deeply-held views” (p.357). Although opportunities for the teachers to reflect on the reform together (which can be seen as a sort of opportunity to learn) were given, teachers’ individualistic tradition (i.e. there was no tradition of collaboration between teachers) did prevail throughout the reform, and this is suggested to have stymied some of the interaction between teachers in relation to the program. Also in Coburn’s (2001) study, described above, there are suggestions possibly relating to tradition. She found that if teachers’ views differed too much communication became difficult, and in relation to this she suggests that perhaps because teachers often engaged with teachers that held similar beliefs, the communication sometimes also encouraged stability rather than a change of practice.

On a different note of tradition, and relating to both teachers’ opportunities to learn, and features of the message among other things, Hill’s (2001) study serves as a last example in this section. She found limited influence of state policy on local policy at the teacher level while observing teachers’ work with formulating a local curriculum from state standards. Also interviews with district supervisors of curriculum, official state leaders, mathematics consultants, heads of professional development organizations, and other stakeholders were made in the study. The transformation of policy from state to local policy at the teacher level resulted in nominal alignment between documents (words used in state standards were used locally, but not always in the way intended by writers of state standards). The novel ideas of the state standards (bearing similarities to the NCTM standards) were transformed as they traveled through the system to the local curriculum and words signifying changes by the ones writing them were, instead of being seen as queues for change, made consistent with existing beliefs and practices. Hill relates the limited influence of policy to both features of the message and the support given to interpret the message (in terms of opportunities to learn), and furthermore relates this to a perspective that can be thought of as relating to teacher tradition. She describes how state leaders seemed to have developed a community with a shared notion about the ideas communicated through the state standards through a system of apprenticeship, while on levels closer to the classroom it seems as it has been expected that the same understanding of these ideas should have come about through reading of the state policy. The teacher tradition did not change in
relation to the message, but rather adopted the words with meanings from traditional instruction.

2.2.1.6 Policy documents’ adversary effects on teachers

Although adversary effects of policy (in the sample of studies reviewed in this dissertation) have been examined more thoroughly in relation to assessments (see Section 2.2.2 below) some examples of this in relation to policy documents of other types also exist and are given here. As discussed by Brooks (1991), Concerns have been raised that trying to centrally control what teacher do centrally (through for example a written curriculum) can have adverse and unwanted effects such as a loss of local control, loss of teachers’ professional autonomy, and a de-skilling of the teacher profession (see also Wilson and Floden, 2001, who presents a summary of hopes and fears connected to standards-based reform). Examining some of these claims Archbald and Porter (1994) surveyed approximately 200 teachers’ teaching high school mathematics and social studies in three states with differing policies communicated through textbooks, curriculum guides, and assessments. Teachers in different states were compared in order to investigate whether curriculum control policies “reduce teachers’ feelings of professional autonomy and local curriculum discretion”, and whether teachers’ self-efficacy and job satisfaction is adversely affected by perceptions of having less control over curriculum decisions. Little evidence was found that job satisfaction was impeded and policies did not seem to affect teachers’ sense of control over content and pedagogy. The largest effect (but not a negative effect in the sense above) from policies was found on decisions about what content to teach in mathematics. In Lefstein’s study (2008) however (described above) focus on standards and test scores demoralized teachers and in some cases created a superficial compliance where teachers adhered to prescribed curriculum materials so that student failure could be blamed on the curriculum material.

Spillane (1999) studied how state policy in Michigan affected Local Education Agency policy where the ones formulating the local policy were district administrators and teachers. Influence on teachers was not studied but since they in this case are a part of the group of people formulating the local policy, this study gives some information of relevance here. It was found that local policy was made to align with state standards when it came to topics covered, but that less influence was found from state standards when more complex parts (i.e. those parts that could be seen as the reforming parts) of the message was considered. Factors important in explaining the results that local policy makers did not attend to the more complex parts of the state policy were: that state policy was not formulated in a way that gave the ones supposed to interpret it opportunities to learn about the complex parts of the reform message (as already mentioned
above), and that the state’s procedures for how compliance was to be reported directed focus away from the part of the message that called for a reformed instructional practice. As an example of the latter Spillane describes how educators of the Local Education Agency were frustrated with the fact that much resources had to be spent on keeping local policy up to date with rules surrounding the policies; i.e. matters not focused on the core ideas of policy. In Ponte and colleagues’ study (1994), described below, teachers were found to have negative feelings of how the reform was implemented.

2.2.1.7 Summary
The major conclusion to be drawn from the review of studies in Sections 2.2.1 with subsections has already been stated, and it also guided the arrangement of this section: influence from policy communicated through national curriculum (state standard or similarly) on it’s own or accompanied by for example assessments and accountability systems, is oftentimes limited (although exceptions have been found). Furthermore, when the message communicated with policy means entails a more profound change in beliefs about the subject, teaching, and/or learning, the influence found seldom encompasses the core meanings of these messages. A common response seems to be to embrace the policy superficially. Several suggestions as to why this is the case have been made and opportunities to learn seem to be an important factor mediating influence from policy. Besides many studies suggesting this directly, it is also possible to interpret a subset of the studies discussing features of the how the message is communicated to point in this direction; not only does opportunities to learn, in terms of for example professional development, affect the influence policy has, but also opportunities to learn, in terms of what aid the formulation of the policy itself gives teachers, are suggested to mediate influence from policy. These aspects highlight teachers’ interpretations to be important. Besides that features of the message seem important, it also seems as opportunities to learn can be understood in relation to what kind of support and resources schools have in place for teachers. Another aspect accounting for limited influence from policy is suggested with reference to that tradition (both student and teacher) is strong and therefore resistant to changes. Although some studies in this review have found negative effects from governance through policy it does not seem to be in relation to the goals communicated through policy. Instead, negative effects on teachers seem to be associated with the way policy is implemented and evaluated through for example accountability.
2.2.2 Assessments’ influence on teachers

Reviews of research on how large-scale assessments affect teachers and their practice concludes that it is difficult to draw clear-cut conclusions about the effects of large-scale assessments and the reasons for these effects (Mehrens, 1998; Cimbricz, 2002; Ferrini-Mundy and Floden, 2007). Hamilton’s (2003) review of large scale assessments’ and accountability systems’ effects on (among other things) teachers’ instructional practice, also acknowledges that clear-cut conclusions are difficult to make but also notes that there is evidence that multiple purposes with assessments can diminish the value of any single purpose of the tests and that besides properties of the test a lot of other factors influence what impact an assessment will have (e.g. teachers’ prior knowledge and belief systems, and capacity of various stakeholders to respond to the assessments in appropriate ways).

Although there have been and are concerns that governing of education through state standards (or national curricula) might have adversary effects such as for example a deskilling of the teaching profession (Wilson and Floden, 2001), it seems that the concerns of detrimental effects from externally imposed assessment are even greater; at least when one compares the literature reviewed below with the studies of Section 2.2.1 (with sub-sections). Because the studies of externally imposed assessments’ influence on teachers reviewed here to a large extent examines different detrimental effects of assessment, the review below is arranged around these types of effects.

2.2.2.1 Assessments’ influence on teachers’ choice of content and subject priorities

A number of studies have found that externally mandated assessments can have an impact on the teachers’ choice of subject content in their teaching. In a study by Smith, Edelsky, Draper, Rottenberg, and Cherland (1989) teachers at two schools were observed and interviewed. The researchers found that teachers used less time on subjects not represented in the external test, and with regard to the subjects included in the test, the teachers focused their teaching on the parts of the subject that they specifically believed where present in the test. This can be described as a narrowing of the curriculum, which also has similarities with test preparation, as will be seen below.

That tests can result in a narrowing of the curriculum is also one of the conclusions in the meta-synthesis of several studies on assessments’ effects by Au (2007), where mostly studies of the effects of assessments in social science on teachers in a high-stakes setting were analyzed. Shepard and Dougherty (1991) found teachers reporting a narrowing of the curriculum in a survey study of third, fifth, and sixth grade teachers in an American high-
stakes school district, and more recently Palmer (2011) found English language learners teachers in third and fifth grade describing this phenomenon. Also Brown (1992) got similar results as in the four studies above in his interview study set in an American context. Further studies that identify less attention or time allocated to non-tested subjects are the survey studies by Jones et al. (1999), Taylor et al. (2003), and Stecher, Barron, Chun, and Ross (2000). Further studies that identifies a narrowing of the curriculum, due to influence from tests, are Watanabe (2007) through case studies and interviews, Rex (2003) through discourse analysis of classroom interactions, Lipman (2002), Moon et al. (2003) through surveys, interviews, and observations of American teachers, and Perreault (2000). Abrams et al. (2003) found that teachers reported narrowing the curriculum to a larger extent in high stakes environments than elsewhere in their national survey of American teachers.

The findings that subjects not tested gets less time and attention and that the tests focus teachers’ instruction on the specific content in a test does not necessarily have to be a bad thing, it depends on what is desirable (Mehrens, 1998; Hamilton, 2003). Clarke et al. (2003), for example, reports on about half of the teachers studied finding it good to remove unneeded content and to get a renewed emphasis on what is important. However, as the influence of narrowing is described in the studies above, it oftentimes seems problematic in the specific situations that other subjects than the ones tested get less time and that the tests also narrow the curriculum within the subject.

The opposite of exclusion of content was found by McMillan et al. (1999). In their study teachers state that they have changed their instruction to cover a larger area of the subject, which in that case also meant less depth. Even though one could argue that this is not a narrowing of the curriculum, it is evident in the article that the broadening of content is problematic due to the consequences of less depth. The narrowing here is not a narrowing, meaning less content areas, but instead meaning less depth of more content.

### 2.2.2.2 Assessments’ influence on teachers’ choices to spend time on basic skill training and to use a teacher-centered pedagogy

In a study, by Romberg, Zarinnia, and Williams (1989), a different kind of influence from tests was found. Teachers stated that because of the state tests, they spent more time on basic skill instruction and less on more creative and collaborative work. This type of influence is also reported by Jones et al. (1999), Shepard and Dougherty (1991), Brown (1992) and Smith et al. (1989). Jones et al. (1999) do however not find this response widespread among the North Carolinan teachers surveyed in their study, and furthermore responses indicating the opposite also existed. Watanabe
(2007) came through sustained observations of two classrooms to somewhat similar conclusion as Romberg et al. (1989), and also found a displacement of teacher priorities. This meant that teachers’ priorities, of which many were in line with the state standards promoting collaboration and communication skills, were not acted upon due to the tests. Similar results as more time on basic skill and a displacement of teacher priorities were also found by Moon et al. (2003) in a survey study of American elementary teachers. Also Pourdavood et al. (2005) who identified a focus on memorizing and mimicry in order to prepare the students for the tests can be said to have results in line with the studies above. Au (2007) concludes from his meta-synthesis that high-stakes testing in many cases lead to the use of teacher-centered pedagogies in the sense that there is a focus on direct instruction where the teacher is in focus. This has also been found in case studies of elementary teachers by Passman (2001), and Rex (2003).

2.2.2.3 Assessments’ influence on teachers’ choice to spend time on test preparation

More direct forms of preparation for tests than omitting content not covered in the tests have been observed in a number of studies. These studies found an increase in time devoted to direct test-preparation, where one for example practices on the test format, on similar tasks as those in the test, or on test taking skills. There are several different problems with test preparation even though all test preparation is not bad. For example practice on the test format might improve scores but is probably not something that is stated that the students should know and that is relevant to the subject taught (Taylor et al., 2003; Schorr and Bulgar, 2003). As with other test taking skills, for example skills to outsmart the test, practice on test format might distort the tests function as a measure of knowledge (if the test has this function) (Schorr and Bulgar, 2003; Hamilton, 2003). Furthermore, doing exercises that resemble the tests’ items does not ensure great opportunities to learn what is tested; it is not certain that test items in the form of for example multiple-choice worksheets are suitable as opportunities to learn what they test (Smith et al., 1989).

In addition to this, one can note that time spent on test preparation is time taken from regular instruction. The study mentioned above by Abrams et al. (2003) also found (apart from teachers reporting a narrowing of the curriculum) that substantial amounts of time were allocated to test preparation, and also more so in high-stakes environments than elsewhere. That teachers allocated a significant amount of classroom time to test preparation was also found by Anagnostopoulos (2003) in her study of English teachers in two Chicago high schools. Teachers reporting different forms of test preparation in response to tests were also found in survey
studies of American teachers by Jones et al. (1999), Taylor et al. (2003), Herman et al. (1993), and Jones and Egley (2007). Further studies (already mentioned in sections before this one) finding evidence of the same phenomenon are those by Moon et al. (2003), Smith et al. (1989), Pourdavood (2005), Shepard and Dougherty (1991), Schorr and Bulgar (2003). Clarke et al. (2003) did not find (contrary to Abrams et al. 2003) an association between stakes attached with assessments and the practice of test preparation or a narrowing of the curriculum.

2.2.2.4 Assessments’ influence on teachers in relation to “educational triage” and forms of cheating

A teacher response to tests, which is not directly connected to what is to be taught and in what way, but still affects what happens in the classroom, is trying to manage the situation of testing by directing teaching resources in different ways than when no external testing was present. Anagnostopoulos (2003) identified several strategies to cope with increased pressure in getting students to succeed on tests, one of which were rationing resources where time were allocated to certain parts of the student population. Booher-Jennings (2005) who studied how the Texas Accountability Assessment System affected the teachers of prekindergarten through 5th grade, also found this kind of behavior of directing resources to different parts of a class, and she labels these practices “educational triage”. Resources were allocated to the ones on the threshold of passing the test and those that would affect the schools accountability rating. Another strategy among the teachers was to remove liabilities to the school’s rating by referring students with poor performance to special education (which was not taken into account when rating the school).

Another form of damage control is when teachers help their pupils in ways that could be considered cheating. Though it is not common that teachers cheat (in the sense that they give the students the answers on a test) as a response to external tests, teachers report that they sometimes help or guide students by for example answering questions regarding the test items or by rephrasing the questions in the test (Shepard and Dougherty, 1991; Amrein-Beardsley, 2010).

2.2.2.5 Assessments’ influence on teachers’ choice to align curricular material toward a more standards based approach

Some studies find a positive influence from tests either in teachers adopting a more standards based approach or aligning their teaching to the tests in an (by the test developers) intended way. In a study by Barnes, Clarke, and Stephens (2000) of Australian teachers conducted with interviews and
surveys, where they also studied curricular materials made by the teachers (e.g. planning, tests, and local assessment procedures), they found clear similarities between the reformed Australian state tests and the teachers' practice. Stecher et al. (1998) found that teachers of mathematics and writing reported their instruction to increasingly include standards based approaches in response to the tests, and that teachers reported beliefs that were closer to the standards-based approach as compared to a more traditional approach. Their study was set in Kentucky were the state assessment had been implemented as a part of a broader reform effort. Although there were evidence that the reform as a whole had influenced instruction, the assessment in particular was concluded to have had an influence. In a study of New Jersey teachers’ teaching nine year olds Firestone, Monfils and Schorr (2004) found that some teachers changed their practice toward a more standards based approach in response to the test, though far from every teacher did this. Not directly in response to a test, but rather to the public release of test scores, Vogler (2002), by surveying English 10th grade mathematics teachers, found a change in teachers’ practice towards more time spent on problem solving and creative thinking, and a decrease in time spent on lecturing and textbook based assignments.

2.2.2.6 Assessments’ influence on teachers’ feelings and beliefs about the assessments

Smith (1991) combines her previous results with studies of Haas, Haladyna, and Nolen (1989), and Nolen, Haladyna, and Haas (1989) and reports that together they indicate that teachers can experience negative feelings as a consequence of public release of test scores, that the tests are not perceived as a good representation of the teaching the teacher has executed, and that the tests can have a negative emotional impact on young students. Brown (1993) came to similar conclusions (negative feelings toward the test) from interviews with teachers.

Concerning beliefs about tests Barksdale-Ladd (2000) found, from interviewing teachers and parents, that these groups had a shared understanding of the tests. An understanding that there were great stakes attached to the tests, that the tests generated a lot of stress, and that they undermined meaningful instruction. In part similar results are also found in a survey study by Hoffman, Assaf, and Paris (2001), and in Murillo and Flores’ (2002) study. Consequences of negative feelings associated with the tests were found by Lipman (2002), where teachers in schools in Chicago who had performed badly felt more pressure to align their teaching to the test. This pressure resulted in test-preparation and a narrowing of the curriculum (as mentioned before). Similar results can be found in Passman’s
(2001) study. Stecher et al. (2000) found that most teachers believe increased test scores are due to test preparation.

2.2.2.7 Assessments’ influence on teachers found to be limited or non-existent

In contrast to the research outlined above, there are studies where no impact, or influences, from the tests were found. According to Grant (2000, 2001), based on interviews and classroom studies of two social science teachers, there were no indications of impact from state tests, neither in the choice of content nor in the teachers’ instructional practice. In the line of no impact Palm, Boesen & Lithner (2011) found a large discrepancy regarding the type of reasoning required in the Swedish national tests in mathematics and the reasoning required in teacher made test at the upper secondary level. Furthermore, Boesen (2006) found that Swedish teacher made tests did not reflect the Swedish national tests in mathematics in terms of the distribution of what mathematical competencies were tested. The study was based on an analysis of the national tests and a representative sample of Swedish upper secondary teachers’ tests, and also interviews with the teachers.

Firestone, Mayrowetz, and Fairman (1998), and Grant (2000, 2001) concludes that the current research indicates that large-scale tests can, under certain circumstances, influence the teachers’ choice of which areas of a subject to focus their teaching on, but that it does not necessarily influence the way that they teach. In Firestone and colleagues’ (1998) study teachers for example changed the order in which content was introduced, but although teachers also reported changes in practice it was found that a focus on describing procedures and then letting students practice them were still prevalent. Similar conclusions are drawn in Wall and Alderson’s (1993) study of language teaching in Sri Lanka. Qi (2007) concludes that tests alone do not bring about the constructors, and policymakers, intended changes in teacher practice but further measures and steps are needed to be taken in order to make a change. In an earlier study Qi (2005) states that this, to some extent, is due to conflicting purposes with the tests. The tests are both designed to induce change and for selection purposes and it seems that it is successful in directing attention to the content with teaching to the test as a result (i.e. the teacher focuses on the content tested), but less successful in promoting reforms in instructional practice.

A study by Cheng (1999) where language teachers in Hong Kong were interviewed and observed also points to no change in teacher’s instructional practice, their beliefs and own views of learning. In a report by McDonnell and Choisser (1997) concerning the impact from tests in Kentucky and North Carolina they conclude that some intended change has occurred (e.g. letting students work in small groups and including cross-disciplinary
assignments), but that it is not deep and profound (i.e. teaching does not reflect the importance attributed to conceptual understanding by the assessment).

2.2.2.8 Summary
The collection of studies focusing on influence from assessments reviewed above give a rather eclectic picture of the influence of assessments. At least when one compares it to the review of influence on teachers from policy documents (sometimes in combination with other means). When it comes to studies on the influence from assessments there seem to have been a greater focus on adversary effects, and also that adversary effects have been found in rather many studies. Whether this, that more findings of adversary effects from assessments as compared to national curricula (or similarly) exist, only is an effect of what focus different studies have had is however beyond this review to disentangle. The most common adversary effects found (or at least effects that are framed to be undesirable) seem to be a narrowing of the curriculum, test preparation, and that instruction time is devoted to basic skill training. Furthermore assessments have been found to give rise to negative feelings among teachers, which in turn in some instances have led to for example narrowing of the curriculum. Educational triage and cheating although found seems less common. That these negative influences from tests have been found should however not be taken as evidence for the idea that assessments are all bad, and it should be noted that there also is evidence that assessments does not produce these negative effects. For example, some studies, which highlight the aspect of assessments as policy tools, have found an intended influence from assessment; for example teachers have adopted a more standards based (in NCTM’s sense) teaching in response to assessments. It should however be said that these studies does not represent the bulk of studies reviewed above, and it should also be said that no intended influence (or a very limited intended influence) from assessments also have been found in some instances (similarly to what many studies on influence from state standards or similarly have found).

2.2.3 Factors important for what influence assessments will have on teachers
The tests' impact on the instructional practice depends on both the tests themselves and on other factors (Grant, 2000, 2001). Some but not all studies reviewed above provide suggestions or come to different conclusions on what factors might be important for what kind of impact a test will have. How this mix of factors does interplay is however an open question. Cimbricz (2002) in her review agrees with Grant, and also suggests that tests might not be the primary lever for change. Chapman and Snyder (2000)
makes a similar point; tests can work as a lever for change though the impact on teaching is more indirect than what has been believed, and that success is not assured. Also Spratt (2005) and Wall (2000) sees other factors as very important for determining influence. Examples given are teacher related factors such as teachers’ attitudes toward the test or their beliefs about for example the fairness of the test. Also school culture and resources in the form of textbooks are stated as factors influencing the effect tests can have (apart form the tests themselves). Below some of the findings and suggestions of what factors are important for policy to have an effect, given in the studies reviewed above, are arranged under different headings.

2.2.3.1 Features of the tests
If tests are to be used as levers for change one would perhaps think that properties of the tests should matter when it comes to what influence the tests can exert. In Mehrens (1998) review it is in relation to test format however concluded that: “Which format is used probably makes far less difference than how it is used” (p.24). Examining other features of tests Yeh (2005) suggests from an interview study that the test will, if it is well aligned with curricular priorities and also in line with teachers’ instructional goals, avoid the problem of an unintended narrowing of the curriculum. In this study the teachers for example stated that it was good that the test avoided recall items that would require drill and memorization. Mehrens (1998) makes a similar note in relation to performance based assessments when stating:

a reasonably summary is that if stakes are high enough and if content is deemed appropriate enough by teachers, there is likely to be a shift in the curriculum and instruction to the content sampled by the test /.../ If stakes are low, and/or if teachers believe the assessment is testing developmentally inappropriate materials and/or teaching to the assessment would reduce the amount of time the teachers wish to spend on other -- what they consider more important -- content, the impact is not so obvious.
(p.11)

Mehrens here also points to the importance of stakes. Some studies reviewed above indicate that impact is due to how serious the consequences of the results are (Brown, 1992, 1993; Smith et al., 1989; Wilson et al., 1991; Smith, 1991; Abrams et al., 2003), while it did not seem to be a factor in other studies (Schorr, and Bulgar, 2003; Grant, 2001). What also can be noted in connection to this mentioning of how serious consequences are is that although the formal stakes of the test can be high or low for different stakeholders (e.g. students, teachers or a school), the stakes as perceived by
teachers do not always coincide with the formal stakes, and the pressure to respond to the test does not always come from formal stakes (Zancanella, 1992; Firestone and Mayrowetz, 2000).

Abrams et al. (2003) found influence toward test preparation in their large national survey of teachers in various grades and subjects, and it seemed that teachers in high-stakes environments were more prone to this than those working in environments where the tests did not have very high-stakes attached to them. Clarke and colleagues’ (2003) interviews with teachers in various grades and subjects seem to indicate that while (as mentioned above) higher stakes did not seem to interact with types of changes made by teachers, the stakes certainly directed attention to the tests. Pourdavood et al. (2005) found that responses to assessments were triggered by stakes, but that stakes did not determine the type of response. Firestone et al. (1999) argues similarly to Clarke et al. (2003) and Pourdavood (2005) that formal sanctions related to the tests can direct attention to them but that this does not ensure a certain type of impact or the intended impact.

Wilson et al. (1991) suggested that positive impact from high-stakes tests are more likely to come about if the stakes even though they are high do not put too much pressure on the teachers. Firestone et al. (2004) suggest that pressure encouraged short-term test preparation. Lipman (2002) found that teachers in schools who had performed badly felt more pressure to align their teaching to the test resulting in test-preparation and a narrowing of the curriculum. McDonnell and Choisser (1997) found no difference in response to the tests even though different stakes were attached to them. Moon et al. (2003) identified that perception of poor test performance (in spite of limited consequences) seemed to lead teachers to engage in ineffective and inappropriate teaching. Herman and Golan (1993) got similar results but with a common response in test preparation with the teachers. Shohamy and colleagues (1996) in a study on two tests (Arabic second language and English as foreign language) found that stakes mattered and that low stakes did not evoke any response whereas high stakes had a great impact on for example time spent on test preparation. Also the purposes of the test, which could be connected to the stakes made a difference in the response. Shepard and Dougherty (1991) suggest that pressure to improve test scores is an important catalyst for evoking a reaction from the teachers (though the reaction might not be desired).

2.2.3.2 Teachers’ beliefs

As mentioned above, Cimbricz (2002) in her review of the relation between state-mandated testing and teachers’ beliefs and practices, concludes that tests might not be a primary lever for change of teachers’ beliefs or practices. She also concludes that the effect on teachers’ beliefs and practices from state mandated tests, at least in part depends on teachers’ prior beliefs and
practices by influencing the way teachers interpret the tests. One can here note the similarity to the conclusion in the summary above, about teachers’ interpretations being an important factor influencing how policy affects teachers (Section 2.2.1.7). On this note Sloan (2006) concludes from three case studies that the teacher’s identity is a crucial factor when it comes to what type of influence a test will have. If the tests’ influence, at least in part, is decided by the teachers’ identity, then Booher-Jennings (2005) conclusion that the tests also changes teachers’ identities complicates the picture and perhaps results in a co-dependent relationship, in line with the reading of Cimbricz (2002) above.

Zancanella (1992), in a case study of three teachers, got in part similar results as Sloan. He concludes, based on a case study, that teachers’ beliefs about both the subject and learning in relation to the picture of the subject and learning that is mediated through the test, and the teachers’ place in the decision making hierarchy of the school were important factors in determining if, and how, the tests influenced the teachers’ practice. If the tests’ goals were not in line with the teacher’s goals, the question of whether the teacher had enough power to argue that her type of teaching, despite not being aligned to the test, still was legitimate, came into focus. In Browns’ (1992) interviews it became apparent that some teachers did not want to change their practice because they believed it to already prepare the students for the test in the best way. Firestone, Monfils and Schorr (2004) identified teachers’ knowledge about the standards as an important factor for which response will come from the teachers (those knowing more of the standards were more willing to try a more standards based approach). Grant (2001) who note little influence from tests argues that other factors are more important for what teaching that teachers chose to engage their students in, and exemplifies this with how the teachers’ views of the subject matter and learners directly influence their teaching.

2.2.3.3 Teachers’ opportunities to learn

Regarding teachers’ opportunities to learn, some studies have suggested this as a factor explaining why influence from assessments has been limited. Firestone et al. (2004) concluded in their study of the influence of a mathematics assessment given to nine-year-olds in New Jersey that different types of support, for example by the principal or by availability of appropriate curriculum material had a positive effect on assessments’ influence, but also that “inquiry-oriented instruction seems improbable without access to learning opportunities [for the teachers]” (p.86). Similarly, McDonnell and Choisser (1997) suggest that tests lack the sufficient guidance for how teachers ought to change and that there is a need for a supporting infrastructure (with e.g. teacher training) if one wants to influence the teachers.
Another aspect of opportunities to learn is presented by Perreault (2000), who suggests principals’ opportunities to learn are important because they in turn are supposed to support teachers in times of reform. In Grant’s (2000) study the teachers themselves raised concerns about the opportunities given to learn about the changes implied by the assessments. Firestone et al. (1998) who compared performance-based assessments influence in two states where the assessments carried different stakes with them concludes that although high-stakes tests themselves might encourage teachers to reflect on how practice might be changed, the tests do not necessarily enhance the teachers’ opportunities to change practice. Also Wall and Alderson (1993) attribute lack of influence to insufficient teacher training (among other things).

2.2.3.4 Subject, grade, and age of teachers

Studies that have looked at the influence from state testing/mandated testing on teachers in different subjects and teaching different grade levels have found some differences in responses from teachers. Stecher, Barron, Chun, and Ross (2000) found that mathematics teachers got more influenced than writing teachers and elementary ones more than those teaching in higher grades. Also Clarke et al. (2003) found that elementary teachers were the ones who changed their practice the most. Grants’ (2000, 2001) studies also indicate that the subject and at what level the teacher taught were factors influencing the response to the testing.

2.2.3.5 Summary

Different factors seem to influence what types of responses teacher have to assessments. Quite a few studies have found a relation between the stakes attached with tests and negative influences from tests (e.g. narrowing of the curriculum). There are however also studies indicating that rather than eliciting a certain response, high stakes direct attention to the tests. Further complicating the picture are studies where no association between stakes and influence have been found, as well as those studies highlighting that there is a difference between perceived and actual stakes. Another factor mediating influence from tests, seem to be teachers’ beliefs and knowledge. Similarly to what many studies in Section 2.2.1 conclude (where focus were on influence from policy documents on teachers), teachers’ prior beliefs and knowledge seem to be one factor influencing what type of effects an assessment might have on teachers. When considering the review of influence from policy documents, this prior knowledge and prior beliefs-factor might explain why some studies only have found limited (or even no) influence from tests. Difficulties in influencing teachers through policy might have to do with policy communicating complex ideas, which might be
difficult to grasp depending on prior knowledge and beliefs. Perhaps can these difficulties be remediated by giving teachers’ opportunities to learn, which both studies on influence from policy and influence from assessments on teachers have suggested being an important factor. This suggestion, however also present in studies focused on influence from assessments on teachers, is far less prevalent when compared to studies focusing on other types of policy documents’ influence on teachers. Finally it has been suggested that mathematics teachers are more readily to change their practice than teachers of other subjects and furthermore that teachers at lower grade levels are more prone to change than those at higher grade levels.
3 Research questions

As mentioned in the introduction, the present study investigates the impact of goals (and the reasons for this impact) roughly similar to the NCTM process standards (NCTM, 2000) communicated through Swedish national curriculum documents and national mathematics tests of upper secondary school since 1994. The aim is to do this by investigating the relation between the intentions of the competence reform, and teachers’ beliefs about the goals communicated by the competence reform. In this section the aim of this study is operationalized in research questions, but before the research questions are presented, reasons for why they were chosen are given.

Cimbricz (2002), in her review of state-mandated testing as a lever for change states that:

Coupling interviews with observations appears to provide data not only on teachers’ understandings of what and how to teach, but also on how those understandings are operationalized and carried out. That said, the question of “why” teachers changed or did not change in lieu of state-mandated testing begs further exploration. For these reasons, I believe that studies that allow for the contextualization of teachers’ beliefs and practice hold considerable promise for future research. For if school reform via state-level testing is to prove constructive for education, research on how teachers understand and interpret new policy in the context of their knowledge, beliefs, experience, and teaching circumstances is vital. (Cimbricz, 2002, p.15)

The quote from Cimbricz (2002), although about ten years old, still seems appropriate when one considers the review of literature presented in Section 2.2, and for example Ferrini-Mundy and Floden’s (2007) review of policy documents’ influence on teachers, which suggest that policy implementation still is an understudied area. The studies reviewed in Section 2.2 (with subsections) show that when complex messages, such as for example the competence message, are introduced, influence on teachers most often is limited. A common influence on teachers seem to be that teachers appraise the reforms as positive, but that their adoption of the message often focus on superficial properties. Furthermore the review of studies in Section 2.2 suggests that the predominant focus of studies on influence on teachers from policies communicated through policy documents and assessments have been on the effect on change in instructional practices. Reasons for why a certain influence from policy is found are in these studies often suggested by directly or indirectly connecting to teachers’ knowledge and beliefs (e.g. by
explaining how teachers’ interpretations are affected by prior knowledge and experiences). This suggests that studies where focus directly is on the effects of policy on teachers’ beliefs are few, and that this is an understudied area in need of further research (although these types of studies do exist; see e.g. Senger, 1999).

The last section of the quote from Cimbricz above, together with the review of studies made in Section 2.2 with sub-sections, then can be seen as suggesting that the aim of the present study should be operationalized with reference to teachers’ beliefs, and also be able to account for the common response that teachers being positive about reforms still only seem to make superficial changes. A more specific guidance to the operationalization of the aim is given by Boesen and colleagues’ (2014) study (briefly described in Section 2.2.1.4). This study shows, on an aggregate level, that the Cognitive-Affective Model of Conceptual Change (CAMCC) (Gregoire, 2003) seems promising when it comes to its’ ability to explain why policy (as often found) only has a limited influence on teachers’ practice, although teachers seem positive to the changes implied by the policy message. That they did this on an aggregate level means that they connected general results from the analysis of interviews with general results from the analysis of observations. In other words, they did not connect individual teacher responses from the interview and the survey, to the same individual teachers’ observed teaching. The CAMCC is primarily concerned with teachers’ belief (or conceptual) change, and it gives an account of why teachers accommodate, assimilate or make no belief change in relation to a reform message. Therefore the research questions are formulated to allow for further investigation of the impact of the Swedish competence reform, here with a focus on teachers’ beliefs, and with an in-depth study of whether the CAMCC can explain why teachers change their beliefs in certain ways or not. Before the research questions are stated it should be made clear that the specific parts of the national curriculum documents that prescribe what mathematics students should learn hereafter are denoted the syllabus. The research questions in this thesis are:

**Research question 1:**
To what extent has the competence reform, as communicated through the syllabus and national tests, resulted in teachers accommodating the competence message, assimilating the competence message, or in teachers making no belief change in relation to the competence message?
Research question 2:
Why have teachers accommodated the competence message, assimilated the competence message, or made no belief change in relation to the competence message?

The concepts accommodation and assimilation (used in the CAMCC) capture an important difference in teachers' belief change. Two persons can believe in for example justice, but because their notions of justice might differ, this does not necessarily mean that the persons believe in the same thing. The concepts included in the CAMCC make it possible to capture the difference between teachers who, although seemingly positive to the competency goals, have not changed their beliefs about the goals of school mathematics in a way that is consistent with the core idea of the reform (the teacher has assimilated the message), and teachers who have changed in a way consistent with the core idea of the reform.

There are many different definitions of beliefs and no single definition of beliefs is universally agreed upon (Philipp, 2007). Gregoire, does not explicitly define beliefs, concepts or conceptions in the description of the CAMCC, a practice which admittedly seems to be rather common (McLeod and McLeod, 2002). Neither does she clearly make a distinction between beliefs and conceptions, which is in line with Thompson’s (1992) view that “the distinction [between beliefs and conceptions] may not be a terribly important one” (p.130). Therefore one can surmise that different definitions of beliefs, if similar enough to Gregoire’s own ideas, can function in relation to her model. A reason that different definitions of beliefs all can be appropriate in relation to the CAMCC, is that although definitions vary and that there are important differences between different definitions, “there is considerable congruence of definition among these three disciplines [philosophy, social psychology, and anthropology] in that beliefs are thought of as psychologically held understandings, premises, or propositions about the world that are felt to be true” (Richardson, 1996, p.103). Based on Green (1971), Richardson herself considers that the term belief “describes a proposition that is accepted as true by the individual holding the belief” (Richardson, 1996, p.103). This view of beliefs is adopted in this study and it is specifically teachers' beliefs about the goals of upper secondary school mathematics and how to teach so that students develop towards these goals that are of interest. Although Gregoire does not define what beliefs are, it is possible to interpret her ideas on belief change and conceptual change, as being about how profound a belief change is. She exemplifies how a teacher might respond to a reform message according to her model, and when in the last stage of her model a teacher accommodates the message she describes it like this: “Bryon [sic!] decides that the NCTM Standards are really on the right track (Yielding? Yes). He undergoes significant changes in his beliefs
about what it means to know and do mathematics well (Accommodation/True conceptual change).” (Gregoire, 2003, p.170). Assimilation on the other hand is by Gregoire conceived of as a superficial belief change where for example a teacher when confronted with the same message as Byron instead of adhering to the deeper meaning of the message, focuses on a superficial aspect such as the use of manipulatives (while still maintaining a very traditional view on the goals and teaching of mathematics). With the ideas of Green (1971) that beliefs are not solitary but instead arranged into systems of beliefs, Gregoire’s notions of accommodation and assimilation in the CAMCC are possible to interpret with beliefs as a frame of reference. Accommodation then is a restructuring of a belief system, whereas assimilation then is conceived of as a minor change to one’s beliefs that do not restructure one’s system of beliefs regarding the goals of mathematics and how one helps students reach these goals.

Although the present study is not experimental in nature, Research question 1 asks to what extent the competence reform, as communicated in the syllabus and national tests resulted in teachers making different types of changes. That it is believed to be possible to ask this relies on the fact that the syllabus and the national tests are the main (and perhaps only) sources that consistently have communicated the competence message to all teachers, and that the message can be considered to have been new to the teachers at the time it was introduced (as argued for in Section 2.1).

In the next chapter a more detailed description of the CAMCC is given, as well as what constructs of this model that are focused on in this study. Furthermore a research framework describing mathematical competencies constructed with the purpose of being suitable for analysis of data is also presented.
4 Theoretical frameworks

As the research questions of Chapter 3 show, this study focuses on policy’s effect (and the reasons for the effect) on teachers’ beliefs about the goals of upper secondary school mathematics. The Cognitive-Affective Model of Conceptual Change (CAMCC) claims to (Gregoire, 2003), and empirically has been shown promising in (Boesen et al. 2014), being able to account for why teachers change or do not change in response to a policy message (of the same type as the message the competence reform communicates). Furthermore the model includes an explanation of the, in previous studies often found, result that influence has been limited even though teachers are positive to the message. Therefore this model is chosen as frame for how the effects, and the reasons for these effects, are to be studied. Because a part of the change intended by the competence reform is a change of teachers’ beliefs about the goals of upper secondary school mathematics, it has to be possible to capture these changes. Therefore the Mathematical Competencies Research Framework (MCRF) (Lithner et al., 2010) is adopted as a further basis for data collection and analysis in this study. The Cognitive-Affective Model of Conceptual Change and what parts of the model that are in focus in this study are described in Section 4.1 and 4.2. Section 4.3 thereafter contains a description of the MCRF.

4.1 The Cognitive-Affective Model of Conceptual Change

Below, a description of the CAMCC follows, and after the model has been described, the aspects of the model focused on in this study, and the rationale for the focus on these aspects is presented. Throughout the presentation of the CAMCC, references to Figure 1 below depicting the model are made by italicizing words used in the description that are also found in Figure 1 below.

The model starts with presentation of reform message, which as mentioned above in Gregoire’s case is exemplified with a reform message in mathematics based on the NCTM standards. The message at hand is strong in the sense that: 1) it has been developed by educators and researchers over many years, 2) it has strong support from researchers, teacher organizations like NCTM, and from policy makers in many countries, 3) it is (as mentioned in the review of literature) difficult in that it requires a non-trivial transformation of teaching, and 4) “Implementing the standards is a difficult process for teachers (Brosnan, Edwards, and Erickson, 1996) because they suggest that the traditional way of mathematics instruction is detrimental to students’ understanding” (Gregoire, 2003, p.164).
Figure 1. Gregoire’s (2003) Cognitive-Affective Model of Conceptual Change.
That the message is strong is important to the next step of the model where the teacher’s response is in focus. If the message was not strong in the third sense described above, a profound change might not be necessary for the teacher.

In the next step of the model the question is whether the reform message puts the teacher’s self at stake (Implicates self?). If the message is not perceived as a threat to the teacher’s self or professional identity (which e.g. might be the case if the teacher already believes she is implementing the reform message), her response to the message is, according to Gregoire, likely going to be neutral or positive (denoted Benign-positive appraisal in the model). One can of course also conceive of teachers who will be opposed to the message and also does not see it as implicating a change to them because of this. These teachers would also take the right route. If however the teacher acknowledges that the reform message entails that something different from what the teacher is doing in her classroom is desirable, then the message can be considered to put the teacher’s self or professional identity at stake (if the teacher acknowledge that the message is strong in the third and the fourth sense described above). The model then posits that because of this the teacher will appraise the situation as stressful (Stress appraisal). That this is a first step on the path that eventually can lead to change is by Gregoire based on identity analytic theory (Schlenker, 1982), according to which attitude change can be motivated by threat to one’s identity. It is also influenced by the notion proposed by other models of conceptual change (see e.g. Posner et al., 1982, or Dole and Sinatra, 1998) that dissatisfaction with one’s existing ideas about for example teaching can promote change. Because the question of whether the message puts a teacher’s self a stake creates different routes in the model (depending on the response to the question) with different properties, each route from Implicates self? will be described in turn. First those who appraise the message as benign or positive are followed to the end state of the model, and then the two routes resulting from a stress appraisal are described.

Based on her review of dual-process models, and especially the heuristic-systematic model by Chaiken et al. (1980), Gregoire posits that those who appraise the message as benign or positive will lack motivation to process it systematically. The lack of motivation leads to a heuristic processing, in which “the individual relies on heuristics generated from previous experiences, affective responses, or other less effortful processing methods to make decisions” (Gregoire, 2003, p.159). The teacher will not engage with the message in a deep way (i.e. systematically process the message) and the results of this type of processing can only be assimilation or no belief change, where assimilation is used in Piaget’s (1977) sense where information is incorporated into existing cognitive schemas. Which of the two outcomes the teacher end up in is specified to be dependent on the
teacher’s prior beliefs. If the teacher initially was supportive of the message he or she will assimilate the message into his or her existing cognitive schema about teaching and goals for students of mathematics. If the teacher was indifferent or opposed to the message initially, he or she will make no belief change.

Now the description of the CAMCC returns to the teachers whose self or professional identity the message has put at stake, and who respond with stress appraisal. A teacher whose self or professional identity is put at stake by the reform message is posited to be stressed (stress appraisal), and psychological stress in Gregoire’s model is “a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being” (Lazarus and Folkman, 1984, p. 19). By noting that stress can lead to different things, such as appraising the stressful situation as challenging (Smith and Ellsworth, 1985) or threatening (Lazarus and Folkman, 1984), Gregoire draws on Lazarus and Folkman’s (1984) research on stress and coping and posits that the appraisal of the situation will depend on the resources the teacher has for coping with the stress productively.

Resources are in Gregoire’s model conceptualized as motivation and ability. An example of what constitutes the motivation part of the model is teacher’s efficacy beliefs, which by Tschannen-Moran, Woolfolk, and Hoy (1998) is defined as “the teacher’s belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context.” (p.233). Gregoire exemplifies this by a teacher believing that he or she can implement the reform message. Examples of what constitutes the ability part of the model are resources such as time, subject-matter knowledge, and supportive colleagues. A reason for Gregoire to interpret resources as motivation and ability comes from research showing that systematic processing depends on both motivation and ability (see e.g. the review by Eagly and Chaiken [1993], or Petty and Wegener’s [1999] review of the Elaboration Likelihood Model). If either motivation and ability is insufficient for coping with the stress created by the reform message in a productive way, it is postulated that the reform message will be appraised as a threat and the teacher will try to avoid the message (and what it entails) as represented in Figure 1 by avoidance intention. This is posited to lead to heuristic processing and at this point this route merges with the route taken by those who initially appraised the message as benign or positive (see above). If however there are sufficient amounts of both motivation and ability to productively cope with the stress experienced by the teacher, the reform message will be appraised as a challenge (rather than as a threat). Based on research that concludes that a feeling of challenge is associated with confidence and approach intentions (Smith and Ellsworth, 1985), Gregoire proposes that challenge appraisal leads the teacher to
approach the message (approach intention), which in turn is stated to lead to systematic processing.

Whether belief change occurs after systematic processing depends on a variety of factors, and in line with Posner et al. (1982) Gregoire (2003) suggests that for true conceptual change to be made, “...the message should be perceived as intelligible, plausible, and fruitful for promoting students’ learning to achieve the best chance of persuading teachers to follow it” (p.168). She also notes that these recommendations are similar to findings from research on argument quality (Eagly and Chaiken, 1993).

4.2 Constructs of the CAMCC that are focused on in this study

In this study it is examined whether the CAMCC can function as an explanation of why teachers change (or do not change) their beliefs about the goals of upper secondary mathematics education. Due to certain limitations, this study cannot utilize all aspects of the model when examining whether it can function explanatory, and therefore it is here presented what aspects of the model that are focused on in this study, and also why aspects of the CAMCC are included or omitted. The choices to either include or omit aspects of the model relate to limitations in the procedures for data collection or limitations in the analysis procedures, but all constructs of the model that include choices of paths in Figure 1 above are included. The inclusion and omission of constructs should not be thought of as a suggestion that certain parts should have been omitted or reconceptualized by the creator of the model. Furthermore, although the depiction of the constructs of the CAMCC focused on in this study as seen in Figure 2 below looks different than the CAMCC it should not be seen as a new model but rather as an interpretation productive for this study’s purpose and limitations. The central tenets of the model are still essentially the same, and parts not used in this study can still be thought of as existing in between the steps in Figure 2. The version of the CAMCC model illustrating the relation between constructs measured in this study is depicted in Figure 2 below.

Although presentation of a reform message is not included in Figure 2, there of course is a message of interest in this study. This message is (as argued for in Section 2.1) highly similar to the one Gregoire uses as an example of a reform message in her description of the CAMCC (i.e. the message communicated by the NCTM). There is also a question of whether this reform message puts a teacher’s self or professional identity at stake or not (Implicates self?). Following the order of the description of the CAMCC above, the first difference between the CAMCC and the depiction of the selected constructs this study focuses on is noted directly after the question
Figure 2. Depiction of what constructs of the CAMCC that are focused on in this study.

of whether the message puts the teacher’s self at stake. In response to this question, the model depicted in Figure 2 does not contain the benign-positive appraisal or stress appraisal. This is not to be interpreted as a suggestion to remove these constructs, but rather that good measures of these constructs were not possible to gather. However, insights gained from the notion of benign-positive appraisal are used in the analysis procedures (see Section 5.2.4) rendering answers to the question of whether the message puts the teachers’ self or professional identity at stake. Although these constructs (stress appraisal and benign-positive appraisal) are not measured in this study, they still may be thought of as happening in the intermediary steps leading to the next construct.

The right route of Figure 2 leads directly to the next difference between the original depiction of the CAMCC and the one displaying this study’s choice of which constructs to focus on. The constructs of systematic
processing and heuristic processing in the original model are in this study thought of as being about degrees of systematic processing on a continuum (from systematic to heuristic processing). That it is reasonable to make this interpretation is supported by the fact that other theories on conceptual change, where the component of processing is present, describe the processing aspect (precluding a possible conceptual change) as a continuum of engagement (see e.g. Petty & Cacioppo, 1986; Dole and Sinatra, 1998; Chaiken et al., 1989). Therefore it seems possible to reinterpret Gregoire’s model without losing features. The step after systematic processing is labeled **Belief change** (for reasons for the change of wording from ‘conceptual change’ to ‘belief change’, see Chapter 3.) and again this by the looks of it differs from the original depiction of the CAMCC. Here no interpretation is made, but rather the depiction in Figure 2 should be read as the last step of **Belief change** containing all three different outcomes explicitly depicted in the original model. Pictorially one loses the clear connection between the ideas that heuristic processing only can lead to assimilation or no belief change, and that systematic processing is the only way to accommodation, though the ideas still are implicitly present in the depiction.

Next we return to the left part of the model, i.e. the part leading from the answer yes to the question of if the message entails such a change for the teacher that the teacher’s self or professional identity becomes at stake. Here one can see further differences from Gregoire’s (2003) description of the CAMCC. This part of the model is about what it is that influences teachers to form an approach or avoidance intention to systematically process the message. Gregoire (2003) conceives this, as seen above, as depending on what she labels motivation and ability, which she exemplifies with efficacy beliefs (in relation to motivation), and with, among other things, actual time at hand (in relation to ability). Although factors such as actual time at hand will influence how successful a person is at processing a message (Petty and Wegener, 1999), it seems most appropriate to think about the ability factors’ influence on the choice to approach or avoid systematic processing as a person’s perception of their abilities. As an example of this it can be noted that Gregoire herself does not refer to some kind of actual ability factors (e.g. time at hand), when giving fictive concrete examples of how her model explains teachers’ responses to a message. Instead the fictive and concrete examples connect ability to a teachers’ perception of her abilities, as can be seen in the following quote: “Her efficacy expectations, or beliefs that she can implement these complex standards in her already disorganized classroom, are low (Motivation/efficacy—weak). Blair prefers to teach reading, so she has concerns about her competence teaching math (Ability—insufficient).” (Gregoire, 2003, p.170). Because of this it seems reasonable to conceive of this part (which in Gregoire’s terms consists of motivation and ability) of the CAMCC as being about factors that affect motivation. In this
study Wigfield and Eccles’ (2000) expectancy-value theory of achievement motivation is adopted to capture factors that might affect teachers’ motivation. Although Gregoire suggests efficacy beliefs and one’s own perception of one’s abilities to influence approach or avoidance intention there are of course other motivational factors that conceivably are important (Chaiken and Stangor, 1987). By putting the expectancy-value theory’s ideas in this part of the CAMCC one both expands on Gregoire’s own examples by including the value construct, but also (in the expectancy construct) captures Gregoire’s ideas about efficacy beliefs and perception of one’s ability as influencing teachers’ choice to approach or avoid a systematic processing of the message. Also an interaction term of value and expectancy are included.

After Expectancy and Value (and the interaction of the two), the next step in Figure 2 is Intention. Similarly to how systematic and heuristic processing is interpreted to be about degrees of processing, Gregoire’s notions of approach intention and avoidance intention is in Figure 2 thought to be about degrees of intention to approach (or if one would prefer: to avoid) a systematic processing of the message. Because Gregoire’s notions of systematic processing and heuristic processing is captured in the idea (introduced above) that these two concepts can be described on a continuum of processing, the left route does not split in two different directions as in the original depiction of the CAMCC. Figure 2 should be interpreted that degree of intention to approach or avoid the message is influenced by the motivational factors, expectancy and value (and possibly the interaction of the two), and that degree of processing depends on the degree of approach intention. Because of difficulties in measuring the constructs of challenge appraisal and threat appraisal, these are not included in this study. The last step in Figure 2, i.e. the one between systematic processing and belief change, has already been described above.

4.3 The Mathematical Competencies Research Framework

The Mathematical Competencies Research Framework (MCRF) by Lithner et al. (2010) is a framework describing one of two main aspects of knowledge in mathematics. In line with NCTM’s principles and standards (2000), and also the KOM framework (Niss, and Jensen, 2002) this framework complements a description of mathematical content with descriptions of mathematical competencies. As previously mentioned (Section 2.1), this type of description of mathematical knowledge was introduced in the form of goals in the Swedish national curriculum documents in 1994 (Swedish National Agency for Education, 2001b), and it is also present in the current curriculum documents. So, what students should know after completing a course was (and is) described in both content (e.g. linear equations) and competencies...
(or if one prefer: abilities, process goals, or similarly) such as reasoning and communication.

To describe what it is to know mathematics by considering competencies is done differently in different frameworks although with a great resemblance across frameworks (see e.g. KOM’s competencies [Niss, and Jensen, 2002], Adding It Up’s strands of mathematical proficiency [Kilpatrick et al., 2001], or the NCTM’s process standards [2000]). Apart from bearing resemblance between the competency goals, process goals, and strands of mathematical proficiency, the frameworks all carry the idea that a description of content needs to be complemented with a description of competencies when mathematical knowledge is to be described. The development of the MCRF might therefore at first glance seem unnecessary given that there are several frameworks describing mathematical competence and mathematical competencies in different (but in essence highly similar) ways. The frameworks apart from MCRF are however mainly supposed to communicate goals and means for educational development, which does not require strict definitions of competencies with a minimum of overlap between them. On the contrary, for example Adding It Up and KOM, emphasize the interconnectedness and overlap of the different competencies to make it clear that it is important to develop all of the strands or competencies. That the frameworks have these properties (i.e. not always strict definitions of competencies and an overlap between definitions of competencies) means that these frameworks are not ideally suited as tools for categorizing data. Therein lies the reason for the development of the MCRF. To make analysis of data less ambiguous, the MCRF was developed to have comparatively more strict definitions of competencies, and also less overlap between competencies. This does not mean that the MCRF in general is better than other frameworks, nor does it imply that others have not been precise enough when defining competencies of other frameworks. The MCRF is merely developed for a different purpose.

Nominally the competencies defined in the MCRF below, apart from the addition of procedural competency, coincide with the process standards of NCTM’s Principles and standards for school mathematics (2000). Sometimes also the actual definitions of the competencies in the MCRF in part coincides with the definitions used in NCTM’s Standards (see e.g. Problem solving), whereas it on other occasions use parts of formulations of different frameworks (e.g. Reasoning which is inspired by both NCTM, KOM, and Lithner’s (2008) framework on mathematical reasoning). MCRF’s definitions of Connection ability and Representation ability on the other hand are more original and even though they nominally bear resemblance to competencies of NCTM’s framework their definition in MCRF differs.

Apart from the definitions of competencies, the MCRF also includes what is called Competency-Related Activites (CRA) that further specify what skills
are included in each competency. This is needed because the definitions of competencies alone do not always indicate what skills that are involved. In this study, the classification of CRA is not considered and therefore only an example of what they are is given. For a full description see Lithner et al. (2010). The categories of CRA are inspired by (mainly the terms but not the specifications) the definition of mathematical competency in Niss (2003). The three CRA’s that are described for each competency are:

   I) Interpret. Taking in information in relation to the competencies, which in the case of reasoning can be to interpret ones own or others reasoning.

   II) Do and use. Using one’s knowledge in order to solve tasks, which again in the case of reasoning with one example could be to use informal and formal arguments to support choices and conclusions in task solutions. The distinction between ‘do’ and ‘use’ is that do concerns developing mathematical knowledge whereas use concerns applying that knowledge either within or outside mathematics. Two main versions of do and use are considered: imitate and construct (see Lithner, 2008).

   III) Judge. Meta-level considerations and concerns evaluating, reflecting, and forming opinions and conclusions on mathematics and on the activities related to learning, understanding, doing and using mathematics. For example it could be to evaluate ones own or another’s reasoning, but also more general things as reflections on qualities of valid reasoning.

   Next the definitions of competencies are presented. Similar presentations can be found in Bergqvist et al., (2010a), Bergqvist et al., (2010b), and Boesen et al. (2014). A full account of the definitions where also the specific CRA’s for each competency are included is found in Lithner et al. (2010). Before the definitions are presented it should however be noted that although the MCRF is created to be suited for use of categorization of empirical data, the definitions alone does not suffice as a procedural description of how for example classifications of observation data is to be done. How the MCRF can be utilized in procedures for categorizing data is described in both the description of how interview transcripts and field notes from observations were analyzed (see Sections 5.2.1.1-5.2.1.7 and Section 5.2.2.1).

4.3.1 Problem solving competency

Problem solving is defined as “engaging in a task for which the solution method is not known in advance” (NCTM, 2000, p. 51) and problem solving competency is the competency to handle problem solving. An implication of
this definition is that mathematical tasks are of two types: problems and non-problems, where the latter often is called routine tasks. Similar definitions of problem solving sometimes includes that the task has to be a challenge (Schoenfeld, 1985) or that it should require exploration (Niss and Jensen, 2002) but this is not the case in the MCRF.

4.3.2 Reasoning competency
Reasoning is defined as “the explicit act of justifying choices and conclusions by mathematical arguments” (Lithner et al. (2010), p.161) and the reasoning competency is the competency to handle reasoning. The definition of reasoning is in part based on NCTM’s (2000) definition of reasoning: “to develop and evaluate mathematical arguments and proofs” (p. 55), but also includes the idea from Niss and Jensen (2002) that reasoning can be seen as a juridical counterpart to problem solving and modeling by also focusing on explicitness. Furthermore, for an argument to be considered mathematically founded it should, in the terms of Lithner (2008), “motivate why the conclusions are true or plausible and are anchored in intrinsic properties of the mathematical components (objects, transformations, and concepts) involved in the reasoning” (Lithner et al. 2010, p.161). Reasoning does not in this definition have to be strict but may be strict, for example in line with Polya (1954). The relation between reasoning and proofs is in this definition that proofs are a sequence of reasoning where the mathematical arguments are logically strict.

4.3.3 Procedural competency
A mathematical procedure is defined as a sequence of mathematical actions that is an accepted way of solving a task. To apply a procedure is to carry out the sequence in order to solve the task and the procedural competency is the competency to handle mathematical procedures. The definition is inspired by ordinary dictionaries (e.g. the Cambridge Dictionary). In relation to the definition of a mathematical procedure above it can be noted that a mathematical procedure either is, or can be reformulated as, an algorithm in the meaning of Brousseau (1997): ”An algorithm is a finite sequence of executable instructions which allows one to find a definite result for a given class of problems” (p. 129).

4.3.4 Representation competency
Representations are defined as being “the concrete replacements (substitutes), mental or real, of abstract mathematical entities” (Lithner et al. 2010, p.163) and the representation competency is the competency to handle representations. Different kinds of abstract mathematical entities are what mathematics is built on, for example functions, numbers, tasks, geometrical
objects, concepts, methods, phenomena, and ideas, and their properties. When one does mathematics one has to think about the abstract entities and their relations, or about aspects of them. Oftentimes it is impossible or very difficult to think about entities in fully general or abstract terms. It is therefore necessary or advantageous to think about more concrete things (mental or real) that can function as a replacement of the abstract entity (and conversely an abstract representation, for example a sphere, can represent something concrete, for example a football). The representation can function in this way if it for the particular situation carries with it useful and relevant aspects of the entity. In Figure 3 below, the vertical arrows signify what counts as representations.

![Diagram](image)

*Figure 3. Relation between representations and connections.*

### 4.3.5 Connection competency

To connect is defined as “the process to use something that connects or makes a link between two things, for example a relationship in fact or a causal or logical relation or sequence” (Lithner et al. 2010, p.163) and the connection competency is the competency to connect between mathematical entities or representations of mathematical entities. In Lithner et al. (2010) p.163-164 the list below of definitions of five different types of connections can be found.
a) Between representations of different entities. Example: Between the number representing the interest rate in % and the number representing the amount of money to be paid.
b) Between different representations of the same entity. Example: Between the graph and a table representing a temperature as a function of time.
c) Between different parts of one representation. Example: Between x and y in a graph of a function (in a coordinate system with x- and y- axes).
d) Between different entities. Example: Between multiplication and addition, for example that multiplication can under certain conditions be seen as repeated addition.
e) Between different parts of one entity. Example: Between the edges and vertices of a cube.

In Figure 3 above, the horizontal lines signify what counts as connections.

4.3.6 Communication competency
To communicate is defined as “to engage in a process where information is exchanged between individuals through a common system of symbols, signs, or behavior” (Lithner et al. 2010, p.165) and the communication competency is the competency to communicate. The definition of communication includes that there is a sender and a receiver of the communication. Also a medium within which both sender and receiver can understand the communicated information is included in the definition. In the mathematics classroom it is usually the teacher, textbook author, or a student who is the sender, whereas the receiver most often is a student or the teacher. The medium is usually auditory (e.g. speaking, listening) or physical (e.g. writing, gestures).
5  Method

The present study uses data on upper secondary teachers and their teaching collected through observations, interviews, and surveys. The data is obtained from the SSI, and is used with their permission. All of the analyses particular to this study were made on anonymized data, meaning that neither individual teachers nor groups of teachers could be identified (i.e. it was not possible to know who the teachers were, and what schools or in which municipalities they worked at/in). For every teacher (N=124), raw data from the observations, interviews and surveys are analyzed in multiple steps to generate a data set with seven variables, corresponding to the selected constructs of the CAMCC. This generated data set (hereafter called CAMCC-data) is then examined statistically in order to answer the research questions. Details of how data was collected and analyzed are presented in this section. In Section 5.1 the collection of data is described. In Sections 5.2.4-5.2.8 the analysis generating the data set mentioned above is accounted for, followed by a description of how the generated data set then in turn was analyzed in order to answer the research questions (Section 5.2.9).

Before turning to the descriptions of the data collection and analysis, some further notes on how the collection of data and some of the analysis was made are given. The data used in this study was collected, and in parts analyzed by the Swedish Schools Inspectorate (SSI) during their quality review of mathematics teaching in upper secondary schools in 2009. A research group of six researchers and one research student (me) were hired by the SSI, to plan parts of the SSI’s data collection, and parts of the SSI’s analyses of data. SSI is therefore responsible for the ethical considerations in relation to the collection of data. The members of the research group were also hired by the SSI to assist in the collection and analysis of data, as were ten more researchers/research students in the field of mathematics education or education in general (these persons are hereafter referred to as analysts). The reason SSI hired more persons, than those of the research group, was that data collection and analysis was to be made within a narrow time frame and that estimates of the extent of work required was approximately one and a half years of full time work. To ensure that both the collection of data and the analysis of data would be done in a sufficiently similar way across all persons collecting and analyzing data (i.e. both those from within the research group and those outside the research group), the research group developed extensive, explicit and thorough instructions for how data were supposed to be collected and also of how the analyses of raw data were to be made. The majority of these instructions are accounted for
both in the sections describing the data collection and in the sections where the different analyses are described. Besides having access to extensive instructions, the assistants were also given a one-day training on the instruments of data collection and the analysis procedures by two persons from the research group. Furthermore one person from the research group were designated to be a contact person for all the assistants, and the assistants were encouraged to contact this person if they had questions regarding either the collection of data or the analysis of data. It should already here be noted that the analyses made by members of the research group and assistants is only a first step in the processing of data in this dissertation, and that subsequent steps are made solely by me. It can also be reminded again that the data collection, and what is described as the first steps in the processing of data was conducted by persons hired by the SSI, and that the subsequent analysis was made by me on data obtained from the SSI. The descriptions of the analysis procedures include information on who made the analysis described.

5.1 Data collection
This section accounts for aspects pertaining to the collection of data during the SSI’s quality review of mathematics teaching in upper secondary school. First an account of how the sample was selected is given and thereafter the instruments of data collection are described in the order in which they were utilized. Observations were made first because the lesson observed should be: 1) possible to discuss during the interview, and 2) unaffected by what was discussed during the interview (due to the topics of the interview it was surmised that the teachers’ choices of what to do during the lesson could have been affected). The survey was administered to the teachers after the interviews because information given during the interview was needed when doing the survey. The following was underlying the construction of instruments for data collection:

- The MCRF (Lithner et al. 2010). See Section 4.3 for details on this framework.
- The research questions of the article Developing mathematical competence: from the intended to the enacted curriculum (Boesen et al., 2014) (which in turn were specifications of the general aims of the quality review during which data was collected, described in Bergqvist et al. (2010b)): 
“What impact has the competence reform had on the mathematics teaching practice in Swedish classrooms?” (Boesen et al., 2014, p.76)

“How can the impact of the competence reform be explained?” (Boesen et al., 2014, p.76)

Descriptions of how data was collected similar to those found in Sections 5.1.1-5.1.4 can be found in Bergqvist et al. (2010a; 2010b) and Boesen et al. (2014).

5.1.1 Sample selection

Which schools to visit for data collection were determined with stratified sampling, which in this case meant that schools were chosen randomly from subsets of all Swedish upper secondary schools. The choice of subsets ensured that the sample would be representative of schools from all of Sweden, of rural and urban schools, of high- and low-performing schools, of small and large schools, and of independent and public schools. The sample consists of 145 teachers at 53 schools. The Swedish Schools Inspectorate carried out the sampling of schools, but the principals of the schools chose which teachers that were to be visited. The principals were instructed not to choose teachers based on performance but if possible to choose teachers with experience of the national tests. The choices of teachers made by the principals were also limited by which teachers’ schedules that fitted with the schedules for the visits given by the Swedish Schools Inspectorate. Of the 145 teachers in the sample, data on 124 teachers is used in this study. This is due to: data being of poor quality in 12 cases, one interview having to be aborted due to illness, and 8 of the remaining teachers not having completed the survey.

5.1.2 Observations

For every teacher that was visited by the SSI, one lesson was observed. The teacher who was to be visited was asked not to make any special preparations, but if possible he or she was to avoid scheduling assessments on the lesson visited. The intention with observing a lesson was to find out what opportunities to develop the competencies of the MCRF (Lithner et al., 2010) the students were given during an ordinary lesson.

To guide the collection of data made by each observer, an observation protocol was used. Guidelines in this protocol included taking notes about the teacher’s actions, statements, and the students’ responses. This was to be done when the teacher lectured or interacted with the students in whole class or in a large group, for example by leading the solving of a task in whole class. When writing down what happened during these activities, the observer was to often note how much time had passed. Also when field notes
could not be taken, for example when the students tried to solve tasks by themselves, notes on how much time had passed during these activities where supposed to be recorded. This was done to make it possible to assess the extent of opportunities the students had to develop the competencies (see Section 5.2.2). Because it was deemed to be too disruptive if the observer would stand beside a teacher and student interacting and taking notes of their interaction, activities where the teacher interacted one on one with the students were not recorded. The visit by the SSI was of course not supposed to affect the students’ opportunities to learn negatively. In general the observer was not supposed to take part in the interaction between the students and the teacher. However if students were working on their own or together in small groups and no field notes could be made, the observer could of course walk around and answer questions from the students about the visit from the SSI or ask questions of what the students were doing.

Photographs of the blackboard and of students’ notebooks were to be taken (but not of persons), and copies of teacher handouts, teacher-made tests, and copies of lesson activities were also collected. The observer was to make clear that no persons would be photographed, so that the camera would not intimidate the teacher or students. At the start of the lesson the observer informed the teacher and the students of why he or she was there and what he or she would do in the classroom during the lesson. At that point the students were given a sheet on which they were asked to record which tasks they worked with during the lesson (e.g. in their textbooks, on a worksheet, or something similar). Each observer made sure that the students were informed that the collection of what tasks they had worked on were anonymous and would not be used to assess their efforts during the lesson. That the SSI was not there to measure the students’ performance was also made clear by the observer when he or she introduced him or herself at the start of the observed lesson. The observer was in addition to the above, also supposed to ask some of the students during the end of the lesson if they thought it had been a normal lesson or if it had been different in any way. This was done as a sort of control of whether the observer had witnessed an ordinary lesson or if it possibly was so that the teacher had decided to make something very different during the visit of the SSI. Only in very few cases did students indicate that the lesson was not an ordinary lesson.

5.1.3 Interviews
After a lesson had been observed, the teacher was interviewed, by the same person from the SSI that had observed the lesson. The interview was audio-recorded, and was highly structured. The questions to ask and in which order they were to be asked, and all information to give to the teachers was written
in an interview guide (see Appendix A)\textsuperscript{4} that each interviewer followed. The main reason for having the interview highly structured was that a large number of interviewers were involved in the collection of data, that there were very many teachers to interview, and that there was a need to transform qualitative interview data to quantitative data in a systematic way (which would not have been possible in more open interviews). Further reasons for having the interview very structured with all questions to be asked and information to be given written down in an interview guide were that there were very many different things that we wanted to know and that it was very important that certain parts of the interview came in a certain order (which will be seen below). Lastly the highly structured nature of the interview also meant that teachers got approximately the same opportunities to make themselves understood.

As mentioned, information that each teacher was supposed to get (besides the questions asked to them), was explicitly stated in the interview guide, and the interviewer was supposed to read this word for word, so that all teachers got as close to the same information as possible during the interviews. This was for example done in the introduction of the interview, where the teacher was reminded of the purpose of the interview and that they did not have to answer questions if they did not want to, and also in the presentation of the idea of describing mathematical knowledge in terms of competencies as a complement to a description focused on content. Also, because the interviews were long both in time (approximately 1.5h) and in that there were many questions (44 questions with 50 follow up questions that were asked if needed) to be answered the interviewers had been explicitly instructed not to deviate from the interview guide. This meant both that they should refrain from asking things not related to the interview guide, and also that they should try to minimize possible deviations made by the teachers during the interview (of course without being rude). As a prevention of anticipated deviations the interviewees were informed of the interview being structured and rather long, so that they would understand that it was important to focus on answering the questions. This information was also given to inform the teachers that the interviewers’ desire to return to the questions of the interview guide was not out of disinterest of the teachers’ own concerns, but rather connected to their assignment of conducting the interview. The interviews were conducted at the school at a location of the interviewees choosing. Specific questions used in the analyses made in this study are presented when the analysis procedures that include these questions are presented (in Sections 5.2.4-5.2.8).

\textsuperscript{4} The interview guide in Appendix A is in the original language Swedish.
The interview consisted of three parts (described below) in which the notion of competencies increasingly came into focus. How the competencies increasingly came into focus is explained in detail in section (5.1.3.1-5.1.3.3). The first part revolved around questions about the teacher’s goals for the students, the teacher’s teaching, and what affected the teacher’s goals and teaching. The second part dealt with the teacher’s interpretations of excerpts of the syllabus and interpretations of tasks from the national tests, which were presented to them by the interviewer. Also if the teacher thought it was difficult to interpret these documents, and if they believed their interpretations had changed over time were dealt with in this part of the interview. In the third part of the interview, the interviewer started by presenting the notion of and idea with competency goals. Thereafter the teacher’s experiences with and thoughts about this type of goals were discussed during the rest of the interview. The idea with this three part structure, was that the interviewer in the beginning did not lead the teacher to talk about competency goals, was that it made it possible to get an indication of whether the teacher had knowledge of these types of goals and also if the teacher valued this type of goals. Furthermore, it made it possible to get an indication of if the teachers themselves already had identified the competence message in the syllabus or in the national tests. If it had been established from the start that the interviewer was interested in the teacher’s knowledge of the competency goals and how the teacher valued, and prioritized these, the answers given by the teacher would most likely have been very different, and also their interpretations of the syllabus and the national tests would most likely have been influenced by this.

5.1.3.1 The first part of the interview
As shortly mentioned above, in the first part of the interview questions revolved around what goals the teacher had for the students, how the teacher worked to help the students reach these goals, and what affected the teacher’s goals for the students. Furthermore questions were asked about how the teacher valued the syllabus and national tests and how these documents affected the teacher. In this part the interviewer did not raise questions relating to competency goals. However, if the teacher, when describing what the goals for the students were (or talking about this in relation to any other question), used words that could be considered to relate to the six competencies of the MCRF, the interviewer was to ask what the teacher meant with these words. If teachers for example stated that they wanted the students to learn how to discuss and understand mathematics the interviewer were supposed to ask what the teachers meant by these words (in this case discuss and understand). This is the first step that can be considered as directing the focus to competencies during the interview. The interviewer was not supposed to say what she thought the teacher meant,
just ask the follow up question. This was done because information of the teachers’ unmediated view on these goals was sought after.

5.1.3.2 The second part of the interview
In part two of the interview, the teachers were asked: 1) to determine what they thought students needed to know in order to successfully solve specific tasks from the national tests, and 2) to interpret excerpts from the syllabus. The tasks and excerpts were all from the first mathematics course of upper secondary school’s national tests and syllabus. The reason for choosing the particular tasks and excerpts to present in the interview was that these tasks and excerpts had been deemed (by the research group) to most clearly communicate the competency goals. Before the tasks were presented the teacher was informed what the interviewer was going to ask (i.e. “What do you think the students need to know in order to solve the task successfully?), but also that tasks can be interpreted in many ways and that it was not a question of right and wrong, but rather the questions were asked because of an interest in how teacher viewed these tasks. After the teacher had studied the task the question was restated. Below an example of task shown to the teachers is given.

![Diagram of a car purchase problem]

English translation (made by the author): Martin and Johanna are going to buy a new car. Johanna likes a car that costs 194 000 kr. Martin claims that the value of this type of car drops by approximately 17% every year. They are thinking about how much the car would be worth in three years and both calculate this in their own way. Martin’s calculation. Johanna’s calculation. Who has interpreted the problem correctly? How might Martin and Johanna have reasoned?
Regarding the excerpts from the syllabus, the teacher got similar information as was given before the tasks were presented, before the excerpts were presented (i.e. what they were going to be asked, and that it was not a question of a right or wrong interpretation, but that it was interesting how teachers interpreted the excerpts). They then got to read the excerpts and were afterwards again asked how they interpreted each excerpt. After they had stated their interpretation of the excerpt they were asked to interpret specific words in the excerpts. The following is an example of an excerpt. It is taken from a part of the curriculum documents under the heading *Goals to aim for*.

The school in its teaching of mathematics should aim to ensure that pupils: /.../ develop their ability to follow and reason mathematically, as well as present their thoughts orally and in writing. (Swedish National Agency for Education, 2001b, p.60)

To this excerpt, besides giving an interpretation of the whole excerpt, the teacher was asked to also explain how they interpreted the word *reasoning*. The choice of the specific words in each excerpt that teachers were asked to interpret was based on the premise that one of the purposes of the interview was to elicit information of the teachers’ knowledge of competency goals. The interviewer did not bring up the idea of competency goals in part two of the interview. However, that excerpts and tasks were chosen because they communicated the competency goals is a second step in directing focus to the competencies during the interview. Also that the follow up questions, to the excerpts from the syllabus, directed the teachers’ attention to the competency goals, can be seen as a part of this second step. After the second part of the interview the teacher was asked if he or she wanted a break.

5.1.3.3 The third part of the interview

The third part started with the interviewer introducing the idea of complementing descriptions of mathematical knowledge in terms of for example geometry, algebra and so on, with descriptions of competencies in the wordings of the MCRF. This introduction was made by first stating a definition of the competency at hand and then exemplifying what was meant with reference to the tasks from the national tests and the excerpts from the syllabus that the teachers had been presented with in part two. The teacher got everything in writing and was instructed to take the time to (apart from hearing it) read it through and ask question where things were not clear. All this was done to create a shared understanding of the idea of competencies so to avoid that interviewer and interviewee talked about different things in the third part of the interview (Speer, 2005). This is the third step in directing focus to the competency goals during the interview. After a shared
understanding had been established the teacher was asked about how he or she valued these goals, if it is difficult to teach them, if they had changed their view on them, whether they have seen them before and tried to interpret them and what relation they see between these types of goals and their own goals and teaching. Because of the nature of the interview and because there most often were more than one teacher interviewed at each school, the interviewed teacher were asked not to discuss the interview with his or her colleagues before all teachers at the school had been interviewed.

5.1.4 Surveys
Each teacher that was observed and interviewed was sent a link to a web-survey by the SSI and was asked to take the survey as soon as possible after the visits by the SSI. The survey consisted of 85 questions, asking about the teachers’ perceptions, opinions, and interpretations of different matters, which meant that there were no right or wrong answers. Generally the questions of the survey were formulated “To what extent...” and had answer options from 1 to 6 (where 1 meant to a very small extent and 6 meant to a very large extent) although some exceptions existed (e.g. questions to be answered with one of the options yes or no). After every tenth question the teacher had the opportunity to make comments if they needed.

Clusters of questions had been constructed with either the intention of getting demographic information on the teachers or the intention of measuring constructs of the CAMCC. The majority of the clusters of questions were concerned with factors that theoretically could affect a teacher’s motivation to process and implement the competence message, but there were also clusters of questions directed at measuring teachers’ affective states, their epistemological orientation (which also can be connected to motivation), and also their own estimates of how motivated they had been to interpret and analyze the syllabus and national tests. Because it seemed reasonable to measure different factors relating to motivation besides those exemplified in the description of the CAMCC (see Section 4.2 for reasons for this widening of the motivation construct), the motivational factors measured in the survey were deduced from self-determination theory (Ryan and Deci, 2000), and expectancy-value theory of achievement motivation (Wigfield and Eccles, 2000). The clusters of questions relating to motivational factors were: the teacher’s interest in mathematics, self-efficacy belief about the implementation of the competence message, the teacher’s perception of the usefulness of the syllabus and the national tests, received support in the form of commentary material or professional development, collegial support, and reasons for interpreting and analyzing the syllabus and national tests.
The survey is found in Appendix B, and the specific questions and clusters of questions used in the analyses in this study are found in Sections 5.2.4-5.2.8. Two reminders were sent out to the teachers who had not completed the survey, and as with the interviews, the teachers were informed that their answers would be confidential.

5.2 Methods of analysis

In this chapter the analyses made in multiple steps on raw data collected through observations, interviews, and surveys are presented. The chapter can be thought of as divided in three parts: Sections 5.2.1-5.2.2, Sections 5.2.3-5.2.8, and Section 5.2.9. In the first part an account is given of: how interviews were transcribed by the SSI, one way that interview transcripts were analyzed by the SSI, and how observations were analyzed by the SSI. In the second part the analysis procedures generating the CAMCC-data (N=124) with seven variables corresponding to the constructs of the CAMCC focused on in this study are presented. The analyses (particular to this study) performed to generate the CAMCC-data are made on raw forms of data obtained from the SSI, and on information obtained from some of the analyses made by the SSI. This means that there in these sections are descriptions of analysis made solely by me, but also of analysis made by the SSI. In the third part an account is made of the analysis procedures used when investigating the CAMCC-data in order to answer the research questions. The first part could conceivably have been subsumed into the second part of this chapter to make for one long section describing how data was analyzed. However, because the second part is fairly complex it makes for an easier read when the sections of the first part are described separately. Furthermore one also more immediately gets a sense of how raw data was initially processed.

5.2.1 Transcription of interviews

Each interview was in part transcribed following certain instructions on how to do this. The person making the interview was the one doing the transcription of the interview. Due to the large amount of data (approximately 1.5h long interviews) combined with time constraints compromises had to be made regarding how the audio recordings of the interviews were to be transcribed. Instructions were given to each interviewer on when to transcribe the recording of the interview word for word, when to summarize teachers’ answers to questions, and when to omit teachers’ answers from the transcription. Citation, or word for word transcription was made when the teachers touched upon or talked about

5 The survey in Appendix B is in the original language Swedish.
competencies in one way or another when answering a question. The interviewer was to be rather inclusive when making this first judgment of whether the teacher talked about competencies or not. The reason for choosing to transcribe these parts had to do with the aim to find out what knowledge the teachers had about the competency goals and it will in the next section be clearer on how these word for word citations helped get an indication of the teachers’ knowledge of the competency goals. The other instance where word for word transcription was used was if it was easier to do this than to summarize the teacher’s answer (for example if the teacher had made a very short answer to a question). Pauses, hesitations, and similar things were not transcribed. In some cases however, for example when the teacher clearly were ironic or pointed at specific things in for example documents in front of him, notes of this were made in addition to the transcription (so that the meaning of the transcribed teacher answer would come through). If the teacher did not talk about competencies in any way, the person transcribing the interview were instructed to summarize the teacher’s answer to the question, with the core of the question in mind. When a teacher’s answer did not directly relate to either competencies or the question asked, this was neither transcribed nor summarized. A short note on what was omitted was however to be made. An example of this is when a teacher for example reads out loud the material we had provided them with or when a teacher when asked what his or her goals for the students are instead talks about how he or she feels that there is a lack of support from the principal in arranging collegial discussions. Because the follow up questions sometimes were asked depending on what the teacher had answered previously, the one transcribing the interview was also to write down when and what follow up questions they asked.

5.2.1.1 Competency indications

Competency indications were one of the means used to evaluate the teachers’ knowledge about the competency goals during the SSI (see Section 5.2.8.1 for details on how teachers’ knowledge of the competency goals were measured), which (as will be seen in Section 5.2.8) in this study is a component of the question of if teachers have made a belief change. This section describes what the competency indications are, how they are identified, classified, and what comments were to be made in relation to the classification.

A competency indication is a statement where it is possible that a teacher is referring to a competency or competencies (in the meaning of the MCRF [Lithner et al. 2010] or similar frameworks). Different ways of identifying competency indications were exemplified to the analysts as an aid in the identification of competency indications. The identification of a competency
indication starts with a study of the transcript of the interview. First a teacher’s answers are analyzed in order to see if some of the teachers’ statements can be thought of as relating to one or several of the competencies of the MCRF. Naturally, the ones making this analysis had to be familiar with the competencies of the MCRF. All persons involved in this analysis had, apart from the training mentioned in Section 5.1, access to an early draft of the paper *Mathematical Competencies: a Research Framework* (Lithner et al. 2010).

The different ways in which the competency indications could be identified were through direct connections to the competencies, general connections, and indirect connections. Direct connections were for example that the teacher used the same words as in the MCRF or direct synonyms of these words. Because the choice of wordings of the MCRF is one of many possible ways to describe the ideas inherent in similar frameworks, the one identifying the competency indications had to be observant of other words that could have similar meanings. Examples of possible synonyms to the competencies of the MCRF were given in the instructions to the analysts. Statements using the words argumentation, explanation, and motivation could for example possibly refer to what in MCRF is called reasoning. The examples were not supposed to be the only words the analyst were to consider as synonyms of the competencies of the MCRF, but rather they were given as reminders of that words could have the same or similar meaning despite being somewhat different. To identify competency indications in this way means that there will be statements that actually do not refer to competencies (in the sense of the MCRF), and also that the analyst might be aware of this. This is remediated by the classifications of the competency indications, which is intended to make it possible to evaluate if the competency indication is a sign of knowledge of the competencies. General connections to competencies could for example be that the teacher talks about general mathematical abilities as for example to think mathematically. Examples of indirect connections that were given to the analysts were that the teacher talks about activities involving the competencies in one way or another. For example the teacher might express that “the students are to discuss their solutions” which would be seen as an indication of that the teacher is talking about the communication competency. After a competency indication had been identified, the analysis proceeded with classification of this competency indication on six different categories: activity/goal, local/global, vague/clear, triggered/spontaneous, refusal, and value. Besides these categories the analysts were also instructed to make comments when they considered the procedure described here to fail in capturing important aspects of the teachers’ statements.
5.2.1.2 Activity – Goal

Is the teacher’s statement a statement about an activity (i.e. something the students should do) or a goal (i.e. a competency the students are supposed to develop)? Because a central idea with competency goals is that students need to develop them in corresponding activities, an important aspect of teachers’ knowledge of competency goals is whether they see the competency goals both in terms of goals and activities. To support the analyst examples of teacher statements that were supposed to be classified as activity, goal, or activity and goal were available. The statement “students usually gets to discuss the tasks before they solve them” was supposed to be categorized as activity. It is clear that the activity includes communicating, but it is not explicit that the teacher also sees the development of communication competency as a goal for the students learning. The statement “I think it is important that the students develop their ability to talk mathematics” on the other hand is an example of a competency indication supposed to be categorized as goal. Here it is clear that the communication competency is a goal set by the teacher, but it is not evident from the statement that the teacher also considers this to be a worthwhile activity. An example of a statement that should be classified as both activity and goal was “in order for the students to develop their ability to talk mathematics I let them talk about their tasks before they solve them”. If the analyst could not classify the statement into any of these three categories, this was to be noted.

5.2.1.3 Local – Global

One property of mathematical competencies is that they can be thought of in general terms without reference to a specific content, but also in relation to specific mathematical content. An understanding that mathematical competencies have this property is seen as one indication of that the teacher has a good grasp of the notion of competencies. To evaluate this, competency indications were classified into the categories local, global, or local and global. Statements of the type “to be able to talk about it” or “to be able to explain to each other” both relate to the communication competency but without connecting it to a certain mathematical content, and therefore these statements should be classified as global (i.e. they are independent of mathematical content). An example of a statement that should be classified as local was “they should have \( \frac{1}{2} + 0.2 \), and then they were supposed to get it from fraction to... be able to see from fraction to decimal form. And that is to connect and... arrive at seven tenths”. It is classified as local because the connection competency here is applied to a specific content. Competency indications were categorized as local and global if the teacher for example started with a statement that would be classified as global and then exemplified it with relation to specific content, or in the opposite direction if
the teacher first gave a local example and then made clear that the example only was a special case of the general phenomenon of for example reasoning. Besides these two examples, teacher statements where several local examples of one competency were given could also at the analysts’ discretion be interpreted as belonging to the category of local and global.

5.2.1.4 Vague – Clear
The idea with the categorization of competency indications into the categories vague, and clear is straightforward in that clear competency indications are taken as a stronger sign of the teacher being knowledgeable of the competencies than vague competency indications. Because the analysts themselves were familiar and knowledgeable of the competencies, only examples of what were considered vague statements were given. Below the list of examples given to aid the analysts is reproduced:

- The teacher self explicitly judge his or her own statements to be vague or expresses that he or she does not really know what they are talking about. For example “I do not know this too well” or “I have a hard time explaining what I mean”.
- The teacher expresses him- or herself contradictory, for example by giving two different meanings to one competency or by on an abstract level underscore the importance of the competency goals but in the concrete always focus on content goals.
- The teacher expresses him- or herself abstractly without making any specifications or concretizations. For example a teacher might repeatedly stress the importance of problem solving without ever explaining what he or she means by it.
- The teacher expresses him- or herself mainly via isolated examples or local instances without tying them together in more general terms. Included in this are statements were a teacher only mentions the concept of for example connections without explaining what they mean by it.
- The teacher has a hard time relating the single statements concerning competencies to each other and to other statements.
- The interviewer has a hard time understanding what the teacher means.

5.2.1.5 Triggered – Spontaneous
Throughout the interview there are questions in which the teachers are asked to relate to the competencies. All parts of the interview contain these questions although most evidently so in the third part of the interview. Furthermore follow up questions and comments from the interviewer might
have spurred the teacher to relate to the competencies. Because of this the competency indications were supposed to be categorized according to whether they were triggered or spontaneous (i.e. if the teachers’ statements about competencies were due to input from the interviewer or not). If a teacher spontaneously talks a lot about the competencies (for example in part 1 of the interview where the teacher’s spontaneous goals are treated) this is a sign of the teacher being knowledgeable of the competencies, whereas if the teacher only reacts to the interviewers questions directed at the competencies, this is seen as lesser indication of the teacher being knowledgeable of the competencies.

5.2.1.6 Avoidance
This categorization was made if the teacher did not relate to the competencies or a competency after the interviewer directly had asked him or her to do this. An example might be a teacher who cannot give a concrete example of a statement he or she had given despite requests from the interviewer. The teacher consciously or unconsciously avoids a question that requires knowledge of the competencies, for example by talking about something else instead.

5.2.1.7 Value
Each competency indication was to be categorized into the categories positive, neutral, or negative. Positive statements were those were the teacher explicitly said for example that developing a certain competency is important. Neutral statements were of the type “students should develop their ability to reason” and an example of a negative statement was “Students should learn to talk mathematics, but only because it says so in the syllabus. I think that it is not necessary.”

5.2.2 Analysis of data from observations
Data collected by observing lessons, as described above, was analyzed in two different ways during SSI’s quality review depending on the character of the data. If data were in the form of field notes the procedure described in Section 5.2.2.1 was utilized, and if data were information on what tasks the students had worked on during the lesson the procedure described in Section 5.2.2.2 was used. These analyses render information on what competencies the students had opportunities to develop and to what extent these opportunities were present during the lesson. It is thus through the presence of certain activities that opportunities to develop the competencies are measured. Because the question of extent of opportunities was to be determined by weighting data from field notes with data on what tasks the students had worked on this required a procedure specifying how to do this,
which is described in Section 5.2.2.3 below. In Section 4.3, the notion of competency-related activity (CRA) was described. All observation data was categorized with reference to CRAs. The results of these analyses have been reported by Bergqvist et al. 2010b, and Boesen et al. (2014). In this study, this level of detail is not considered, and therefore the descriptions of the steps in the analysis procedures relating to the CRAs are omitted when it comes to the analysis of field notes. However, instructions to analysts where CRAs are mentioned, are included when the descriptions of how tasks were supposed to be analyzed are made. This is done because the descriptions of the CRAs in this case lent rather specific support to the analysts (which therefore might make it more clear, what was considered an activity that gave students opportunities to develop the competencies, than if these descriptions would have been omitted).

5.2.2.1 Analysis of field notes
The field notes were notes on when the teacher had demonstrated or explained something to the whole class, or when the teacher together with at least a large part of the class engaged in solving tasks. A first step in the analysis of these field notes was to structure the field notes into sequences. These sequences were made as large (in time) as possible while still being possible to consider as one activity. If for example (it was evident in the field notes) that the teacher had demonstrated how to solve systems of linear equations in different ways with minimal interaction from the students, this would have been considered one activity and would therefore have been marked as a sequence of a certain length of time. If however the teacher at the end of the demonstration in whole class had let the students try to solve a system of two linear equations with little guidance from the teacher herself, the demonstration and the whole class solving of the task would have been considered two activities, and accordingly this would have become two sequences of a certain length. In some instances a whole lesson could be considered as one activity, and in other instances sequences could be as short as a few minutes.

After the field notes of the lesson had been divided into sequences, each analyst determined what opportunities to develop different mathematical competencies that were present during the sequence. This was done with direct reference to the Mathematical Competency Research Framework (MCRF). Each analyst was instructed to make an argument for which competencies that the students had opportunities to develop, with reference only to what could be read from the field notes and the MCRF. Because the description of the MCRF in this dissertation is somewhat shortened (e.g. it does not include the examples of competency-related activities) the full extent of support that the analyst had can be found in Lithner et al. (2010). To make it possible to compare classifications of field notes, the analyst's
possible recollection of what happened (besides what could be read in the field notes) was not supposed to be included in the argument for the conclusion about what opportunities the students had to develop certain competencies. Two further reasons for this were that because the analysis: 1) most often could not be made directly after the lesson, it seemed risky to rely on analysts’ recollection of the lesson, and 2) often was made after the interview with the observed teacher, conversations about the lesson during the interview might affect the analysts’ recollection of what happened. Results from the analysis procedure described above are used in this study (see Section 5.2.8.3).

5.2.2.2 Analysis of tasks
The students themselves made a record of all tasks that they worked with during the lesson. This could for example be (but was not restricted to) tasks in textbooks, in teacher handouts, or on tests taken by the students during the observed lesson. All tasks that the students had made a record of working with during the lesson were retained (by e.g. collection of handouts, and photos of textbooks) and analyzed. The particular focus of the analyses of the tasks was on what was required (in terms of competencies as defined in the MCRF) of the students in order for them to successfully solve each task. This means that actual opportunities to learn are not determined; students could do much more than is required competency wise, which therefore would mean that they had opportunities to possibly develop other competencies than the ones required. However, studies on students reasoning and problem solving show that students rarely do more than what is required in order to solve a task correctly when it comes to competencies (Lithner, 2008; Boesen et al. 2010). Therefore is the requirement perspective reasonable as a measure of what opportunities to learn a task presents.

One difficulty with the requirement perspective concerning all competencies, but in particular with the procedure competency since it is (essentially) never strictly required, is that it can be difficult to determine when a certain competency is required or when it is not required. Because of this difficulty, this perspective was complemented with an idea that focus should not only be on what was required (since one possibly can come up with unusual ways to solve tasks that does not require certain competencies) but also what was reasonable as a solution to the task. This added focus led from the requirement perspective to the Required and Reasonable perspective (RR). Before the analysis procedure for how tasks were to be analyzed is presented an example of how the RR perspective differs from a requirement perspective is given. Assume that the task is to find the maximum of a polynomial for a grade 11 student. Then it is not required to use a standard procedure (thus the classification in a requirement perspective is 0), but a solution not using a standard procedure is on the
other hand not reasonable. In this example it is better to add some kind of ‘reasonable’ criterion, saying that any reasonable solution is using a standard procedure. Thus we can say that it is not required to use a standard procedure but this is what we judge is required and reasonable (RR) and the classification is 1.

5.2.2.2.1 The analysis procedure
Because the RR perspective was adopted, the key idea in the analysis procedure was that instead of trying to show directly that a competency is required, one starts by trying to show that it is not required. Embryos for this idea can be found in Lithner (2004). The instructions given to the analysts, containing the idea that one should try and show that a competency is not required, are given in a chronologically numbered list below. After this more general description of how tasks were to be analyzed, the specific support given to the analysts regarding each competency is presented in Sections 5.2.2.2.2-5.2.2.2.7.

- First, try to show that a competency is not required by finding a reasonable solution (that fulfills the task conditions) but does not include using the competency. If this is possible the task is given classification Competency not RR.
- If this is not possible and a reasonable solution including the use of competency can be found, then the task is classified as Competency RR.
- Reasonableness is determined by considering primarily the information in the textbook and the teaching, and if such information is insufficient other types of information may be used as a complement. This includes clarifying that the concepts and methods used may be known to the student, and that the reasoning is not too difficult. Furthermore it includes considering the conditions under which the solving of the task took place, for example time frames and access to equipment.

Following this procedure, the polynomial task above would be classified as procedure competency RR even though it is not strictly required, since one cannot find a reasonable solution without standard procedures. Throughout the following sections the support provided to the analysts regarding classification of each competency is given. This support was arranged around the different competency-related activities (CRAs), so although this study (which is a part of a larger research project) does not utilize results from analysis at this level of detail, the instructions given are reproduced as they were given to the analysts. To avoid excessive repetition, the instructions given to the CRAs interpret, do and use, and judge, are labeled I, II, and III
respectively. If a task RR a competency only very locally, the task was to be classified as not RR the competency. This could for example be the case if it only was one minor step in the task solution that required the competency in a task with many different steps. Next, in Sections 5.2.2.2.2-5.2.2.2.7, procedures for each specific competency given to the analysts are presented.

5.2.2.2.2 Problem solving
The first step is to determine if the task is a problem, that is, if the RR solution method is known to the student or not. The solution method is seen as known if it is familiar (the student have seen it several times earlier), or if it is provided together with the task as a rule or a similar solved example by the teacher, the textbook or another given source. It may be difficult to know if a solution method actually is familiar or not, but the procedure does not go further than specifying that in addition to trying to identify if procedures already had been demonstrated (e.g. by the teacher or in the textbook) to the students the analysts were supposed to use their own experience and judgment, when determining whether the task is a problem or not.

I and II) Whether the task is a problem or not is determined by the requirements on the solution (relating to the CRA do and use), but it is seen that every problem needs to be interpreted (the CRA interpret) and thus it is the same classification for what competency requirements the task is considered to have, i.e. if the task is determined to be a problem, the task is classified as if it required both the interpretation aspect and do and use aspect of the problem solving competency.

III) In problem solving it is in a sense always useful to judge and evaluate ones own solution process (although this may be very simple in easy problems). However, this classification will only include judgments that go beyond this (which is probably rare). For example to explicitly evaluate another person’s solution or to compare two given problem solving strategies.

5.2.2.2.3 Reasoning
I) Determine if it is RR to interpret reasoning (not use reasoning to interpret information or to monitor ones own task solving reasoning). This means that it is explicitly included in the task formulation to interpret a sequence of reasoning (which is probably rare).

II) Determine if it is in the response format RR to use explicit arguments in the answer. Note the distinction intended here between answer and solution: solution = answer + justification. The answer is what is requested to produce in the task. 4 is an answer to the equation 2x+3=11, but the solution includes (for example) the calculations that lead to the answer. Sometimes the response format requires that the justification is included in the answer.
III) Determine if it is in the assignment RR to judge and evaluate ones own or others’ reasoning, above the metacognitive evaluations that are generally useful. This means that it is explicitly included in the task assignment to evaluate a sequence of reasoning (which is probably rare).

5.2.2.2.4 Procedures
I) Determine if it is RR to interpret a standard or given procedure. This includes both procedures given in the task and procedures given earlier in information (from e.g. the teacher or the textbook) that can be used to solve the tasks.
II) Determine if it is RR to use a standard or given (from e.g. the teacher, the task or the textbook) procedure in the solution.
III) Determine if it is in the solution RR to judge and evaluate ones own or others’ standard or given procedures (which is probably rare).

Procedures that are trivial for the age-group are not included. As a guideline a standard procedure that an average student should have learnt 3 years earlier is considered trivial.

5.2.2.2.5 Representations
I) Determine if it is RR to interpret the explicit representations given in the task formulation. This includes: 1) identifying the central representations given in the task formulation, and 2) determining if these representations need to be interpreted (that it is insufficient to only use the representations without considering their relations to the entities they are representations of). To interpret a representation means establishing properties, not already given of the entity, the representation and/or their relation.
II) Determine if it is RR to formulate representations in the solution. This includes: 1) identifying the central representations that have to be used in the solution, but are not given which means they have to be formulated, and 2) if there are new representations that need to be formulated, determining if this includes considering properties of relations to entities or if it can for example be done by applying a familiar algorithm without such considerations.
III) Determine if it is in the solution RR to judge and evaluate representations (which is probably rare).

If there in the task is i) a text giving a real-world context, ii) a given mathematical expression (or several), iii) an assignment imbedded in the text leading to a standard procedure that is similar to standard procedures in the textbook (or if the similar information is given by another source) in every central modeling aspect except that the context may be different (e.g. maximizing an area instead of a profit by differentiating a given function),
and iv) in such a way that the task can be solved by applying a familiar algorithmic solution method, then the representation competency is not RR.

5.2.2.2.6 Connections

I) Determine if it is RR to interpret the explicit connections given in the task formulation. This includes: 1) Identify the central representations given in the task formulation. 2) Determine if there are explicit connections given between or within these representations that need to be interpreted (that it is insufficient to only use these connections without considering properties of them that are not given). That a connection is given means that some property of the connection is given, including merely stating that there is a relation between representations a and b. To interpret a connection means establishing properties of the connection, which are not already given.

II) Determine if it is RR to formulate connections in the solution. This includes: a) Identify the central connections that have to be used in the solution, but are not given which means they have to be formulated. b) If there are new connections that need to be formulated, determine if this includes considering properties of the connections or if it for example can be done by applying a familiar algorithm without such considerations.

III) Determine if it is in the solution RR to judge and evaluate connections (which is probably rare).

It should be noted that the classification procedure is based on connections between representations, so it has to fit with the Representations classification. In line with the addition to the Representation definition, the competency is not activated in the real-world connections that can be done by applying a familiar algorithmic solution method. Furthermore, to compare two (parts of) representations is seen as establishing a new connection, or a new property of a connection.

Although the descriptions above of classification procedures for Representations and Connections are very similar, there is at least one difference that seems important in classifications (in particular in I). The given representations are immediate; it is just a question to decide which of them that are central. It seems more difficult to determine what a given connection is.

5.2.2.2.7 Communication

Because the definition of the communication competency does not exclude trivial (see an example below) communication (both when one interprets communication and produces communication), a classification of tasks would render that almost all tasks RR the communication competency in one form or the other. To exclude trivial communication, which probably is not a rich learning opportunity, additional requirements are made to these CRAs
when tasks are supposed to be classified as RR the student to interpret, or do and use communication.

I) Determine with reference to the task if it is RR to interpret communication from a sender. In any task that is given to the student by someone else, information is transmitted. If the information is already familiar then the classification is 0. Familiar information includes tasks that are familiar and can be solved by recalling a familiar or provided (by the textbook or by some other source) fact or algorithmic solution method.

II) Determine in the response format if it is RR to construct communication to a receiver. Transmitting a piece of information by just saying or writing it in the same form as it is mentally stored (meaning the way one is thinking about it) is classified as 0. For example transmitting a fact, for example the answer ‘5’ to the task 2+3, is 0. Another example is to do nothing more than follow a known template for describing an algorithm, for example describing the familiar steps in an equation solution. A third example is to recite a memorized proof. A “1” classification shall be motivated by the way the communication goes beyond the trivial communication above. Examples of when this is likely to be the case are:

- When explaining solutions to problems.
- When describing non-trivial objects.
- When presenting judgments and evaluations.
- When students work in pairs and do exercises that are not trivial to them, and discuss how to solve them.

Furthermore, the communication shall be intended to be received by someone else than the sender, which could be thought of as included in the definition but still is elaborated upon here. For example, writing a solution in the notebook that is not meant to be read by someone is 0 (even if the teacher has said that the students shall “do complete calculations” or “explain how they think”).

III) Determine in the assignment if it is RR to judge and evaluate communication (which is probably rare).

5.2.2.3 Weighting of different activities during the lesson
As mentioned above, the observer of the lesson was supposed to take notes on how much time had passed during the lesson. The time tracking of the different lesson activities was essential to obtain a measure of the extent of opportunities given to the students to develop the competencies. Below it is described how the time of different activities related to the extent of students’ opportunities to develop the competencies. Because activities
during the lesson do not necessarily engage all students at once T (in the description below) represents the weight a certain activity has.

The extent of opportunities to develop each competency was determined by following the steps presented below (in addition to the categorizations described above in Sections 5.2.2.1 and 5.2.2.2):

i If it is one specific activity that engages essentially the whole class simultaneously then T is simply the length of the activity. Most field notes on the teacher lecturing or teacher solving tasks together with the students were of this type.

ii If this is not the case, for example if the students are working with different tasks from a list of 12 tasks during 20 minutes, then the average distribution of time among the assigned exercises is estimated by the analyst. Continuing with the example, one may from the records of what tasks the students had made find that Task 1 was done by each student and estimate that it took 10 minutes on average, so T=10 for the sequence consisting of Task 1. Tasks 2-11 took (on average) 1 minute each to solve (it may be that each task took 5 minutes to solve but each student only worked with at few tasks) so T=1 for each task 2-11. Task 12 was done by no student so T=0. The key is that the T-sum for the classification of all activities during these 20 minutes has to be 20 (in this example).

iii If there is a set of textbook tasks (e.g. 9 tasks) with exactly the same characteristics (with respect to our analysis) then they can be classified simultaneously as one sequence. If each task is estimated to have T-value 2 minutes then T=18 for the exemplified set of 9 tasks.

The procedure described above could become rather complicated when all students had worked with different tasks during a lesson. In that case the analysts were to try and use version iii above. It was not unusual that some tasks were done by so few students so that the T-value was too small to motivate an analysis. Those tasks were disregarded.

5.2.3 Generating the CAMCC-data
As stated in the beginning of Chapter 5, the research questions of this study are answered by analyzing the CAMCC-data, and in Sections 5.2.4-5.2.8 that follow, the analysis procedures used to generate the CAMCC-data are described. The data set generated consists of seven variables (N=124), which represent selected constructs of the CAMCC (the choice of which constructs to focus on in this study is explained in Section 4.2).
The constructs of the CAMCC that are focused on in this study (and represented by variables) are quite complex. Therefore it is not possible to reliably and validly measure them directly (by e.g. asking a teacher if she has heuristically processed the competence message). Because of this, the measure on each variable (representing a construct of the CAMCC) needs to be obtained by considering many different types of information from different types of data. In this study this means that an overall assessment of the different types of information available and relevant is made to obtain a measure on each variable. This assessment of data is made in several steps. Starting with analysis of raw forms of data (e.g. teachers’ utterances to interview questions) one answers increasingly more general questions (or questions containing more or different information) until it is possible to answer a question that represents each variable connected to a construct of the CAMCC. It is these steps that are described when the analysis procedures are presented. Next it is explained how these steps, described in the analysis procedures, are structured on different levels.

As mentioned, all analysis procedures starts with raw forms of data (e.g. teachers’ answers to a set of interview questions and survey questions), which are used to construct answers to questions on what is labeled the *Data* level. A concrete example of this is that transcriptions of teachers’ different interpretations of several excerpts from the syllabus are analyzed to obtain an answer to the question of what the teachers in general focus on when interpreting these excerpts. Oftentimes are several sets of answers to interview or survey questions analyzed (as exemplified) in order to obtain answers to more general questions on the data level (or questions containing more or different information). This (i.e. answering question by analysis of raw forms of data) is the first step in the chain of analysis procedures that makes it possible to obtain measures on the variables representing constructs of the CAMCC.

After this has been done, the answers to the questions posed on the *Data* level are in turn analyzed to answer more general questions (or questions of which the answers contain more or different information) on what is labeled the *Synthesis* level. A concrete example of this is how a teachers’ knowledge of the competency goals is determined by analyzing answers from questions posed at the *Data* level. In this case, the questions posed at the *Data* level generate answers on what knowledge a teacher has regarding different aspects of the competency goals, and it is these answers that on the *Synthesis* level are analyzed in order to determine a teachers’ knowledge of the competency goals. A teacher might for example on the *Data* level have been judged to understand the global nature of the competencies, but not their roles as goals. This information is then used on the *Synthesis* level to determine what knowledge the teacher has of the competency goals. On the *Synthesis* level there are often multiple steps of analysis, meaning that sets
of answers to questions obtained on the Data level are analyzed in order to answer more general questions (or questions containing more or different information), and that these answers generated in turn sometimes again are used to answer an even more general questions (or questions containing more or different information) still on the Synthesis level.

Thereafter, on what is labeled the Variable level, are the answers obtained in the last step on the Synthesis level analyzed in order to answer a final overarching question that generates the measure on the variable studied. A concrete example of this is how the question of to what degree teachers have systematically processed the competence message in the syllabus or the national tests is answered by studying the answers to two questions asked on the Synthesis level. The questions answered on the Synthesis level are questions of to what the degree the teacher has systematically processed the competence message in the syllabus, and to what degree the teacher has systematically processed the competence message in the national tests. The answer to the questions on the Synthesis level are in this particular case both considered when the question on the Variable level is answered. It is assumed that systematic processing of the competence level in either the syllabus or the national tests is sufficient for belief change (in the sense of accommodation) to be possible, and therefore if a teacher (on the Synthesis level) for example has been found to have systematically processed the competence message in the syllabus, the answer to the question on the Variable level is that the teacher has systematically processed the competence message in the syllabus or the national tests.

Because there sometimes are many different kinds of information on the data level, and also many steps in the analysis procedure on the synthesis level, it can be difficult to foresee how the steps will lead to a measure on each variable. Because of this the presentation of the analysis procedures is made in the opposite direction of the order of analysis, as illustrated in Figure 4 below. So although the actual analysis starts in raw forms of data, the presentation starts with the variable that a measure is obtained for.

Figure 4. Illustration of that the order of the presentation of the analysis procedures is opposite to the actual order of analysis.
Before the analysis procedures used to generate the CAMCC-data are presented it is reminded that the generation of the CAMCC-data is based on data obtained from the SSI. Some of the data obtained was in raw forms, such as a transcription of an interview, whereas some of the data were in the form of already analyzed data, made by SSI-analysts during the SSI’s quality review. Therefore the validity of the CAMCC-data, in some parts relies on if analyses made by the SSI-analysts, validly can capture what is intended. The analysis procedures used by the SSI are therefore also described in detail in the next section together with the analyses particular to this study. When analysts hired by the SSI have made analyses, this is indicated by using the word ‘analysts’ when describing analysis procedures. The analyses made, by analysts hired by the SSI, during the SSI’s quality review of mathematics teaching in upper secondary school are with one exception described at the Data level, whereas the other analyses are made solely by me as a PhD-student (with advice from supervisors), which also includes analyses made at the data level. The survey data obtained from the SSI is solely analyzed by me.

5.2.4 Variable 1: Implicates self?
After the presentation of the reform message (in this study the competence message) it is in the CAMCC assumed that the teacher has come into contact with the competence message somehow. The question then is whether the message has put the teacher’s self at stake. Some fifteen years after the reform of the goals of upper secondary mathematics all teachers should have met the message in one form or the other, either through the syllabus, national tests, in-service training, textbooks, teacher education or some other source. As described in Section 2.1, this message is both based on and similar to the ideas of the NCTM standards. In relation to this type of message Gregoire (2003) writes that the NCTM standards message is a strong one and that “...for many traditional instructors, the message received threatens their professional identity and, as identity-analytic theory suggests, such a threat can motivate attitude change to occur (Schlenker, 1982).” (p.164). If the message does not put the teacher’s self or professional identity at stake, the model specifies that the teacher will take the right route and heuristically process the message, but if he or she is perceives that the message entails a change, the model states that he or she will appraise the situation as stressful, which is the beginning of the left route of the model. To construct a variable giving information on whether teachers have perceived the message as entailing a change for them, an overarching question connecting to this is posed. The variable generated by this overarching question is named Implicates self?, and each teacher is classified with a Yes or No on this variable. The overarching question generating the measures on the variable Implicates self? is:
1 Does the teacher think that the competence message entails an important non-trivial change of the teacher’s teaching objectives or practice? (Yes / No)

In question 1 the change is specified to be important and non-trivial because it is supposed to lead to stress. If the change entailed by the competence message is perceived as easy, minor, or unimportant, then it will not actually put the teacher’s self at stake and stress the teacher, but rather be a cue for benign or positive appraisals which in turn are cues for heuristic processing (Gregoire, 2003). That the change can be perceived as non-trivial depends of course on both the change itself and the one perceiving it. The assumption here is that for all teachers the change entailed by the competence message is a non-trivial one if the competence message is reasonably appreciated. This idea is based on 1) the results of several of the studies reviewed in Section 2.2 with subsections, which show that similar messages are not easily implemented and that teachers who find change easily being made do not consider the more difficult aspects of the messages (see e.g. Boesen et al., 2014), and 2) Niss’ (2007) conclusion (which, as acknowledged by himself, is not new) that mathematics learning and teaching is very complex. Both of these things point to the change at hand being non-trivial if reasonably appreciated.

There are several ways in which a teacher can come in contact with the competence message. To narrow it down, two important sources are considered below and in addition to these sources a more general question disregarding the source is also considered. So, to obtain answers to the overarching question 1 above combinations of outcomes from three questions are studied. These questions are:

1a Does the teacher think that the competence message as communicated through the syllabus entail an important non-trivial change to the teacher’s objectives? (Yes / No / NA)  
1b Does the teacher think that the competence message as communicated through the national tests entail an important non-trivial change of the teacher’s objectives? (Yes / No / NA)  
1c Disregarding the source of the message, does the teacher think that the competence message entail an important non-trivial

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6 The category NA signifies that an answer to a question is missing.
change to the teacher’s practice?
(Yes / No / NA)

The three questions 1a-c all are used as indicators for which answer to assign to question 1. Table 1 below describes the combinations of answers to question 1a, 1b and 1c that assign a certain answer to the overarching question 1.

Table 1

Table displaying what combinations of answers to questions 1a-c that assigns a certain answer to question 1. Shaded area is output on question 1.

<table>
<thead>
<tr>
<th>1a Syllabus</th>
<th>1b Tests</th>
<th>1c Regardless of source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>NA</td>
<td>Yes</td>
</tr>
<tr>
<td>NA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>NA</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
<td>Yes</td>
</tr>
</tbody>
</table>

In Table 1 above, the shaded area is the output on question 1. It can be seen that Yes on either of the questions 1a, 1b or 1c assigns a Yes as the answer to the overarching question 1. This choice is based on the idea that it does not matter from what source the message, entailing an important and non-trivial change to the teacher, is communicated, or if it is the teacher’s goals for the teaching or the actual teaching that the change concerns. Either way, if the teacher thinks that the competence message entails an important and non-trivial change to the teacher’s objectives or teaching, this will give rise to stress that needs to be coped with. The combination of answers No, No and No is self-explanatory. Missing answers does not affect the outcome unless of course answers are missing to all questions 1a-c (which however did not occur).
5.2.4.1 Synthesis 1a-b: Does the syllabus or the national tests entail an important and non-trivial change of the teacher’s objectives?

Question 1a and 1b has inherent requirements, by virtue of their formulations, of what needs to be fulfilled in order for a teacher to be classified with a Yes on either of them.

i  The competence message has to constitute a change to the teacher’s objectives.

ii The change entailed needs to be considered important.

iii The change entailed needs to be considered non-trivial.

That the message constituted a change (i) for all of the teachers is argued for in Section 2.1. The second requirement stating that the change entailed needs to be considered important (ii) is studied by considering if the teacher thinks it is important that his or her teaching is aligned with the syllabus (or the national tests). If the teacher thinks it is important that his or her teaching is aligned with the syllabus (or the national tests) and if the teacher also makes a reasonable initial interpretation of the competency goals in the syllabus (or the national tests) then this is a sign of that the teacher considers the competence message to be important and thus considers the change entailed by the competence message important. The notion of reasonable initial interpretation of the competency goals, what it means and how it is determined if a teacher has made this, is accounted for below and as will be seen there, the notion of reasonable initial interpretations also covers the third requirement of if the teacher considers the competence message to be non-trivial (iii). If the requirement of reasonable initial interpretation of the syllabus is not included as a requirement, the questions of whether teachers thinks it is important that their teaching is aligned to the syllabus (or the national tests), do not necessarily include the notion of competencies present in the syllabus and national tests. This means that if teachers have made a reasonable initial interpretation of the competency goals in the syllabus (or the national tests) and also thinks it is important that their teaching is aligned with the syllabus (or the national tests) then the answer to question 1a is Yes (1b is Yes).

As stated above, to determine whether teachers think it is important that their teaching is aligned with the writings of the syllabus or the national tests, two things were considered. It was examined whether teachers thought it was important that their teaching was aligned with the syllabus (or the national tests) and it was examined whether the teachers had made a reasonable initial interpretation of the competence message. The first part was elicited from a teacher’s answers to two survey questions:
- To what extent has it been important for you that your teaching is aligned with the syllabus?
- To what extent has it been important for you that your teaching is aligned with the national tests?

If the teacher had answered four or above on the six point Likert scaled items the teacher was deemed to have considered it important that his or her teaching is aligned with the syllabus (or the national tests). The second part, i.e. whether a teacher can be considered to have made a *reasonable initial interpretation* of the competence message in the syllabus (or the national tests) was determined by studying the three questions x-z below. The analysts had answered questions x and y by analyzing several transcribed answers to several interview questions, and question z were answered directly from analysis of one interview question. For 1a the questions x-z were:

**x** Is the teacher familiar with the syllabus and does the teacher make a reasonable interpretation\(^7\) of it?  
(Yes / Partly / No)

**y** What types of goals does the teacher focus on when asked to interpret excerpts from the syllabus?  
(Competencies / Content and competencies / Content / Nothing)

**z** Does the teacher find the syllabus difficult to understand and interpret?  
(Yes / No / NA)

For question 1b the questions x-z were:

**x** Is the teacher familiar with the national tests and does the teacher make reasonable interpretations of what they test?  
(Yes / Partly / No)

**y** What does the teacher think the national tests require from the pupils, in terms of what knowledge the pupils need to answer the test items satisfactorily?  
(Competencies / Content and competencies / Content)

**z** Does the teacher find the national tests difficult to understand and interpret?  
(Yes / No / NA)

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\(^7\) It should be noted that reasonable interpretation in question x refers to the whole of the syllabus and not only to reasonable interpretations of the competence goals in the syllabus.
Table 2 below explains which combinations of answers to the above questions regarding the syllabus that are considered an indication of that the teacher has made a *reasonable initial interpretation* of the competence message in the syllabus.

Table 2

*Combinations of answers to x-z that assign a certain answer to the question: has the teacher made a reasonable initial interpretation of the competency goals in the syllabus? Shaded area is output.*

<table>
<thead>
<tr>
<th>x – Familiar</th>
<th>y – Interpretation</th>
<th>z – Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Partly</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Partly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Yes</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Partly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

The idea behind Table 2 is that in order for teachers to be considered to have made a reasonable initial interpretation of the competence message in the syllabus they must fulfill the three conditions listed below. In parenthesis it is indicated which question/s mentioned above that relate to each requirement, and after the list is presented these relations are explained. The teacher needs to:

i. be at least somewhat familiar with the syllabus (question x)

ii. have identified the competence message in the syllabus (question x and y)

iii. have found the syllabus difficult to understand and/or interpret (question z)

The first condition (i) must be fulfilled because if the teacher is not familiar with the syllabus it is deemed highly unlikely that he or she has made a reasonable initial interpretation of the competence message *in the syllabus*. Question x (of whether teachers are familiar with the syllabus and
makes a reasonable interpretation of it) deals with this requirement and if teachers have been categorized with a No on this question they are not considered to have made a reasonable initial interpretation of the competence message in the syllabus.

The second condition (ii) has to be fulfilled because if teachers have not identified the competence message in the syllabus they obviously cannot be said to have made a reasonable initial interpretation of the competence message in the syllabus. In terms of questions x and y this means that the teachers have been categorized (on question y of what the teachers have focused on when interpreting the excerpts from the syllabus) as focusing on competencies, or content and competencies and at least have been categorized as Partly being familiar with the syllabus (on question x), or that teachers have been categorized to be both familiar with the syllabus and also to have made a reasonable interpretation of the syllabus, i.e. gotten a Yes on question x. As can be seen in the descriptions under the heading “1a-b Data” below the question of familiarity and a reasonable interpretation of the syllabus include identification of the competency goals of the syllabus, which here means that it is possible that the teacher has made a reasonable initial interpretation of them (if also the third condition is fulfilled).

Lastly, the third condition (iii) has to be met because a reasonable initial interpretation of the competence message must include recognition of that the syllabus is difficult to interpret (if one has seen the competence message in it). The idea with competency goals and the specific meaning of the different competencies certainly is not trivial (Niss, 2007), and furthermore, compared to frameworks such as KOM, and NCTM, which are several hundred pages long, the syllabus is short, was written without definitions of the competencies, and does not contain any examples of what the competencies could entail in terms of teaching. If one therefore does not find the syllabus difficult to interpret, one has not made a reasonable initial interpretation of the competence message in the syllabus. An objection to this line of reasoning could be that there must be teachers who already have processed this message and are very knowledgeable about the competency goals and therefore do not consider the competence message difficult anymore. However, it is here assumed that those people who have processed the competence message still would say that it is a difficult message. If one was to be very knowledgeable of the competence message, this should also include an understanding of that the message is not a trivial one.

So a reasonable initial interpretation of the competence message in the syllabus means that the teacher to some extent uses the syllabus (is familiar with it), identifies the competencies in the syllabus (sees them in the excerpts presented before them) and also appreciates that the syllabus is difficult to interpret.
Relating to the rest of the entries of Table 2 above, it is in the idea with the three requirements (i-iii) included that those who are not familiar with the syllabus, or have not interpreted the excerpts from the syllabus in terms of competencies, or do not find it difficult to interpret the syllabus are categorized with No as an answer to 1a. The missing-answer category was assigned if the teacher at least in part was familiar with the syllabus and had identified the competence message but the answer to question z was missing.

The procedure for answering question 1b (Does the teacher think that the competence message as communicated through the national tests entails a non-trivial change of the teacher’s objectives?) is in essence the same as the one used for 1a, even though 1b has fewer categories to question y. Also the arguments for which answer to 1b a certain combination of answers to the sub-questions x-z should assign are also in essence the same and therefore not restated in full detail. However, that a reasonable initial interpretation of the competence message in the national assessments includes an appreciation of that the national tests are difficult to interpret (in the competence-message aspect) is argued for shortly in the following. The assessments themselves only communicate the competence message implicitly, which (together with that the competence message is not trivial, as argued for above) indicates that teachers should find it difficult to interpret the tests with regards to the competence message. The tests are however accompanied with instructions for how tasks are to be graded, and these instructions explicitly state what a task is supposed to test (in relation to both content and competencies), which then might make it less difficult to interpret the tasks. However, since these statements of what the tasks are supposed to test, are made with reference to the syllabus, the difficulty of the message being communicated implicitly in the national tests remains (because as argued for above, the syllabus is short, without definitions, and without examples of how the competencies can be expressed in terms of teaching). The procedure for assignment of answers to question 1b is illustrated in Table 3 below.
Table 3

*Combinations of answers to x-z that assign a certain answer to the question: has the teacher made a reasonable initial interpretation of the competency goals in the national tests? Shaded area is output.*

<table>
<thead>
<tr>
<th>z - Difficult</th>
<th>x - Familiar</th>
<th>y - Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Partly</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Partly</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NA</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Partly</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>NA</td>
</tr>
</tbody>
</table>

5.2.4.1.1 Data 1a-b: Answering questions 1ax-z, and 1bx-z
The last step in the analysis, working backwards, is between transcribed interview data and answers to sub-questions x-z for both 1a and 1b. A recapitulation of the questions is given before the procedures are explained. To avoid repetition the questions are formulated to capture both sets of x-z questions (i.e. the ones relating to the syllabus and the ones relating to the national tests).

x  Is the teacher familiar with the syllabus (or national tests) and makes reasonable interpretations of it (them)?

y  What does the teacher focus on when interpreting the excerpts from the syllabus (or national tests)?

z  Does the teacher find the syllabus (or national tests) difficult to interpret?

5.2.4.1.1.1 1ax and 1bx: Teachers’ familiarity with, and reasonable interpretations of, the syllabus and the national tests
To answer the question 1ax (and 1bx), asking if the teacher is familiar with and make reasonable interpretations of the syllabus (or national tests), analysis procedures similar to each other were utilized. For question 1ax, analysis of transcripts of ten interview questions was made. These questions were about the teacher’s relation to the syllabus (four of them) and six of them were asking the teacher to interpret different excerpts from the syllabus. The four interview questions were formulated as shown below.
Before answering the questions, the teachers had been handed a print of the syllabus that they could look through or point to if they wanted to exemplify something from the syllabus.

- What access do you have to the syllabus for the course Mathematics A?
- To what extent do you use the different parts of the syllabus?
- Do you consider that there are some parts of the syllabus that you are affected by in your teaching?
- Is there something in the syllabus that you have found problematic regarding what the students should learn and in that case what?

The six questions relating to excerpts were formulated as:

- How do you interpret this excerpt? (The question was asked after the teacher had the opportunity to read through the excerpt.)

For an example of an excerpt presented to the teachers, see Section 5.1.3.2 (all excerpts are found in Appendix A). Analysts were instructed to analyze the transcripts from the perspective of if they could find indications of that the teacher was familiar with the syllabus and made reasonable interpretations of it. The analysts were given the following as examples of indications of the teacher being familiar with the syllabus:

- The teacher has easy access to the syllabus documents.
- The teacher often reads the syllabus.
- The teacher easily points out different parts of the text that the teacher usually reads.
- The teacher uses the names of the different parts of the syllabus without having to look at the paper with the syllabus we handed them.
- The teacher clearly can connect his or her teaching to the syllabus.
- The teacher spontaneously has objections to certain parts of the syllabus or says that certain parts are better.

Examples of indications of that the teacher made reasonable interpretations of the syllabus were:

- The teacher has reasonable interpretations, both regarding competency goals and other aspects, of the excerpts we asked them to interpret and of other parts discussed during the interview.
- The teacher can formulate specified interpretations, examples or connections to the teaching practice
- The teacher understands the structure of the syllabus, i.e. what roles different parts of the syllabus has and their relation to each other.

With support from the instructions above the analyst formulated an answer to question 1ax, which straightforwardly could be coded into the categories Yes, Partly, and No. Yes was for example assigned if the analyst stated that:

The teacher states that he has good access to the syllabus. The teacher claims to use all parts of the syllabus. The teacher mostly talks about goals to attain, goals to aim for, and the grading criteria-parts of the syllabus, although all parts are mentioned. The teacher can give concrete examples how the teachers’ teaching is connected to the syllabus. The teacher therefore seems familiar with the syllabus. Furthermore, the teacher makes reasonable interpretations of the excerpts from the syllabus and can often make specifications of the interpretations of these excerpts. The teacher seems to understand the syllabus. (SSI-analysts’ written statement)

A slightly different but still highly similar procedure for answering 1bx (i.e. the question of familiarity with the national tests) is accounted for in the following. For question 1bx the analysts were instructed to analyze transcripts of answers to four interview questions asking the teacher different things about their relation to the national tests and four questions asking the teacher to interpret different tasks from the national tests. The four questions about the teacher’s relation to the national tests were:

- What access to national tests do you have?
- How many times have you been involved with the national tests?
- Do you consider that there is something in the national tests that you are affected by in your teaching?
- Is there something in the national tests that you have found problematic regarding what the students should learn and in that case what?

The four questions relating to excerpts were formulated as:
What do you consider the pupils need to know in order to solve the task? (Asked after the teacher had the opportunity study the task).

For an example of a task presented to the teachers see Section 5.1.3.2 (all tasks presented are found in Appendix A). Analysts were instructed to analyze the transcripts from the perspective of if they could find indications of that the teacher was familiar with the national tests and made reasonable interpretations of them. The analysts were given the following as examples of indications of the teacher being familiar with the national tests:

- The teacher had good access to previously held national tests.
- The teacher had administered them several times.
- The teacher mentions examples of items from national tests previously done or talks about properties of the test without having to look in the documents.
- The teacher spontaneously has objections to aspects of the tests or says that certain parts are especially good.

Examples of indications of that the teacher made reasonable interpretations of the national tests were:

- The teacher has reasonable interpretations of the tasks presented to them (and possibly other tasks) that were discussed during the interview, both in terms of competency requirements and in other aspects (e.g. regarding what content the tasks covered).
- The teacher can formulate specified interpretations, examples or connections to the teaching practice.

With support from the instructions above the analyst formulated an answer to question 1bx, which straightforwardly could be coded into the categories Yes, Partly, and No. Yes was for example assigned if the analyst stated that:

The teacher makes reasonable interpretations of the task demands in the tasks shown to the teacher. The teacher has good access to the tests, and talks about how the tasks in the tests are different from the tasks in the textbooks. The teacher has administered several national tests. The teacher therefore seems familiar with the tests and seems to make reasonable interpretations of the tasks. (SSI-analysts’ written statement)
5.2.4.1.2 1ay and 1by - Teachers’ focus when interpreting the syllabus and analyzing the national tests

Questions 1ay and 1by (of what types of goals the teacher focused on when asked to interpret excerpts from the syllabus and national-test tasks?) were answered by analyzing the transcripts of a teacher’s answers to the six questions (for 1ay) and the four questions (for 1by) described in the previous paragraph (i.e. the questions where the teacher was supposed to interpret excerpts from the syllabus or determine requirements of national test tasks). For both sets of questions the expert summarized what the teacher focused on: content, competencies, or content and competencies? For the questions relating to the syllabus the summary of what the teacher focused on also used the category nothing. Teachers, who most of the time interpreted the excerpts and the task demands in terms of the (to the excerpts and tasks) relevant competencies, were categorized with competencies, and conversely teachers, who most of the time interpreted the excerpts and task demands in terms of content, were categorized with content. Teachers who interpreted the excerpts and tasks in terms of both competencies and content to approximately equal amounts were categorized with content and competencies. The category nothing was assigned to only a few teachers, and this was done because these teachers did not give an interpretation of most excerpts. An example of a teacher statement that was taken as one indication of that the teacher had a focus on competencies when interpreting the syllabus is this transcribed teacher answer to the question of how the teacher interpreted the excerpt about reasoning exemplified in Section 5.1.3.2:

It is mainly about that they should be able to explain how they think, both through talking and through displaying a mathematically correct solution. For example when we did problem solving. They reason with each other for example about if something is reasonable or not. [The teacher imitates students talking to each other:] How are we going to solve this? We must do like this, because we do not know that thing, so how are we supposed to find out what that thing is. Yeah right, we have this model… (Transcribed teacher answer)

There is an overlap between the procedures for answering question 1ax and 1ay in that both questions in part uses the same interview data. This however is not a problem here, because both question x and y are subsequently used to find out if the teacher has identified the competence message in the syllabus and it there does not matter if this shows in either x, y or in both answers to these questions.
5.2.4.1.3 1az and 1bz – Teachers’ perception of whether the syllabus and the national tests are difficult to interpret

To answer questions 1az and 1bz two interview questions were analyzed. For 1az the question analyzed was:

- Do you consider it easy or difficult to interpret the syllabus?

For 1bz the question was:

- Do you consider it more difficult for national test tasks than for textbook tasks to in advance determine what a task requires a pupil to know in order for them to solve the task?

For question 1az an answer that in some way indicated that the teacher thought that at least some parts of the syllabus were difficult to interpret were categorized as Yes and teachers who stated that they did not find the syllabus difficult to interpret were categorized as No. If the interviewer had missed the question or if the teacher did not answer it the categorization was NA. The same analysis procedure was applied to the interview question connected to 1bz. Examples of statements and which coding they got is given in the following:

- Example of statements categorized as Yes:
  - T: I guess it is not always easy but it gives some guidance. I: In what way is it not easy. T: I guess it is because the formulations necessarily has to be general in nature, it is things that are difficult to capture... (Transcription of interaction between teacher and interviewer)

- Example of statements categorized as No:
  - T: It is easy. I have seen it so many times. (Transcribed teacher answer)

That the categorization of interview answers to the question of if the teacher considers it more difficult to determine what is required of national test tasks than text book tasks can be used as answers to question 1bz of if the National tests are difficult to understand or interpret is argued for in the following. Because 1) textbook tasks largely focus on the practice of procedures (Jäder et al., 2014), 2) national tests’ requirement of what competencies the students need in order for them to solve the tasks successfully is rather evenly distributed among all competencies (Boesen, 2006), and 3) the competence message is not a trivial one (Niss, 2007), a recognition of that national test tasks are more difficult to determine in
terms of what they require of the students than textbook tasks is taken as an indication of that the teacher finds the national tests difficult to interpret.

5.2.4.2 Synthesis 1c: Does the teacher think that the competence message entails an important non-trivial change of the teacher’s practice

To answer question 1c of if the teaching of the competencies entails an important and non-trivial change to the teacher’s practice, two questions are studied.

\[ x \text{ Does the teacher think it is (or would be) difficult to work with the competency goals in the teaching?} \]
\[ (\text{Yes} / \text{No}) \]
\[ y \text{ Does the teacher think it is important for the students to develop the competencies?} \]
\[ (\text{Yes} / \text{No}) \]

Different combinations of answers to these two questions assign the category Yes or No to question 1c as is shown in Table 4 below:

<table>
<thead>
<tr>
<th>1cx - Difficult</th>
<th>1cy - Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 4 shows that in order for teachers to be considered to have perceived the competence message as entailing an important and non-trivial change to their practice they must both believe the competencies to be important and think that it is difficult to teach them. This organization of the table is based on the idea that this combination will stress teachers because they think helping their students develop the competencies is important but finds it difficult to manage this.

5.2.4.2.1 Data 1cx and 1cy: Do the teachers think it is/would be difficult to work with the competency goals in the teaching and do they think it is important?

To answer question 1cx of if the teachers think it is difficult to help their students develop the competencies, answers to one interview question (with
follow up-questions) were analyzed. The interview question, with follow up questions is:

- Do you think it is/would be difficult to work with the competency goals in the teaching?
  - In what way?
  - Why is it difficult?

The transcribed answers to these questions were coded with the categories Yes and No, and the rule applied for coding was quite straightforward. If the teachers had answered yes or no, without any qualifications indicating otherwise, the answer was coded as Yes or No respectively. If however the teacher qualified his answer in some way, for example by following his statement that it is not difficult with another statement saying that although it is not difficult in general it might be difficult under certain circumstances, the teacher was coded with a Yes. The same was done (i.e. the statement was coded with a Yes) if the situation was reversed, i.e. the teacher first says it is difficult but then qualifies his or her statement by saying that it is easy under certain circumstances. A third case (which is similar to the two previous cases) where the analysis rendered a coding of Yes was when the teacher at first does not state it as being easy or difficult but rather say that it can be both easy and difficult to work with the competency goals in the teaching. This coding which can be thought of as rather inclusive in which types of statements that were coded with a Yes is used because even if teachers sometimes find it easy to work with the competency goals they also at least sometimes find it difficult, and even though this might not be the general case the assumption is that they at least then (i.e. when they find it difficult) would find the obstacle implicating their professional identity (given that the they find the competencies important for their students to develop). Two examples of statements (from teachers) coded as Yes are:

- No, it should not be difficult. However it is difficult to find appropriate forms for the teaching when it comes to the competency goals.
- Yes it is difficult because the pupils are not motivated to do these things.

Two examples of statements coded as No are:

- Not difficult, it exists in the tasks.
- No, they are included automatically when you work with mathematics. You have to do all of this (referring to the
competencies), but it is not the case that it is made explicit, like: today we are going to train reasoning competency.

The coded answers to the interview question are used as answers to question 1cx.

To answer question 1cy of if the teachers think it is important that their students develop the competencies, the analysts’ summaries of how the teachers value the competence message were coded into the categories Yes and No. First it is described how the analysts’ answers were coded, and thereafter a presentation is made of the instructions given to the analysts for how they were to answer the question of how the teacher values the competence message. If the analysts in their summaries had written explicitly that the teachers thought the competence message was important, then this statement from the analyst was coded with Yes, but if it was not explicitly stated that the teacher thought the competence message was important, then this was coded with No. Examples of statements from analysts that were coded with No:

- The teacher sees the competencies as one way of describing mathematics but concludes that there are other ways to think about this.
- The teacher does not perceive the message very clearly. Keeps neutral in relation to it (almost exclusively neutral competency indications).

Examples of statements from analysts that were coded with Yes:

- Important. Sees it (the competency goals) as the core.
- The teacher is deemed to value the competence message highly. Partly because he says it is important and partly because he often talks positively about them.

The statements made by the analysts used above, were based on the following instructions. The analysts were to give a summarized answer to the question of how the teachers value the competency goals. Answers to interview transcripts of two interview questions and the study of competency indications (see Sections 5.2.1.1-5.2.1.7 for an explanation of what competency indications are) were supposed to be used when arguing for how the teacher values the competency goals. The interview questions (with follow up questions) studied were:

- How important do you think it is that your students develop the competencies?
Why?
- Do you think it is/would be difficult to work with the competency goals in the teaching?
  - In what way?
  - Why is it difficult?

The second interview question with follow up questions is the same as used when answering question 1cx. Here 1cx is included because answers to this question might help the analyst in constructing an answer to the question of how the teacher values the competence message. Without further instructions, the analyst was to study the answers to the two questions and with the help of the value aspect of competency indications (i.e. a numerical value of how many statements in the interview that were negative, neutral, or positive in relation to competency related goals), answer the question of how the teacher values the competency goals.

5.2.5 Variable 2-4: Value, expectancy, and the interaction of the two

If a teacher has perceived the competence message as entailing an important and non-trivial change, then the CAMCC states that the teacher will be stressed. How productively a teacher is able to cope with the stress is determined by motivational factors, i.e. whether the teacher will have an approach intention or an avoidance intention depends on motivational factors. In this study the motivational factors measured are divided in two different variables, and also one variable representing the interaction effect of the first two variables. These variables 2-4 are value, expectancy, and the interaction effect of value and expectancy. The overarching questions connected to the variables value and expectancy are:

2 To what extent does the teacher believe that it can be valuable to process and implement the competence message? (Mean value on the interval 1-6)
3 To what extent does the teacher believe that he or she would succeed to process and implement the competence message? (Mean value on the interval 1-6)

Variable 4, which is the interaction term of value and expectancy was created by multiplying value with expectancy, after first having centered these variables, i.e. subtracted the means of each variable (which is done to reduce multicolinearity, which in turn arises if one creates an interaction term by multiplying two variables with only positive values).
5.2.5.1 Synthesis - Variable 2: Teachers' valuing of processing and implementation of the competence message

To answer question 2 above four questions were used as indicators of whether the teacher thinks it is valuable to process and implement the competence message. These questions were:

- 2a. To what extent does the teacher think it has been valuable to process the competence message in order for him or her to be able to teach in a good way?  
  *Mean value in the interval 1-6*

- 2b. To what extent has the teacher had the reason: “that it is interesting in itself”, to interpret the syllabus and analyze the national tests?  
  *Mean value in the interval 1-6*

- 2c. To what extent is the teacher interested in mathematics?  
  *Mean value in the interval 1-6*

- 2d. To what extent does the teacher think the syllabus and national tests represent a good choice of school mathematics?  
  *Mean value in the interval 1-6*

Question 2 is answered by taking the mean of questions 2a-d. It is possible to calculate the mean of questions 2a-d to get a sort of index variable from question 2 because the questions 2a-d conceptually relate to different parts of the Subjective Task Value-construct as it is described in Wigfield and Eccles (2000). Below, short explanations are given of the nature of the relations between question 2a-d and the parts of the achievement value construct, which are: utility value, attainment value and intrinsic value.

- Question 2a relates to utility value, or alternatively formulated usefulness of task, and the task at hand here is processing of the competence message in the syllabus. It is thus not directly related to implementation of the competence message, even though one could argue that the line is not clear-cut. Therefore on could say that it mostly relates to the processing aspect of question 2.

- Question 2b is connected to intrinsic value, which Eccles and Wigfield (2002) states “…is the enjoyment the individual gets from performing the activity or the subjective interest the individual has in the subject”, (p.120). Here the subject is interpreting the syllabus and analyzing the national tests. This

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8 In all cases where means are calculated, both here and below, the means of available data is calculated, which is appropriate for summated scales (De Vaus, 2002).
question clearly relates to the processing aspect of question 2, but not the implementation aspect.

- Question 2c also relates to the intrinsic value aspect but on a more general level than 2b. Because the question is more general it can be said to relate either to the implementation and/or the processing aspect of the overarching question because a general interest in the subject would make it more probable that the teacher tries to process and implement the competence message.

- Question 2d relates to implementation, albeit somewhat indirectly. If teachers think that the syllabus and national tests represent a good choice of mathematics to be learned in school, this is interpreted as an indication of that they want to teach in line with what these documents represent in terms of goals for the pupils learning. In that sense the question is connected to the implementation part of the overarching question. This relies on that teachers have identified the competence message in the syllabus and national tests. Since motivational factors are only used to explain why teachers, who have perceived the competence message as entailing an important and non-trivial change, either approach or avoid to systematically process the competence message, this means the teachers have identified the competence message.

The first and second question (2a and 2b) most directly relates to processing of the competence message, while the third and fourth question (2c and 2d) mostly relates to implementation of the competence message. As stated above the line is not clear-cut between what can be considered a relation to processing or to implementation in all of the cases. Also the level of specificity differs between questions where question 2c and 2d obviously are more general than questions 2a and 2b.

Before the descriptions of procedures relating to question 3 are given, the procedures for how the scales used for answering question 2 were constructed from survey data are presented.

5.2.5.1.1 Data 2a-d: How answers to questions 2a-d were obtained
The paragraphs below account for the connection between survey data and the questions 2a-d used on the synthesis level. When constructing scales from survey questions one can use the approach described by De Vaus (2002) to first determine which survey questions that conceptually relate to each other and to the construct they are supposed to measure. Then, secondly, if sufficiently many questions are at hand, a test of if the scale is unidimensional is performed and also a test of internal consistency. If the questions can be argued to relate conceptually to each other and if the scale
is determined to be unidimensional and also shows reasonable internal consistency, then this is interpreted as it being possible to use the scale as a measure of the construct intended. Sometimes scales are constructed from two survey items, and in those cases it is argued solely on conceptual grounds that the items are suitable to sum.

5.2.5.1.1.1 2a: Have the teachers believed it to be valuable to process the competence message?
Question 2a of whether a teacher believes it to be valuable to process the competence message is answered by making a scale from four survey questions. Three of them concerns the syllabus and one the national tests. The survey questions are formulated as follows:

- To what extent have you thought that what is written in the syllabus under the following headings have been useful for you in your teaching?
  - Aim of the subject
  - Goals to aim for
  - Structure and nature of the subject
- To what extent have you thought an analysis of what type of knowledge (in the meaning of different competencies, as discussed during the interview; e.g. communication and reasoning) that is tested in the national tests have been useful for you in your teaching?

First, the mean of the three questions relating to parts of the syllabus is calculated, then this mean value is added to the answer to the question relating to the national tests, and this sum is then divided by two. The value obtained by these calculations is the answer to question 2a, i.e. the value calculated is taken as an indication of to what extent the teacher think it has been valuable to process the competence message in order for him or her to be able to teach in a good way. That the mean of all questions is not calculated directly is because the weight of questions relating to the syllabus should be the same as for the question relating to the national tests.

The teachers were in the survey asked the same question as stated above in relation to all five parts of the syllabus (i.e. the question “To what extent have you thought that what is written in the syllabus under the following headings have been useful for you in your teaching?”), but only the three parts mentioned above are used to answer question 2a. A short account of the reasons for this is given below.
To determine if the five survey questions relating to the usefulness of the syllabuses different parts could make up a scale of the general usefulness of the syllabus perceived by the teacher, tests of unidimensionality and the reliability of the scale that was to be created were performed. An exploratory factor analysis on the five items (one item per part of the syllabus), with the recommendations of Costello and Osborne (2007) to use principal axis extraction and oblique rotation, revealed two factors with high loadings and no crossloading items: one with “The aim of the subject”, “Structure and nature of the subject” and “Goals to aim for” (accounting for ~65% of the variance) and one with “Goals that pupils should have attained on completion of the course” and “Grading criteria” (accounting for ~20% of the variance). An interpretation of this is that the five survey questions measure two different underlying constructs and therefore might not be suitable to sum (De Vaus, 2002). However both the factor analysis and an ocular inspection of the survey data reveal that the two questions relating to “Goals that pupils should have attained on completion of the course” and “Grading criteria” account for a small part of the variance and one can see that 1) most teachers has answered on the very high end of the scale and 2) those who has not done this has also answered low on the three questions that the first component consist of. The conclusion drawn from this is that the two questions mentioned do not function very well to distinguish between teachers’ sense of usefulness of the syllabus. Due to this only the three questions accounting for the largest part of the variance were used when constructing the scale. Cronbach’s alpha for these three questions is .884 and omission of any of the items would not render a higher alpha. The interpretation of the factor analysis, the inspection of data and Cronbach’s alpha is that the three questions selected can be interpreted as measuring a single underlying construct. The nature of this construct is teachers’ sense of how useful the whole syllabus is to them.

Although the survey questions relating to the syllabus used to answer 2a do not explicitly mention the competency goals, it is assumed that the teacher also thinks of this aspect of the syllabus when answering the survey questions. This assumption is based on the following. The constructs included under motivational factors are according to the CAMCC only relevant to teachers who have perceived the competence message as entailing a change for them (and thus have made at least a reasonable initial interpretation of the syllabus/national test, which include that one has noted the competency aspect of these documents). Furthermore the competency goals exist in a high proportion of the syllabus (Bergqvist and Bergqvist, 2014). These two things together form the basis for the assumption that the teachers’ answers to if they have found the different parts of the syllabus useful to process include the idea that the usefulness of the syllabus also relates to the writings about competency goals in the syllabus. This line of
reasoning is in some cases also applied below and then a reference to this section will be made.

5.2.5.1.1.2 2b: To what extent have the teachers had the reason: “that it is interesting in itself”, to interpret and analyze the syllabus and the national tests?

To answer question 2b of to what extent the teachers have had the reason: “that it is interesting in itself”, to interpret and analyze the syllabus and the national tests, the survey questions below were studied.

- To what extent have you had the following reason for interpreting the syllabus?
  - That it is interesting in itself.
- To what extent have you had the following reason for analyzing the national tests?
  - That it is interesting in itself.

The mean of these two questions is calculated and the value obtained is the answer to question 2b. The relation to question 2b is straightforward in that the survey questions are almost identical to 2b but make up for the different parts inherent in 2b.

5.2.5.1.1.3 2c: Are the teachers interested in mathematics?

Question 2c was answered by taking the mean of four survey questions supposed to measure the teacher’s interest in the subject of mathematics. The questions were:

- To what extent do you think mathematics is an interesting subject?
- To what extent do you find it exciting to discuss mathematics outside of school (on a level at which you feel comfortable with)?
- To what extent would you prioritize to watch a TV show about mathematics if it was on?
- To what extent do you find mathematics to be an enjoyable subject?

To ensure that these questions could be interpreted as measuring an underlying construct of interest in mathematics a test of internal consistency and a test of dimensionality were done in the same way as described above. To evaluate internal consistency of the four questions Cronbach’s alpha was calculated (alpha=.840). Omission of any of the survey questions would not have rendered a higher alpha-value. To control the dimensionality, an exploratory factor analysis was performed, and the analysis rendered one
factor with high loadings on all items explaining ~70% of the variance in data, which suggests unidimensionality. A reasonable interpretation then is that the questions all measure a single underlying construct of interest in mathematics and thus can be used in the way intended, i.e. that the mean of these questions functioned as an answer to question 2c.

5.2.5.1.1.4 2d: To what extent do the teachers think the syllabus and national tests represent a good choice of school mathematics?

To answer question 2d of to what extent the teacher has had “that it is interesting in itself” as a reason for interpreting the syllabus and analyzing the national tests two survey questions are studied. These questions were:

- To what extent do you think the syllabus represent a good choice of school mathematics?
- To what extent do you think the national tests represent a good choice of school mathematics?

The mean of these two questions is calculated and the value obtained is the answer to question 2d. The relation to question 2d is straightforward in that the survey questions are almost identical to question 2d but make up for the different parts inherent in the question.

5.2.5.2 Synthesis - Variable 3: Teachers’ expectations of succeeding to process and implement the competence message

To answer question 3 above four questions were used as indicators of whether the teacher believes that he or she has had the possibility to thoroughly process the competence message and implement it. The competence message were analyzed it is valuable to process and implement the competence message. These questions were:

3a Does the teacher think he or she has the ability to implement the competence message?
   \((\text{Mean value with minimum 1 and maximum 6})\)

3b Does the teacher think he or she has good enough conditions to implement the competence message?
   \((A \text{ value of 2 or 5})^9\)

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9 To obtain an answer to question 3, the sum of questions 3a-d is calculated. Answers to 3b are obtained by analyzing interview data. The analysis of the interview transcript assign teacher statements the value 2 or 5, which represent the extent (on the interval 1-6) to which teachers think they have good enough conditions to implement the competence message. The categories were chosen so that teachers who thought they had good enough conditions to teach in a way they wanted, were assigned 5, and teachers who did not think they had good enough conditions were assigned 2.
3c Does the teacher think that he or she has taken part in enough in-service training and has had enough time to read commentary material regarding the syllabus?
*(Mean value with minimum 1 and maximum 6)*

3d Does the teacher think that he or she has devoted enough time to interpret the syllabus and analyze the national tests?
*(Mean value with minimum 1 and maximum 6)*

Question 3 is answered by taking the mean of questions 3a-d. It is possible to calculate the mean of questions 3a-d to get a sort of index variable from question 3 because the questions 3a-d conceptually relate to different parts of the Expectation of Success-construct as it is described in Wigfield and Eccles (2000). The nature of the relation is outlined below.

- Question 3a relates to beliefs about one's ability, which in turn can be seen as a precursor to (that is empirically related to) beliefs about expectancy of success (Eccles and Wigfield, 2002). In this case it is teachers' belief in their ability to teach in accordance with the competence message that is measured. The relation to question 3 thus lies in the implementation part.
- Question 3b relates to expectancy and ability beliefs in that if teachers do not believe they have the necessary prerequisites to implement the competence message, their expectations on the success of doing so probably are low, whereas if they do not experience that their working conditions limits what goals to set for their students it might be assumed that they expect to succeed in implementing a teaching that helps the pupils reach the goals.
- Question 3c on a general level relates to expectancy of success of processing of the competence message. If teachers do not believe that they have taken part of enough in-service training, this is interpreted as teachers finding the task of processing the competence goals of the syllabus too difficult. This is where the connection to expectancy of success lies since difficulty of task can be seen as an aspect of expectancy of success (Eccles and Wigfield, 2002). As discussed above this interpretation depends on that the teachers have perceived the competence message as entailing and important and non-trivial change for them (see Section 5.2.5.1.1.1).
- Question 3d is interpreted in a similar way as question 3c in the sense that it interpreted to relate to difficulty of task. The task at hand is processing of the competence message. If teachers consider themselves to not have devoted enough time on interpreting the syllabus and analyzing the national tests, this is
taken as an indication of that the task is difficult, given the circumstances. Again this interpretation relies on teachers having perceived the competence message as entailing an important and non-trivial change for them (see Section 5.2.5.1.1.1).

5.2.5.2.1 Data 3a-d: How answers to questions 3a-d were obtained
In this section accounts are made of the connection between interview or survey data, and the questions (3a-d) used on the synthesis level.

5.2.5.2.1.1 3a: Do the teachers believe that they can implement the competence message?
Question 3a was answered by taking the mean of nine survey questions asking the teacher to state how confident the teacher felt in being able to help his or her pupils develop different competencies (on a scale from 1-6 with integer values). The questions connected either to writings of the syllabus or national test tasks and two examples of how the questions were presented are given below. For the five questions connected to the syllabus an excerpt of the syllabus was first presented and after that the question was asked as can be seen from the example that follows.

The school in its teaching of mathematics should aim to ensure that pupils: /.../ develop their ability to follow and reason mathematically, as well as present their thoughts orally and in writing (Swedish National Agency for Education, 2001b, p.60)

- How confident are you that you can help your students develop the ability to follow and carry out mathematic reasoning?

For the questions connected to the national tests a national test task was first presented and after that the teacher was asked a question, as can be seen from the example that follows.
Martin and Johanna are to buy a new car. Johanna likes a car that costs 194 000 kr. Martin claims that the value of this type of car drops by approximately 17% every year. They are thinking about how much the car would be worth in three years and both calculate this in their own way. Martin’s calculation. Johanna’s calculation. Who has interpreted the problem correctly? How might Martin and Johanna have reasoned?

- How confident are you that you can help your students learn to argue for their conclusions, for example in the way that is required when solving Task C?

The procedure for ensuring that these questions measure an underlying construct of expectation of success with implementing the competence message and thus are suitable to take the mean of is the same as with 3a and 3c. Ten questions survey questions (of which two are exemplified above) were selected because they were deemed to conceptually relate to question 3d. After that tests of dimensionality and internal consistency were performed. In this case one of the items was dropped due to the test of internal consistency giving a slightly higher Cronbach’s alpha if that particular item was dropped. For the nine questions used to construct the scale, Cronbach’s alpha was alpha=.95 and omission of any of the items would not render a higher alpha. A test for dimensionality was performed in the same way as under 3a and 3c. The exploratory factor analysis revealed a one-factor solution with high loadings on all items. The test of internal consistency and the test for unidimensionality together suggest that the nine items can be combined to form a scale and that the scale can be interpreted.
as a measure of one single underlying construct of the teachers’ self efficacy regarding their ability to implement the competence message. The relation to question 3a then is rather straightforward since according to Eccles and Wigfield (2002), measuring of expectancy of success and measuring of self-efficacy can be said to be analogous.

5.2.5.2.1.2 3b: Do the teachers believe they are working under sufficiently good conditions for them to be able to implement the competence message?

Question 3b was answered by analyzing interview transcripts of the teachers’ answers to the question:

- Would you have other goals if your work conditions were different?

The “other goals” of the question refers to the teachers’ own goals for their students’ learning. If teachers had answered “no” or similarly to the interview question they were assigned the value 5 as an answer to question 3b. If they had answered “yes” or similarly they were assigned the value 2 as an answer to question 3b. Examples of statements where teachers were considered to have answered “no” or similarly, or “yes” or similarly, are given below.

- If I had an NV-class, then I would have done much more problem solving. I think you could have more projects and open-ended tasks. Break new ground and build models. But now you just have to deal with the situation as it is. (“yes”)
- Yes, if they had a better knowledge when I get them there would be more problem solving and communication. (“yes”)
- No, I would have the same goals. (“no”)
- The goals would be the same, but I would distribute the time a bit differently. (“no”)

The interpretation of the teachers’ answers above and the coding of them into answers of question 3b rests on the notion that if teachers would not have other goals for their students if they had other work conditions, then they are in some sense satisfied with their work conditions. At least they are satisfied in the sense that the work conditions do not hinder the teachers to give their students opportunities to learn directed at the goals the teachers have for their students. That this also can be interpreted to relate to the competency goals is because 1) this construct is only relevant to those teachers that believe the competence message entails a change for them (see Section 5.2.5.1.1.1), and 2) hindering conditions likely hinder the teachers to
implement any of the goals they have for their students in the way they like; i.e. this also hinders implementation of the competency goals.

5.2.5.2.1.3 3c: Do the teachers believe they have taken part of enough in-service training and professional development?

Question 3c is answered by taking the mean of two survey questions. Because the survey questions are follow up-questions to two other survey question a total of four survey questions are presented. It is the follow up questions that the mean, which is taken as the answer to questions 3c, is calculated from.

- To what extent have you participated in professional development on the syllabus in mathematics (1994/2000)?
  - To what extent has this been enough for your needs?

- To what extent have you read any commentary material on the syllabus in mathematics, for example from The Swedish School Agency or followed discussions of the syllabus in Nämnaren?
  - To what extent has this been enough for your needs?

The relation between the follow up survey questions and question 3c is straightforward in that the survey questions are almost identical to question 3c but make up for the different parts inherent in question 3c.

5.2.5.2.1.4 3d: Do the teachers think that they have devoted enough time to interpret the syllabus and analyze the national tests?

Question 3d is answered by using the same procedure as for question 3c but with the following survey questions:

- To what extent do you experience that the amount of time you have spent on interpreting the syllabus have been enough?

- To what extent do you experience that the amount of time you have spent on analyzing national tests have been enough?

Again the relation between survey questions and question 2bv is straightforward and lies in the formulations of the questions.

5.2.6 Variable 5: Intention

The CAMCC stipulates (as described in Section 4.1) that teachers who has perceived the competence message as entailing an important and non-trivial change for them, depending on motivational factors (i.e. expectancy and

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10 The years 1994, and 2000, refers to the year when the syllabus was introduced and the year it was revised.
value, and the interaction of the two) and ability, will either intend to approach or avoid systematic processing of the competence message. The overarching question here therefore is:

5 To what extent has the teacher had an intention to systematically process the competence message in the syllabus and national tests?  
(*Mean value, 1-6*)

Because it is assumed that systematic processing of the competence message in either the syllabus or the national tests makes belief change (in the accommodation sense) possible (see Section 5.2.7 below), the question above is formulated in line with this idea. A high value assigned to this question is thought of as an indication of an approach intention while a low value is thought of as an indication of avoidance intention. To answer this question the two questions inherent in the formulation were studied.

5a To what extent has the teacher had an intention to systematically process the competence message in the syllabus?  
(*Mean value, 1-6*)

5b To what extent has the teacher had an intention to systematically process the competence message in the national tests?  
(*Integer Value, 1-6*)

The values obtained to these two questions were summed and it is this sum that is the answer to question 5.

5.2.6.1 Data 5a: Have teachers had the intention to systematically process the syllabus?

Question 5a of whether the teacher has had an intention to process the competence message in the syllabus was answered by analyzing Likert scaled (1-6) survey questions formulated as:

- To what extent have you been motivated to thoroughly interpret what is written in the syllabus under the headings:
  - Aim of the subject?
  - Goals to aim for?
  - Structure and nature of the subject?

The teachers’ self reported extent of motivation is thus taken as an indication of approach or avoidance intention. If the teacher states that he or she has been highly motivated to process the syllabus, then the interpretation of this is that he or she wanted to do this, i.e. had an approach
intention. This interpretation is based on experience that phrases like “I am motivated to process the competence message in the syllabus”, does not reveal 1) that the person will choose to do this, 2) the persistence with which the person will process the message (if he chooses to), and 3) which effort the person will put into processing the message (if he chooses to), which are the three things that are central to definitions of motivation. Instead, again based on experience, these kinds of phrases rather indicate what a person wants to do, which is closer to intention than motivation. Although the survey questions does not ask specifically of whether the teacher has been motivated to process the competence message of the syllabus, the part of question 5a stating that the processing is of the competence message is still reasonable for the same reasons given in Section 5.2.5.1.1 above. The teachers were asked the same question in relation to every part of the syllabus, which consists of five parts, but only the three parts mentioned above are used to answer question 5a. A short account of the reasons for this is first given and then an explanation of how the questions survey questions stated above were combined to give an answer to question 5a is given.

An exploratory factor analysis on the five items (one item per part of the syllabus), with the recommendations of Costello and Osborne (2007) to use principal axis extraction and oblique rotation, revealed two factors with high loadings and no crossloading items: one with “The purpose of the subject”, “The subject’s character” and “Goals to strive for” (accounting for ~65% of the variance) and one with “Goals to attain” and “Grading criteria” (accounting for ~18% of the variance). One interpretation of this is that the five survey questions measure two different underlying constructs and therefore might not be suitable to sum (De Vaus, 2002). However both the factor analysis and an ocular inspection of the survey data reveal that the two questions relating to “Goals to attain” and “Grading criteria” account for a small part of the variance and one can see that 1) most teachers has answered on the very high end of the scale and 2) those who has not done this has also answered low on the three questions that the first component consist of. One conclusion that can be drawn from this is that the two questions mentioned do not function very well to distinguish between teachers’ degree of stated motivation to thoroughly interpret the syllabus. Due to this only the three questions accounting for the largest part of the variance are used when constructing the scale. Cronbach’s alpha for these three questions is 0.917 and omission of any of the items would not render a higher alpha. The interpretation of the factor analysis, the inspection of data and Cronbach’s alpha is that the three questions selected can be interpreted as measuring a single underlying construct. The nature of the construct is the teachers’ stated motivation to thoroughly interpret the whole syllabus.
The mean of the three survey questions arrived at above is the answer to 5a. In cases where there were missing answers to one of the survey questions the mean was calculated from the two other questions. Because the measure on this variable is based on experience of what persons usually means with statements such as: “I am motivated to...”, this variable might not be able to capture the construct of degree of approach intention. How this is dealt with in the analysis of the CAMCC-data is explained in Section 5.2.9 (with subsections).

5.2.6.2 Data 5b: Have teachers had the intention to systematically process the national tests

Question 5b corresponds directly to the survey question reproduced below.

- To what extent have you been motivated to thoroughly analyze what types of knowledge (in the meaning of competencies as discussed during the interview; e.g. communication and reasoning) that is tested in the national tests?

The teachers’ stated extent of motivation is the answer to question 5b. The same line of reasoning as made under the previous paragraph concerning the interpretation of the survey questions formulation of “To what extent have you been motivated to...” as being an indication of “intention to process” as formulated in 3b is supposed to hold here and will not be reiterated.

5.2.7 Variable 6: Systematic processing

When it comes to what type of processing the teacher has made, one would in relation to the CAMCC ultimately want to know if the teacher has made a systematic or heuristic processing of the competence message. As already mentioned in Section 4.2 several theories on conceptual change where the component of processing is present view the processing aspect as a continuum of engagement rather than as distinct categories (see e.g. Dole and Sinatra, 1998, and Chaiken et al., 1989). Therefore lack of indications of systematic processing is in this study interpreted as a sign of heuristic processing. This interpretation is of course only reasonable if the teachers at some point have come into contacts with the message, for if they had not noticed the message at any time, the lack of indications of systematic processing would not indicate a heuristic processing but rather no processing of the competence message at all. However, some fifteen years after the competence reform was introduced in the syllabus and the national tests all of the teachers most likely have come into contact with the message in one form or the other. Therefore the overarching question intended to give a measure on the variable Systematic processing is:
Are there indications that the teacher has made a systematic processing of the competency goals in either the syllabus or the national tests? (Yes / Partly / No)

This overarching question is answered by studying the two questions inherent in the formulation:

6a Are there indications that the teacher has made a systematic processing of the competency goals in the syllabus? (Yes / Partly / No)

6b Are there indications that the teacher has made a systematic processing of the competency goals in the national tests? (Yes / Partly / No)

Depending on the combination of answers to these two questions a teacher has, an answer to question 4 is assigned in accordance with Table 5 below:

Table 5

<table>
<thead>
<tr>
<th>6a Syllabus</th>
<th>6a National tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Partly</td>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The organization of Table 5 with a Yes on either of the questions 6a and 6b resulting in a Yes, a Partly on either of the questions resulting in a Partly (if Yes is not an answer to either question) and only No to both questions assigning a No to the overarching question implies that it does not matter which of the sources that have been processed. This organization of the table is appropriate because the CAMCC does not specify that a certain source has to be systematically processed, but rather it is the message itself that has to be processed (disregarding which source it comes from) in order for belief change (in the sense of accommodation) to be possible.
5.2.7.1 Synthesis 6a-b: Indications of systematic processing of the syllabus or the national tests

Answers to question 6a and 6b were obtained by synthesizing information from analysts’ analyses of interview transcripts, and teachers’ answers to survey items. The synthesis of these different kinds of data is accounted for in this section and after that, on the data-level, a presentation is made of procedures describing how selected parts of the interview transcript were to be analyzed by the analysts. In order to understand the synthesis it is important to know that the information obtained from the analysis of interview transcripts were in the form of answers (Yes, Partly and No) to questions formulated exactly the same as 6a and 6b. The synthesis step thus can be described as a way to refine the information retrieved from analysis of interview transcripts by weighting this information with survey data. The survey questions that the information obtained from analysis of interview transcripts were weighted with were:

- To what extent have you devoted time to interpret the syllabus?
- To what extent have you devoted time to analyze the national tests?

If the teacher had answered one or two on the six point Likert scaled survey item, the answers retrieved from analysis of interview transcripts were weighted down one step; a Yes became a Partly and a Partly became a No. Because systematic processing requires time (Eagly and Chaiken, 1993), the answers obtained by analyzing the interview transcripts could in this way be improved by taking into account the teachers’ own estimates of how much time they had spent on interpreting the syllabus or analyzing the national tests. The argument for only weighting answers obtained from the interview analyses downwards is that when survey answers indicate that the teacher has dedicated a lot of time on interpreting the syllabus or analyzing the national tests one does not know if this time is associated with processing of the competency goals in the syllabus or the national tests, but when the teacher states that he or she has spent little time on interpreting the syllabus and analyzing the national tests one can say that they overall (according to their own estimates) has spent little time with the syllabus and the national tests. That the teacher has spent little time overall means that the teacher has not spent a lot of time processing the competency goals of the syllabus or the national tests. Table 6 below illustrates how the synthesis of survey answers and answers obtained from the analysis of the interview transcripts (already described above) is carried out.
### Table 6

_How survey data and analysts’ analysis of interview data was used to obtain an answer to 6a, and 6b. Shaded area is output._

<table>
<thead>
<tr>
<th>Survey answer</th>
<th>Information from the interview of if the teacher has systematically processed the message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>Yes           Partly       No           No</td>
</tr>
<tr>
<td>3-6</td>
<td>Yes           Partly       No           No</td>
</tr>
</tbody>
</table>

#### 5.2.7.1.1 Data 6a-b: Description of the experts’ analyzes of interview transcripts

As stated before, the analysts’ analysis of interview transcripts were made in order to answer questions formulated exactly as questions 6a (i.e. Are there indications that the teacher has made a systematic processing of the competency goals in the syllabus?) and 6b (i.e. Are there indications that the teacher has made a systematic processing of the competency goals in the national tests?). The procedure for doing this analysis is described next. Transcribed answers from nine interview questions that could have generated answers involving aspects of processing of the syllabus were analyzed with the intention of finding presence or absence of indications of a systematic processing. These questions were asked in different parts of the interview and were formulated as follows in the list below.

- Do you experience that your goals for the pupils learning and your methods of teaching have been the same for a long time, or that they have changed over time?
- Have your view of the competency goals changed over time?
- Have your interpretation of the syllabus changed over time?
- What has foremost influenced you regarding your goals for the pupils learning?
- What has foremost influenced you regarding your methods of teaching?
- Approximately how large part of your and the pupils’ work during the lessons is guided by the textbook?
- To what extent are the different parts of the syllabus used?
- Do you think that there are some parts of the syllabus that you are affected by in your teaching?
- Have you in any way tried to interpret, understand, or process competency goals of the type that we describe?
Even though one hypothetically could find answers indicating presence or absence of processing anywhere in the interview, these nine questions were selected to limit the scope of the analysis while maintaining the best possible chance to get an accurate answer to the question formulated as 6a. Indications of that the teacher had made a systematic processing of the syllabus were exemplified to the analysts in the following way:

The teacher states that:
- his or her view of the goals (of school mathematics, both own and as interpreted from the syllabus) had changed over time
- the syllabus is an important factor influencing him or her and that he or she has focus on not only the goals to attain and the grading criteria parts of the syllabus
- he or she has worked with trying to understand and interpret the competency goals

The analysts, based on the interview answers and with the support of the examples of indications of systematic processing, made a judgment of whether teachers had systematically processed the syllabus. In practice (although no explicit rule was given) this usually meant that Yes was assigned to teachers if the analyst found that teachers considered: 1) themselves to have changed their goals and teaching, 2) the syllabus to be an influence and that the teacher focused not only on goals to attain and the grading criteria, and 3) themselves to have worked with interpreting the competency goals, then the teachers were classified with Yes. If the analyst did not find any of the above the teacher was categorized with No. Teachers who displayed one, or some, indications of having systematically processed the syllabus were categorized with Partly. An example of a teacher answer to the question: “Do you experience that your goals for the pupils learning and your methods of teaching have been the same for a long time, or have they changed over time?” that the analyst interpreted as one indication of that the teacher had systematically processed the syllabus is:

They change over time. That is what is fun with it. To find new things, to try them, to see, can I skip this, why does not this work, can I skip this? And to see the how things develop. [Interviewer asks follow up question: Is it both the goals and the methods that change?] The goals are from when the syllabus was introduced. But then again it of course takes time get into a new thinking when a new syllabus is introduced. One can read and see how it is, but then one of course has to work with it for some time, to see.
And then connect with methods to see what works. *(Transcribed teacher answer)*

For the question formulated as 6b the answers where obtained in a similar way, but instead of nine questions interview questions there were five interview questions analyzed. They were formulated as follows:

- Have your opinion of what pupils need to know to solve national test tasks changed over time? (2avi)
- Do you think that there is something in the national tests that you and your teaching are affected by? (1diii)
- Is there something in the national tests that you have found problematic regarding what the pupils should learn, and in that case what? (1ddiv)
- Have the national tests in any way worked as a support for you when interpreting the syllabus and the six competencies we describe? (3cii)
- Is there one or some of the six competencies that you think are tested more clearly than others in the national tests? (3ciii)

Examples of indications of systematic processing of the national tests that were given to the expert were that the teacher:

- states that his or her view on the national tests had changed over time
- states that the national tests are influencing him or her
- has opinions about what the tests imply that students should learn, that relates to competency goals
- thinks the national tests has been a support when interpreting the curricula
- thinks one or some of the competencies more obviously are tested in the national tests

A similar procedure as the one connected to the question of if teachers had systematically processed the syllabus, was used here. For teachers to be categorized with Yes, teachers usually had displayed signs of having systematically processed the national tests by: 1) stating that their view on the national tests had changed over time, 2) stating that the national tests influenced them, 3) stating that the national tests had been a support when interpreting the syllabus, and 4) stating that one or some of the competencies more obviously are tested in the national tests. An example of a teacher answer to the question: “Have the national tests in any way worked as a support for you when interpreting the syllabus and the six competencies
we describe?” that the analyst interpreted as one indication of that the teacher had systematically processed the national tests is:

Yes, absolutely. The grading guide is very helpful, not only when you grade the tests, but also for the teaching in general. They are an indication of where you are supposed to be at the time when the national tests are going to be taken by the students, and at what level their abilities to reason, explain, and communicate mathematics has to be. (Transcribed teacher answer)

5.2.8 Variable 7: Belief change
The last construct of the model is about whether the teacher has made a belief change in relation to a reform message (which in this case is the competence message) and what type of belief change the teacher has made. It is posited that this in part depends on whether the teacher has made a systematic or heuristic processing of the message. Apart from belief change depending on processing it is also conceived of as depending on teachers’ prior beliefs, and how teachers, after having processed the message, value the competence message. In the model, three possible outcomes exist: accommodation of the competence message, assimilation of the competence message, and no belief change. The question to be answered is thus:

7 Has the teacher accommodated the competence message, assimilated the competence message, or made no belief change?
(Accommodated / Assimilated / No belief change)

The categories: Accommodated, Assimilated and No belief change, listed after question 7 directly correspond to the possible end states of the CAMCC where an accommodation is a reflection of a true belief change, and where an assimilation can be described as for example a superficial adoption of the wordings of a reform message. No belief change is simply no belief change. To answer question 7, questions 7a-c (below) are studied. The questions 7a-c listed below relate to teachers’ knowledge of the competency goals, their beliefs about the centrality of the competency goals, and their priorities in relation to the competency goals. It is argued that different combinations of answers to these questions can function as indications of if the teacher has accommodated the competence message, assimilated the competence message, or made no belief change in relation to the competence message.

7a What knowledge of competency goals does the teacher show?
(Functional / Limited / Scarce)

7b Does the teacher consider the competency goals to be central?
(Yes / No)
Does the teacher consciously prioritize to give the students opportunities to develop the competencies? (Yes / Partly / No)

Table 7 below presents which combinations of answers to questions 7a-c that assign a certain answer to question 7. After the table has been presented arguments are given for why certain combinations of answers indicate a certain type of belief change.

Table 7

<table>
<thead>
<tr>
<th>7a Knowledge</th>
<th>7b Centrality</th>
<th>7c Consciously prioritized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>Yes</td>
<td>Accom.</td>
</tr>
<tr>
<td>Functional</td>
<td>No</td>
<td>NA</td>
</tr>
<tr>
<td>Limited</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Limited</td>
<td>No</td>
<td>Assim.</td>
</tr>
<tr>
<td>Scarce</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Scarce</td>
<td>No</td>
<td>Assim.</td>
</tr>
</tbody>
</table>

In order for teachers to be categorized as having made an accommodation of the competence message (i.e. a true belief change) it is required that they: 7a) have a functional knowledge of the competency goals, 7b) consider the goals to be central, and 7c) partly or fully consciously prioritize to give the students opportunities to develop the competencies (hereafter shortened to consciously prioritize the competency goals). The choice of which combinations that should assign accommodated to a teacher as an answer to question 7 is of course contingent on the meaning of the categories of 7a-c.

Without going into details about these meanings here (since these detailed descriptions are made below in Sections 5.2.8.1-5.2.8.3), short notes on what they mean are made throughout the following argumentation in order to make the arguments possible to understand.

Regarding the first requirement (i.e. that the teachers have to have a functional knowledge of the competency goals), it is trivial that teachers who have been categorized as having scarce knowledge of the competency goals cannot be considered to have accommodated the competence message. That a limited knowledge of the competency goals does not suffice hinges on what the category limited represents (which is elaborated upon in Section 5.2.8.1). In short it can however be said that teachers with limited knowledge has shown a lack of understanding of important aspects of the competency goals such as: their global character, their role as goals for the students, how they
can be expressed in the teaching, and/or the competency goals’ precise meaning. A functional knowledge of the competency goals is assumed to include understanding of these aspects, and therefore this is one of the prerequisites for teachers to be categorized as having accommodated the message.

The arguments for the second requirement, which are connected to the answers to 7b, are straightforward. Because the competence message (with associated competency goals) together with descriptions of what content the competencies should cover, if understood must be considered a fundamental aspect of what students should learn, it is required that the teachers consider the competency goals to be central. In practice (see Section 5.2.8.2 for details) this entails that teachers, in the beginning of the interview, should have mentioned at least one of the non-procedural competency goals as a goal for the students. That it is deemed sufficient for teachers to only mention one non-procedural competency-related goal has to do with the opportunities the teachers got during the interview to talk about this. Whereas question 7a, of what knowledge the teachers show signs of, is answered by considering the whole interview, question 7b, of if teachers believe the competency goals to be central, is based on only a certain part of the interview. A consequence of this is that the teachers only had limited time to discuss their goals for the students. In addition it has to be noted that there of course are many different types of goals that are reasonable to highlight when asked about what goals one has for the students. Therefore it is unreasonable to require teachers to mention many of the competency goals.

The third requirement for a teacher to be classified as having accommodated the competence message, relates to question 7c. This requirement states that it is sufficient that there in part are signs that the teacher consciously prioritizes the competency goals. The answer to question 7c is determined by analyzing both observation data and interview data. For reasons given in Section 5.2.8.3 below, the lowest of the indications found in either observation data or interview data is used as an answer to question 7c. Therefore it is not fair to set the requirement to high; it is for example not reasonable to require that accommodation imply that every lesson should contain lots of various competence activities in large amounts, and since only one lesson was visited the requirement on this specific lesson cannot be set too high. That is, Yes or Partly is seen as sufficient.

The category of assimilation is more inclusive than accommodation when it comes to the number of combinations of answers to 7a-c that assign this category to the teacher. Here both the categories Limited and Scarce are allowed when it comes to knowledge of the competency goals. Scarce is allowed because it is possible to have virtually no knowledge of the
competency goals and still have assimilated them. A teacher can for example be very enthusiastic about reasoning without the teacher’s ideas about reasoning resembling the reasoning competency.

Regarding if teachers consider the competency goals to be central both Yes and No are allowed as answers to 7b in order for a teacher to be categorized as having assimilated the competence message. Although teachers who have assimilated the competence message are positive to their own interpretation of the message, this does not necessarily entail the same notion of centrality of the message as a functional grasp of the competence message does. For example, one might see competency goals as goals that are added to content goals, and which one therefore can choose to focus on or not, rather than comprehending the competencies as being an integral part of what it is to know mathematics.

For the question 7c of whether the teachers consciously prioritize the competency goals, the answer Yes is excluded as allowed for a classification of assimilation of the teacher. The assumption here is that a teacher who has only assimilated the competence message cannot show strong signs of consciously prioritizing the competency goals. The exact nature of the answers to 7c is elaborated upon below, which will make it more concrete what the categories of the question actually entail.

Lastly the category of No belief change does allow the teacher to have a functional knowledge of the competence message. The CAMCC states that after systematic processing has taken place, teachers might yield to the message and accommodate it, or they might decide not to change their beliefs about the goals for the students of upper secondary school mathematics, for example if they do not find the message “intelligible, plausible, and fruitful for promoting students’ learning” (Gregoire, 2003, p.168). If teachers have a functional knowledge of the competency goals, but do not consider them to be central and also show no signs of consciously prioritizing the competency goals, then they are categorized as having made No belief change. The other sets of combinations of answers to questions 7a-c rendering no belief change as an answer to question 7 have the requirements that teachers should only have limited or scarce knowledge of the competency goals (7a), not consider them to be central (7b), and there should be no signs that they consciously prioritize the competency goals (7c). Again, what no signs that the teacher consciously prioritizes the competency goals means, is explained in Section 5.2.8.3 below, but one can already here note that this is not to be interpreted to mean that there were no opportunities at all for the students to develop competencies during the lesson observed.
5.2.8.1 Synthesis 7a: Teachers’ knowledge of the competency goals

Question 7a of what knowledge of the competency goals teachers show during the interview, is answered by analyzing the answers to questions i-iv (listed below), but also by considering the interview as a whole. The answers to questions i-iv had in turn been obtained by the analyst through study of competency indications (see Section 5.2.1.1 for details on what these are). Before the procedure given to the analysts as a support for answering questions i-iv is described, it is described how the answers to these questions, and considerations of the whole interview, were used when answering 7a. The questions i-iv are given in the list below.

i Has the teacher understood the global character of the competency goals?
\( \text{(Yes / No)} \)

ii Has the teacher understood the competencies’ role as goals?
\( \text{(Yes / No)} \)

iii Can the teacher exemplify how competencies can be expressed in the context of teaching?
\( \text{(Yes / No)} \)

iv Does the teacher generally express her or himself clearly when talking about competencies?
\( \text{(Yes / No)} \)

To obtain an answer of what knowledge the teacher show, the analyst was in a first step instructed to write a short paragraph, were a motivation is given of what knowledge of the competency goals that the teacher could be considered to show during the interview. This motivation was to be based on the four questions above, on study of competency indications, and (if needed) on qualitative information from the transcript of the interview. The analysts were also instructed to note if competency indications characterized as global and local, or as activity and goal were plenty, but only existed in relation to a few of the competencies. This motivation constructed by the analyst was only considered if the more quantitative analysis based on the instructions given below, could not capture an accurate answer to question 7a (as judged by the analyst).

The quantitative classification of what knowledge teachers showed during the interview was made by the analysts with the following instructions. If teachers had Yes on all four questions, the teacher was classified as having a Functional knowledge of the competency goals. If teachers had many competency indications (which usually meant above 40) but did not have Yes on all of the above questions the teachers were classified as having Limited knowledge of the competency goals. Lastly, teachers were classified as having
Scarce knowledge of the competency goals if they had few competency indications (which usually meant below 20), and that these were mainly vague.

The requirement that teachers had to have Yes as an answer to all four questions in order to be categorized as having a functional knowledge of the competency goals is argued for in the following. If a teacher has not understood the global character of the competencies (i), this will severely limit the teacher. For example this might entail that the teacher considers reasoning only to apply to a specific content (e.g. geometry) and not to other content areas. If a teacher does not understand the competencies’ role as goals (ii), the knowledge of the competency goals cannot be considered to be functional because without this understanding it seems improbable that the teacher systematically will arrange the teaching so that the students get opportunities to develop all of the competencies. Regarding question iii: even if teachers were to both understand the competencies global character and their role as goals, this helps them little if they cannot conceive of how they could be expressed in the context of teaching. If teachers cannot give their students opportunities to develop the competencies, their understanding of the competency goals cannot be considered functional. Lastly, if teachers do not have a clear understanding of what the competencies are, this severely limits their ability to give their students opportunities to develop them. These requirements as to what a functional knowledge of the competence message entails, and the reasons for these requirements, also implies that a No to any of the questions at least indicate that the teachers’ knowledge of the competence message is limited.

The reason that the quantity of competency indications was taken into consideration when differentiating between teachers with limited knowledge of the competencies and those with scarce knowledge of the competencies is given next. Because of the design of the interview (see Section 5.1.3), where focus increasingly was directed toward the competency goals, it was in practice impossible to not get any competency indications during the interview. For example the third part of the interview started with the interviewer presenting the competencies, and after this most questions asked directly connected to this presentation of the competencies. However, it is assumed that a teacher with limited knowledge of the competencies would have greater possibilities to talk about the competencies (even though they might talk about them in vague terms) when answering questions that did not direct attention to this topic, than teachers with scarce knowledge of the competencies. The teachers with limited knowledge would then get more competency indications, than teachers with scarce knowledge.
The written motivation (of what knowledge that the teachers could be considered to show), that the analysts were supposed to construct, was used in the following way. If analysts made the judgment that the rules given above did not accurately capture what knowledge of the competency goals the teachers showed during the interview, they were instructed to instead base the categorization of the teacher's knowledge on their own motivation of what knowledge the teacher could be considered to show. This happened in only a couple of cases. An example of where the quantitative procedure above might not have captured the teachers' knowledge, and where it would be appropriate to base the categorization of the teachers' knowledge of the competency goals on the analysts' motivation, was when a teacher for example had many competency indications characterized as global and local, and activity and goal, and where these competency indications always were in relation to only a couple of the competencies.

5.2.8.1.1 Data 7a: Analysts’ study of competency indications
To answer each of the questions i-iv, listed in the previous paragraph, each analyst was to study the competency indications obtained from analysis of the interview transcripts (see Section 5.2.2.1 for details on competency indications).

The question of whether the teacher understood the global character (i.e. that the competencies are independent of content; see Section 5.2.1.3 for details) of the competency goals (i) was answered by the analyst by looking at the number of competency indications that were global, and local. It was difficult to beforehand specify a certain number of competency indications that should be global in order for a teacher to be classified as having understood the global character of the competency goals. Therefore the analyst was instructed to study the number of competency indications that were characterized as being global, both in absolute terms, and in relation to the number of competency indications that were characterized as being local. The analysts were encouraged to motivate why they assigned a certain answer to the teacher. Especially this was to be done if there for example were a small number of competency indications (in both absolute and relative terms) that were characterized as global, but there still were reasons for why the teacher could be considered to have understood the global character of the competency goals. Also if global characterizations of competency indications were plenty but only in relation to one or two of the non-procedural competencies, the analyst should take this into consideration. Studying the analysts’ answers, one can conclude that commonly teachers were categorized with a Yes if there were more competency indications that were global than those that were local and with
a No if the opposite were the case. Few analysts qualified their answers in any other way.

The question about whether the teacher had understood the competencies’ role as goals (ii) was answered by the analyst after studying the amount of competency indications that were of the type goal. Again it was difficult to set a requirement on the number of competency indications characterized as being of goal type. The analyst had to make a judgment of whether there were enough competency indications that were of goal type for the teacher to be considered to have understood the competencies’ role as goals. Also here the analyst had to consider if the competency indications characterized as being of goal type only related to one or two of the competencies.

The question of whether the teacher could exemplify how competencies can be expressed in the context of teaching (iii) was answered by the analyst after studying how many of the competency indications that were characterized as local and global, and activity and goal. Again the analyst had to make a judgment in order to answer question iii. If there were few competency indications characterized as local and global, and activity and goal, this did not necessarily lead to a No on question iii. If there were plenty of competency indications characterized as local, and as global, or as activity, and as goal, this could be interpreted as the teacher being able to express how competencies can be expressed in the context of teaching. Also here the analyst had to consider if the competency indications characterized as being local and global, and activity and goal only were related to one or two of the competencies.

The question of whether the teacher generally expressed himself clearly when talking about the competencies (iv) was answered by the analyst after studying how many competency indications that were characterized as being clear in relation to the ones being vague. This brings fourth a qualitative aspect of the competency indications that is lacking in the three questions above. A teacher might very well have many competency indications that are characterized as global, as goal, and as local and global in addition to activity and goal, but still not have a functional knowledge of the competency goals because their grasp of the meaning of the competencies might be far off central aspects of the definitions of the competencies in the MCRF (or similar frameworks). Without going into detail of the distinction between vague, and clear competency indications (since this distinction is already described in Section 5.2.1.4) an example of a typical statement characterized as being vague is: “I want my students to learn how to use linear equations, and therefore I let my students solve problems where one would have to
solve linear equations\textquotedblright. This statement is vague because one cannot
determine whether the teacher talks about problems in the sense of the
MCRF, or in the sense of a task that does not have any special properties
apart from involving a requirement of solving linear equations.

5.2.8.2 Data 7b: Do the teacher believe the competency goals to be central?

Question 7b, of whether the teacher believes the competency goals to be
central, is answered by studying whether the teachers include competency
goals in their spontaneously stated goals. The idea is that teachers who
consider the competency goals to be central will spontaneously state that
they have these goals for their students. To answer question 7b, two things
are studied: 1) analysts' classifications of competency indications from
answers to three interview questions, and 2) the transcribed answers to the
questions. The three questions were asked in the beginning of the interview
(before the teacher knew that questions relating to competencies would be
asked during the interview). Below the interview questions are listed.

- What do you want your students to learn during mathematics
  lessons?
- How are you working to help students achieve what you want?
- Do you believe your students reach your goals?

By studying the analysts' classification of competency indications on these
three questions it was identified how many different non-procedural
competency goals that the teacher could be said to have mentioned as goals
for the students. Because traditional teaching is very much focused on the
procedural competency, what is of interest is if teachers mention non-
procedural competencies as goals for the students’ learning (because this can
be considered to be part of what is new with the competence message). In
addition to the study of the analysts’ classification of competency
indications, the interview transcripts to the questions were also analyzed.
This was done because the classification of competency indications does not
capture all possible goals that are of a similar type (as the competency goals).
If statements from the teachers could be interpreted to be about the same
type of goals this also counted as the teacher having mentioned a competency
goal as a goal for the students’ learning. For example, a goal mentioned
might not have been possible to interpret as being about any of the
competencies of the MCRF, but still might have been similar to a description
of competency-related goals from another framework describing the same
type of goals (for example the KOM-projects definitions of competencies
(Niss, and Jensen, 2002)). An example of such a statement is: “I want my
students to be able to think mathematically”. If teachers had mentioned at least one non-procedural competency goal, they were categorized with a Yes on question 7b, otherwise the category No was assigned.

5.2.8.3 **Synthesis 7c: Do the teachers consciously prioritize giving the students opportunities to develop the competencies?**

Question 7c of whether the teachers consciously prioritize giving the students opportunities to develop the competencies has Yes, Partly, and No, as categories. Before the procedures for how these answers are obtained are described, a reminder is given of how these answers to question 7c are used (in combination with answers to questions 7a-b) to determine whether a teacher has accommodated the competence message, assimilated the competence message, or made no belief change. The category Yes, on question 7c, is assumed to only be possible to achieve for teachers who have accommodated the competence message. The category No to question 7c on the other hand is chiefly used to discriminate between teachers who have assimilated the competence message, and those who have made no belief change. For example if a teacher has limited knowledge of the competency goals, and does not consider them central, then the answer to 7c will determine whether the teacher is categorized as having assimilated the competency message, or as having made no belief change. The teachers of the example, if categorized as not consciously prioritizing the competency goals (No on 7c), would be categorized as having made no belief change (on 7), whereas teachers if categorized as partly consciously prioritizing the competency goals (Partly on 7c) would be categorized as having assimilated the competence message. The assumption is that teachers, who have made no belief change, will not show signs of consciously prioritizing the competency goals, whereas teachers, who have assimilated the competency goals, might show some signs of this due to how the categories are derived (see Sections 5.2.8.3.1 and 5.2.8.3.2). For example, teachers who have assimilated the competence message reasonably can be assumed to talk about how they work with competencies (although in a superficial way) more than teachers who have made no belief change. The category No (on 7c) also has bearing for which teachers that are categorized as having accommodated the competence message. It is assumed that teachers who have accommodated the competence message must show some signs of consciously prioritizing the competency goals. Therefore teachers, who have a functional knowledge of the competency goals and consider them central, cannot be categorized if they do not have Partly or Yes on question 7c. With this in mind, focus now turns to how answers to 7c are obtained. Whether teachers consciously prioritize the competency goals is determined by studying the questions i and ii, listed below.
Are there signs from the interview that the teacher consciously prioritizes the competency goals?
(Yes / Partly / No)

Are there signs from the observations that the teacher prioritizes the competency goals?
(Yes / Partly / No)

From the interview signs are gathered from the teachers’ utterances of whether the teachers consciously prioritize to give their students opportunities to develop the competencies, whereas it from the observation are gathered signs from their actual teaching of whether they actually prioritize the competency goals (i.e. that they, when teaching, arrange opportunities for their students to develop the non-procedural competencies). How combinations of answers to questions i and ii above assign a certain answer to question 7c is displayed in Table 8 below.

Table 8

<table>
<thead>
<tr>
<th>ii - signs of prioritizing from the observations</th>
<th>i - signs of consciously prioritizing from the interview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Partly</td>
<td>Partly</td>
</tr>
<tr>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

In Table 8, one sees that the lowest of answers to questions i and ii is taken as the answer to question 7c of if a teacher can be said to consciously prioritize the competency goals in their teaching (e.g., a No from the interview and Partly from the observation render No as an answer to question 7c). That the combinations of answers Yes and Yes, Partly and Partly, and No and No (to 7ci and 7cii) render a Yes, Partly, and No respectively as an answer to question 7c (as represented by the diagonal from the upper left to the lower right of the table) is self explanatory. The other combinations might however need some explanation. The idea is that for teachers to be categorized as consciously prioritizing the competency goals, they must both show signs of enacting teaching that gives students opportunities to develop the competencies, and of that this is a conscious choice made by the teacher. Therefore, it is the lower of the two answers (to 7ci and 7cii) that renders the answer to question 7c. If teachers show no signs
of *consciously* prioritizing the competency goals during the interview, they cannot be considered to do this, and if teachers show no signs of prioritizing the competency goals during the observation (i.e. giving the students opportunities to develop the competencies) they cannot be considered to *consciously prioritizing* the competency goals. If one does not consider how answers to 7c are used, and the teachers’ opportunities to show signs of each of these things, it might seem like an overly tough requirement to use the lowest of the answers. Therefore a reminder was given in the beginning of this section of how the answer to 7c is used to when determining if a teacher is to be categorized as having made an accommodation, assimilation, or no belief change on question 7. This reminder highlights that for teachers to be categorized as having accommodated the competence message, only *Partly* on 7c is required, and because teachers had ample opportunities to display signs of being conscious about prioritizing the competency goals, and also considering that it might be difficult to wholly avoid working with the non-procedural competencies, even when focusing on procedures (Boesen et al., 2014), these requirements should not be considered unreasonable.

5.2.8.3.1 Data 7ci: Signs from the interview that the teacher *consciously* prioritizes the competency goals

Question 7ci, of whether there are signs from the interview that the teacher *consciously* prioritizes the competency goals, was answered by studying analysts’ answers to the following questions.

- What indications of presence or absence of competency activities in the teacher’s teaching exist?
- Is there information that explain why they are present or absent?

As will be seen below, the analysts’ answers to the above questions, were based on whether teachers during the interview talked about giving their students opportunities to develop the competencies. That the teacher can describe how he or she works with the competency goals can be seen as an indication that the teacher consciously chooses to do this. Therefore it is assumed that the analysts’ answers to the questions above can be used as indications of whether teachers consciously prioritize the competency goals or not. The procedure for analyzing the analysts’ answers to the above questions is described in the list below.

- **Type of analyst answers that were classified with No as an answer to 7ci.**
  
  If an analyst states that there are no or very few of indications of that competency related are present in the teaching or if the analyst lists several strong indications of that competency
activities are absent in the teaching, then the teacher is assigned No as answer to question 7ci. Furthermore, when an analyst states that indications of presence of competency activities are negligible in the light of indications of absence of competency activities No is assigned as an answer to question 7ci.

- **Type of analyst answers that were classified with Partly as an answer to 7ci.**

  If an analyst states that there are a few indications of presence of competency activities in the teaching, or if there are several indications of presence but at the same time also some indications of absence, the teacher is assigned Partly as an answer to question 7ci.

- **Type of analyst answers that were classified with Yes as an answer to 7ci.**

  If an analyst states that there are many indications of competency activities being present in the teaching, and at most only a few indications of absence, then the teacher is assigned Yes as an answer to question 7ci. Also if the analyst has stated that although there are not many indications of competency activities being present in the teaching but that the existing indications are very strong, the teacher is assigned Yes.

An example of an analyst answer that was categorized with a No is:

  Absent. The teacher states that he does not address the competency goals, so there are no indications that they are present in the teaching. (*SSI-analyst’s statement*)

An example of an analyst answer that was categorized with a Partly is:

  The teacher seems aware of communication and emphasizes this a bit. The teacher also mentions every-day mathematics in relation to problem solving. Weak students (i.e. mathematically) seem to be a reason for the teacher to focus on content goals and procedures. (*SSI-analyst’s statement*)

An example of an analyst answer that was categorized with a Yes is:

  Competency activities are present. The teacher can give clear examples from the observed lesson of that competencies were present. Furthermore, during the interview, the teacher connects competency goals with competency activities. (*SSI-analyst’s statement*)
5.2.8.3.1.1 Description of the experts’ analyses
In the previous section a description was given of how analysts’ answers to two questions were analyzed. The questions that the analysts had answered are restated below, and after that the instructions given to the analysts in order for them to answer the questions are presented.

- What indications of presence or absence of competency activities in the teacher’s teaching exist?
- Is there information that explain why they are present or absent?

To answer the above questions the analysts were first instructed to summarize transcribed answers to seven interview questions (see list below). The summarizing of each transcribed answer was to be done by removing superfluous statements made by the teachers (superfluous in the sense that the statements could not be considered as an answer to the question asked) and thereafter the analyst were to write a condensed answer capturing the statements in the transcript that directly related to the question asked, in one or two sentences. The seven interview questions were:

- Who chooses which textbook that is to be used, and on what grounds are textbooks chosen.
- How do you teach in order for your students to reach your goals?
- Is it possible to connect any activity that you organized during the lesson you taught while I was visiting to any of the competencies?
- Do you think it is/would be difficult to work with the competency goals in the teaching?
- In what way?
- Why is it difficult?
- Do you consider that the students reach your goals?
- Do you consider your students to develop the six competencies?
- Would you have other goals if you had different working conditions? (Other goals refer to goals besides the ones teachers have stated that they have for their students.)

Secondly the analysts were to study the summarized answers to the seven questions listed above, and thereafter answer the questions of whether there are indications of presence of competency activities and whether there are indications of why this is or is not the case. Although no further instructions were given to the analysts it should be reminded that each analyst had taken part in a one day training in the collection and analysis of data, and that they also had been encouraged to contact a member of the research group if questions were to arise during any of the phases of data collection and analysis.
An example of how a transcribed answer was summarized, where this summarized answer lets the analyst draw the conclusion that this is one indication of the competencies being present in the teaching is given in the following. A truncated transcribed teacher answer is presented first (to the question of how the teacher teaches in order for the students to reach the goals):

I try in all my subjects not to solve the tasks in the textbook beforehand, instead I want to show how I think if I attack a problem. That is one thing. So, when I am put in front of a new task, hopefully I will not remember it but instead start to discuss with the student what we have and what we can use... *(Transcription of a teacher answer)*

The analyst then summarized this transcribed part of an answer into the following (again truncated) answer to the interview question.

The teacher tries to show how he goes about solving problems and at the same time involve students by discussing this with them... *(SSI-analysts’ summary of a transcribed teacher answer)*

This summary (together with summaries on the other questions) is then used when answering the questions of whether there are indications of presence or absence of competency activities in the teaching, and if there are indications of why this is the case. A part of the analysts’ answer (that is based on the summary of the transcribed teacher answer) to the last question was:

That the teacher explicitly connects to competencies when he talks about how he teaches /.../ and this indicates that competency activities are present in the teaching... *(SSI-analysts’ written statement)*

That it says competencies (plural) in the analysts’ answer above (even though mostly only the problem solving competency were talked about in the transcribed teacher answer) has to do with this answer being obtained by study of more questions than the one of which an answer was exemplified in relation to.
5.2.8.3.2 Data 7cii: Signs from the observations about presence of the competencies in the teaching

Question 7cii was answered by using results from analyses of lesson observations made by the SSI, which included both analysis of field notes and of tasks that the students had worked with during the lesson (see Section 5.2.2 with subsections for a detailed account of how lesson observations were analyzed). The results from the analysis of lesson observations used here contained information on how long each lesson was and of how much time during each lesson that the students had opportunities to develop the different competencies of the MCRF (the classification of opportunities to develop different aspects of each competency is not considered here). From this information two measures are constructed. The first measure is of how many of the different non-procedural competencies that the students had opportunities to develop during the observed lesson. The second measure is of how large proportion of the activities during the lesson that were focused entirely on giving the students opportunities to develop one or several of the non-procedural competencies. These two measures are combined to get an answer to question 7cii of if the teacher prioritizes the competency goals. Because it is difficult to argue for how these measures generate different answers to question 7cii without having a clear picture of what they are measures of, the construction of the measures is first accounted for.

The first measure (i.e. how many of the different non-procedural competencies that the students had opportunities to develop during the lesson) was constructed by counting how many of the different competencies that were present during the lesson regardless of the amount or length of these opportunities. Because it (as already stated above) is difficult to entirely exclude opportunities to develop the competencies during a lesson (Boesen et al., 2014), and because this measure does not take amount of time into consideration, this means that it will not be uncommon that observed lessons will include opportunities to develop many of the competencies (regardless of whether the teacher has accommodated the competence message or not). For example if only one activity that was five minutes in length during a ninety minute long lesson by chance were unusually rich (for the observed lesson) and presented opportunities to develop all five non-procedural competencies and the rest of the lesson only gave opportunities to develop the procedural competency, this measure would show that opportunities to develop all of the competencies were present during the lesson. It is thus not necessarily difficult to get high on this measure.

The second measure is obtained by subtracting the amount of time devoted to development of the procedural competency from the amount of
time that was devoted to opportunities for the students to develop one or several of the non-procedural competencies, and thereafter dividing this difference with the total lesson time. This measure therefore ranges from minus one to one. Minus one represents a lesson where only opportunities to develop the procedural competency were present, zero represents a lesson where equal amounts of time were devoted to development of procedural competency as to the other competencies, and lastly the value one represents a lesson where only opportunities to develop non-procedural competencies were present. The choice of constructing the measure in this way has to do with that it is difficult to wholly avoid giving opportunities to develop the non-procedural competencies, even when one focuses on the procedural competency (Boesen et al., 2014). Because of this, one gets a clearer indication of to what extent the teacher prioritizes the competency goals if it can be determined that the teacher has a greater focus on the non-procedural competencies than on the procedural competency, which this measure allows, and which a measure of for example only the amount of activities where opportunity to develop the non-procedural competencies cannot capture. One should note that this not is to be interpreted as some kind of ideal. As argued for in Boesen et al. (2014), a rich lesson would ideally include opportunities to develop all of the competencies.

To answer question 7cii both measures are considered. This is done based on the assumption that it is a stronger indication of that the teacher prioritizes the competency goals if the teacher both spends a large part of the lesson exclusively giving the pupils opportunities to develop any of the non-procedural competencies and also gives the pupils opportunities to develop many different competencies, than if just one of the measures are on the high end of their respective scale. Table 9 below displays what combinations of the measures that assign a certain category to 7cii.

Table 9

<table>
<thead>
<tr>
<th>Nr. of non-procedural competencies</th>
<th>Proportion of activities that solely focus on any non-procedural competency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 ≤ x</td>
</tr>
<tr>
<td>5</td>
<td>Yes</td>
</tr>
<tr>
<td>3-4</td>
<td>Partly</td>
</tr>
<tr>
<td>0-2</td>
<td>Partly</td>
</tr>
</tbody>
</table>
As can be seen in Table 9 above, the only combination of the measures that generates a Yes as an answer to question 7cii, is when students are given opportunities to develop all competencies during the lesson, and when there is more time devoted to students having opportunities to develop the non-procedural competencies than there is time devoted to the development of the procedural competency. These requirements might seem overly strong. However, because the category Yes here only is required in order to get a Yes to question 7c, and because Yes to 7c functions in the way that it is an answer not allowed if teachers are to be categorized as having assimilated the competence message or made no belief change in relation to the competence message, this requirement does not exclude teachers who have a functional knowledge of the competency goals to be categorized as having accommodated the competence message even if they only have Partly to question 7cii. The idea with this category functioning in this way is that even though it is difficult to wholly avoid working with the competencies, and even though the procedures used for categorizing observation data overestimate the opportunities to develop the non-procedural competencies, it is assumed that a teacher who has assimilated the competence message (or made no belief change) cannot (intentionally) give the students opportunities to develop all of the non-procedural competencies, and at the same time do this to such an extent that the second measure would indicate that more time during the lesson was spent on giving opportunities to develop the non-procedural competencies than the procedure competency (as captured by the proportion measure).

The limits for when a teacher is categorized as showing signs of prioritizing the competency goals are set the way they are because these amounts of opportunities to develop the non-procedural competencies (i.e. the amounts close to the limits) are, based on previous experience (Bergqvist et al. 2010a, and Bergqvist et al. 2010b), judged to not uncommonly arise by chance due to the both the difficulty of avoiding the competency goals but also because the procedures used to categorize observation data overestimate the amount of opportunities to develop non-procedural competencies (Bergqvist et al. 2010a; Bergqvist et al. 2010b). In addition to this one might here also be reminded that the proportion measure represents a comparison of opportunities to develop the procedural competency with opportunities to develop any of the non-procedural competencies combined. Again it can also be reminded that this category functions as a lower bound for what can be expected of a teacher who has accommodated the competence message (i.e. those teachers should not have been categorized with a no on 7cii), and also in part differentiates between if teachers are to be categorized as having assimilated the competence message, or having made no belief change.
5.2.9 Answering the research questions by statistical analyses of CAMCC-data

Research question 1:
To what extent has the competence reform, as communicated through the syllabus and national tests, resulted in teachers accommodating the competence message, assimilating the competence message, or in teachers making no belief change in relation to the competence message?

Research question 2:
Why have teachers accommodated the competence message, assimilated the competence message, or made no belief change in relation to the competence message?

Answers to Research question 1 and 2 are obtained in different ways, but all answers rely on the analysis of the CAMCC-data (obtained through the analysis procedures described in Sections 5.2.4-5.2.8 precluding this section). The answers to the first research question are arrived at by studying the variable Belief change in the CAMCC-data, whereas the answers to Research question 2 are obtained through statistical analysis of the relationships between all the seven variables of the CAMCC-data. Because a part of the statistical analysis is made through path analysis, a short account of what this technique entails will be presented before the analysis procedures are described. This is done to make reading of the results, and the descriptions of the analysis procedures, as intelligible as possible, also for those not familiar with the method. Furthermore, for those already familiar with path analysis, this means that lengthy descriptions of the details of this method can be avoided in the sections where the analysis procedures are described (and subsequently also where the results are presented). In Section 5.2.9.1 below, this short explanation of path analysis is given, and after that in Sections 5.2.9.2, and 5.2.9.3, the analysis procedures used to obtain the results that answer each research question are presented.

5.2.9.1 A short explanation of Path analysis
Before the short explanation of path analysis is given it should be noted that this short description obviously does not cover all aspects of path analysis and that simplifications are made when describing this method. The choices of what to focus on in the description are made based on what aspects of path analysis that are most relevant to this study.
Path analysis can be conceived as a way of investigating whether a model can explain the variation and covariation in a dataset. The word ‘model’ here refers to a set of relationships between variables. ‘Relationships’ (between variables) in turn refers not to any kind of relationships, but to the type of relationships that can be investigated with regression. The model to be tested is usually depicted in a path diagram, as in Figure 5 below, where A, B, and C are variables that are specified to relate to each other in a certain way.

Figure 5. Path model specifying that A influences B, which in turn influences C.

The model specified in Figure 5 is a model, which states that A is supposed to influence B, and that B is supposed to influence C (because of the arrows pointing in that direction). One does not see in Figure 5 above if the relationships between the variables are positive (i.e. high on A gives high on B, and low on A gives low on B) or negative (high on A gives low on B, and low on A gives high on B), so text accompanying the figure has to make this evident. If one were to have: 1) a theoretical model stating what relationships are supposed to exist between these three variables (e.g. as in Figure 5), and 2) a sample with data on the three variables A, B, and C, it would with path analysis be possible to test if this theoretical model can give an explanation of the covariation in data. It is important to note that already with three variables, there are several conceivable models that one can specify, and because of this, it is often possible to find a model that has a good fit (i.e. that can explain the covariation in data in a satisfactory way). Therefore it is important that one has a good idea a priori of what model to test (e.g. based on theoretical considerations), and not just try different models until one arrives at a model with good fit.

With the help of statistical software, path coefficients for the paths (i.e. the relationships between variables) of the specified model can be fitted to data (with regression). This renders what is called a fitted model, which for example can look like Figure 6 below. In Figure 6 one sees that the paths of the specified model displayed in Figure 5 now have path coefficients (.3 and -.4) associated with each path. These coefficients can be statistically significant or not, (although this is not illustrated in Figure 6). The interpretation of the coefficients depends on what scale that the variables are measured on.
have been measured on (and of course if they are statistically significant or not).

Figure 6. Path model with fitted coefficients.

The above coefficients at least tell us (if they are statistically significant) that the fitted model displays a positive relationship between A and B, and a negative relationship between B and C. In addition to the path coefficients, one also gets different measures of fit when running a path analysis. Whereas path coefficients specify the strength of relationships between variables (and if they are statistically significant), fit indices can be described as measures of how good the fitted model is at explaining the covariation in data. These measures of fit are determined by different means depending on which fit index is being calculated (see below for details on how they are determined). Some of the indices measure how good the model is at explaining the covariation in data in absolute terms and some by comparison with another possible model. Different fit indices might give contradictory indications; one index might indicate a good fit while another indicates a poor fit. If this happens when running path analysis, the recommendation is to consider a model to have poor fit if any one of the fit indices calculated indicates this. Through the examples below one can get a sense of why a model gets a good or bad fit without going into technical details. These examples also show how one might interpret the results of a path analysis, and how this interpretation is connected to a judgment of how good the theory (on which the specification of a model preferably is based) is at explaining the covariation in data.

When doing path analysis to assess whether a theoretical model can explain the variation in data, it is always important to consider the path coefficients and the fit indices. A fitted model can for example have a good fit, although one path lacks statistical significance. An example of this would be if there only was a large positive covariation between B and C in the data on the three variables A, B, and C, and a path analysis was made on the model depicted in Figure 5 above with this data. The path coefficient between A and B would be close to zero and not significant while the path coefficient between B and C would be positive and significant. Then because the fitted model (i.e. the model with path coefficients calculated) does account for the covariation in data (which only existed between B and C in
data) the fit indices of the model will indicate a good fit. It might seem peculiar that the model will have good fit, but this is a result of that fit indices only are concerned with evaluating how good the fitted model is at explaining covariation in data (as mentioned above). The indices alone do not function as an evaluation of whether the theory underlying the specification of the model can function as an explanation as to why data covaries in the way it does. This evaluation has to be done by the researcher (as explained below). Returning to the example, the fitted model of the example above has a good fit to data (in the sense that it sufficiently can account for the covariation in data) but it differs from the model specified in that the relationship between A and B is not significant. The model specified (i.e. the model that one wants to test) does then in some sense give an explanation to the covariation in data by being right in predicting that there would be a statistically significant positive relationship between B and C. On the other hand, the model specified does not explain why there is no covariation between A and B. How this effects an evaluation of the usefulness of the theory (from which the specified model is derived) is an open question. Reasonably however, one should (besides obviously relating the fitted model to the theory underlying specification of the model that was fitted), consider if there are explanations as to why one got these results from the path analysis. These considerations can for example be of whether there are competing theories that have alternate ideas about the nature of the relationships of the constructs of the theoretical model, and whether the quality of data is good enough.

Fitted models can also have all paths significant and with the right sign (i.e. in concordance with the theory guiding how to construct the specified model), and still have a bad fit. If there was a large covariation between all variables A, B, and C in data, a path analysis made on the specified model in Figure 5 would render a fitted model with significant path coefficients, but possibly with poor model fit. This means that the fitted model cannot account for all of the covariation in data. In turn this means that the specified model does not give a good explanation of the covariation in data, because the relationships predicted to exist in the model, does not explain why for example A and C has covariation unaccounted for by their indirect relationship through B (if this were to be the case). Besides information relating to the path coefficients and fit indices, most software products used for path analysis also give suggestions on how re-specifications (e.g. addition of a path) of the model would improve fit. These suggestions are made with reference to what is called a modification index, and if you get several suggestions these are ranked by which re-specification of the model that would render the biggest increase in fit. One has to be careful with which suggested re-specifications should be made. This has to be considered in relation to if they make theoretical sense, so that one does not go astray and
specifies models that have no reasonable interpretations. The software does not discriminate between reasonable re-specifications of the model and unreasonable ones, it only suggest those re-specifications that would improve model fit. In this study the software Mplus 7 (Muthén and Muthén, 1998-2012) is used, and this software was chosen because of its capability of handling categorical variables in path analysis.

5.2.9.1.1 Fit indices used in this study
As mentioned above, fit indices can be thought of as measures of how good a fitted model is at explaining the covariation in data. In this study the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Chi-square are used when evaluating if a model has good fit. Without going into details, the nature of each measure is shortly described in the following. The Comparative Fit Index (CFI) fit index makes a comparison of the fitted model with a model where variables are assumed to not have any correlation (i.e. an independence model). The measure ranges from zero to one and one can interpret it as how much better the fitted model can account for covariation in data as compared to the independence model. The Tucker Lewis Index (TLI) is similar to CFI in that it ranges from 0 to 1, and also is based on the comparison between the fitted model and a model where variables are assumed to not have any correlation. Root Mean Square Error of Approximation (RMSEA) is based on a comparison between the covariation in data and the covariation that the fitted model can reproduce. Smaller values are better, because they mean that the covariance matrix of the data does not differ that much from the covariance matrix reproduced by the fitted model. The Chi square-test also assesses the magnitude of discrepancy between the sample covariance matrix, and the fitted covariance matrix similarly to the RMSEA. The criteria, for what values of the indices that indicates a good fit for a fitted model, used in this study are as recommended by Hu and Bentler (1999): CFI > .95, TLI > .95, RMSEA < .06, and the Chi-square test should not be statistically significant. As mentioned above models are not considered to have a good fit unless all indices indicate a good fit.

5.2.9.1.2 A short note on sample size
There exist different recommendations of how large the sample size has to be in order for path analysis to be meaningful. In this study all path analyses meet the minimum requirement that the number of observations should be at least five times greater than the number of free parameters in the model, suggested by Bentler and Chou (1987).
5.2.9.2 Analysis procedures generating an answer to Research question 1

Research question 1:
To what extent has the competence reform, as communicated through the syllabus and national tests, resulted in teachers accommodating the competence message, assimilating the competence message, or in teachers making no belief change in relation to the competence message?

The first research question is answered by studying the variable of Belief change constructed from the overarching question: “Has the teacher accommodated the competence message, assimilated the competence message or made no belief change in relation to the competence message?” (see Section 5.2.8 for details). By studying the frequencies of how teachers have been categorized on the variable, it is possible to evaluate the reform’s effect on teachers’ beliefs. Not because this is an experimental study, but because the syllabi and the national tests are the main direct ways that the competence message has been communicated consistently and because this message is considered to be new to the teachers at the time it was introduced (as argued for in Section 2.1). The results on Research question 1 are presented in Section 6.1.

5.2.9.3 Analysis procedures generating an answer to Research question 2

Research question 2:
Why have the teachers accommodated the competence message, assimilated the competence message, or made no belief change in relation to the competence message?

The second research question is answered by investigating if the CAMCC can give an explanation of why teachers have changed their beliefs in certain ways or why they have not done so. The investigation will be made by studying if the relationships between variables, stipulated by the CAMCC, can explain the variation and covariation present in the CAMCC-data. Some relationships in the model are only relevant to those who have perceived the competence message as entailing an important and non-trivial change for them, and one relationship is only relevant to those who have not perceived this. Therefore the data set will be split in two groups based on whether the teachers have or have not perceived the message as entailing an important and non-trivial change to them. For convenience the group of teachers who
have not perceived the competence message as entailing an important and non-trivial change will be referred to as group $N$ (as in “No they do not perceive this”), whereas the group of teachers who have perceived the competence message as entailing an important and non-trivial change will be referred to as group $Y$ (as in “Yes they do perceive this”).

The two groups $N$ and $Y$ are studied separately with the help of different statistical means. This is done because of the differences in the types of relationships between the variables relevant to each group of teachers. After this is done, an evaluation of the CAMCC’s ability to give an explanation of the variation and covariation existent in data is given. To illustrate the relationships that are relevant to the different groups of teachers, a version of the figure of the CAMCC presented in Section 4.2, is given below in Figure 7.

In Figure 7, it might seem peculiar that there is a dotted arrow that leads to Motivational factors from Implicates self, whereas a regular arrow leads to Systematic processing from Implicates self. The reason for this has to do with what the arrows represent in the figure, and therefore also with the interpretation of the model. A full account of this interpretation is found in Section 4.2. Here a short reminder of the interpretation is given to make the descriptions of the analysis procedures easier to follow. The model states that it is necessary for teachers to have perceived the competence message as entailing an important and non-trivial change in order for them to have the possibility of making a systematic processing of it. This means that teachers who do not perceive the competence message as entailing a change will not systematically process the message (which means there is a connection between not having perceived the competence message as entailing a change and the degree of processing). It is however only a necessary and not sufficient condition. For those who have perceived the competence message as entailing an important and non-trivial change the degree of processing depends on other variables (Motivational factors and Intention). The arrow from Implicates self to Systematic processing is therefore regular (so that it in line with other regular arrows of Figure 7 represent that there is a direct relationship between the two variables). That the arrow between Implicates self and Motivational factors is dotted then has to do with there being no direct relationship between these two variables. It however signifies that the left-hand side of Figure 6 only is relevant to those who have perceived the competence message as entailing an important and non-trivial change (i.e. the teachers in Group $Y$). Next, the analysis procedures pertaining to group $N$ and $Y$ respectively are presented.
Figure 7. Illustration of what constructs of the CAMCC that are focused on in this study and how they relate to each other.

5.2.9.3.1 Study of group N

For group N (i.e. the teachers who have not perceived the competence message as entailing an important and non-trivial change to them) there are two relationships that potentially can explain the variation and covariation present in the CAMCC-data (and ultimately why teachers changed their beliefs in certain ways or did not do this). These relationships are the ones on the right-hand of Figure 7 (above) ending with Belief change. For clarity this part of Figure 7 is presented by itself in Figure 8 below (caveat: Figure 8 should not be interpreted to represent a regression model; how it is to be interpreted is presented below).
We see from Figure 8 that for group $N$ there is a direct relationship between *Implicates self* and *Systematic processing*, and a direct relationship between *Systematic processing* and *Change*. As stated in the caption, this particular depiction is not to be interpreted as a regression model. The nature of each relationship is described in 1 and 2 below.

1. The relationship between *Implicates self* and *Systematic processing* is that teachers who have not perceived the competence message as entailing an important and non-trivial change (i.e. all teachers in group $N$) will not have made a systematic processing of the competence message.

2. The relationship between *Systematic processing* and *Belief change* is that *Systematic processing* influences what type of change that is possible for a teacher to make.

The first relationship is a prediction of to what degree the teachers of group $N$ will have systematically processed the competence message. The CAMCC states that those who have not perceived the message as entailing an important and non-trivial change will not systematically process the message. By studying the distribution of teachers over the different categories (*Yes*, *Partly*, and *No*) of the variable *Systematic processing* it is determined if this relationship could explain the variation in the CAMCC-data on the variable *Systematic processing*. The second relationship posited above is examined by studying if there is an association between the two variables *Systematic processing* and *Belief change*. Because both variables are categorical, this is done by interpretation of the contingency table where *Systematic processing* and *Belief change* are cross-tabulated. Fisher’s exact test is calculated to see if an association (if observed) can be considered to have arisen by chance or not.

5.2.9.3.2 Study of group $Y$

For group $Y$ (i.e. the group of teachers who have perceived the competence message as entailing an important and non-trivial change for them), there are five relationships that possibly can explain the variation in the CAMCC-
These relationships are the ones starting on the left-hand side of Figure 7 (above) in motivational factors, and ending in Belief change. For clarity this part of Figure 7 is extracted and presented by itself in Figure 9 below.

Figure 9. The left part of the CAMCC.

The relationships of Figure 9, represented by arrows between variables, specifies that:

1-3 Motivational factors (i.e. Value, Expectancy, and the Interaction between the two) influences Intention
4 Intention influences degree of Systematic processing
5 Systematic processing influences Belief change

For group Y path analysis is utilized in order to study if the set of relations between variables together can explain the variation observed in the CAMCC-data. This method is used because of the advantage (over e.g. doing a series of separate regressions) that it generates a measure of how well the model (i.e. the set of relations specified) fits the data.

The path analyses starts with the model specified in Figure 9 above. If the model has a good fit, the path coefficients are studied next and an interpretation of the model is being made. If all path coefficients are significant and with the predicted sign, testing of other reasonably conceivable models will ensue to see if there is a model with an even better fit. If some of the path coefficients are not significant, theoretical and methodological considerations guide a re-specification of the model. Also
suggestions based on modification indices (see Section 5.2.9.1) are considered when re-specifying the model. If the model does not have a good fit, the same considerations made when paths were not significant guide re-specification of the model. This procedure is repeated until: 1) there is a model with good fit, with all path coefficients statistically significant and with the direction in accordance with what theory predicts, and 2) no other reasonably conceivable model has a better fit, or 3) the idea of the CAMCC being able to account for the variation in data of the teachers who have perceived the competence message as entailing an important and non-trivial change has no support.

As mentioned above, theoretical and methodological considerations are to be made when re-specifying a model (if one would need to do this). The methodological consideration is here a consideration of the quality of the analyses procedures used to generate the data on the variable Intention. Some uncertainty exists as to whether the analysis procedures generating data on the variable Intention actually can obtain measures that can function as representations of the theoretical constructs of approach and avoidance intention (as mentioned in Section 5.2.6). Therefore this variable is included in the analysis with the caveat that it (if retainable) might have to be interpreted with caution. The theoretical considerations have to do with which re-specifications that can be justified in relation to the CAMCC or research relating to the constructs of the CAMCC. It would for example be difficult to argue based on the CAMCC for a re-specification of the model to test, that said that Systematic processing influences Intention. These considerations direct what modification indices to pay heed to and (as mentioned) how to re-specify models. Throughout the presentation of the results stemming from the path analyses, the theoretical and methodological considerations are made explicit.
6 Results

The presentation of the results of this study is arranged in two parts directly relating to the two research questions posed. Each part starts with a restatement of the research question and after that the results are presented. Because both research questions are answered by considering aspects of the CAMCC in one way or another, a reminder of what aspects of the model that have been examined is presented in Figure 10 below for convenience.

![Diagram of CAMCC model](image)

*Figure 10. Illustration of what constructs of the CAMCC that are focused on in this study and how they relate to each other.*

6.1 Results - Research question 1

**Research question 1:**
To what extent has the competence reform, as communicated through the syllabus and national tests, resulted in teachers accommodating...
the competence message, assimilating the competence message, or in teachers making no belief change in relation to the competence message?

Table 10 below presents the distribution of answers on the variable *Belief change*. It shows that the share of teachers having made an accommodation of the competence message is 15 percent and that most teachers, 56 percent, have assimilated the competence message. Furthermore, 25 percent of the teachers have made no belief change with respect to the competence message and 4 percent were recorded as missing. The missing cases are due to the analysis procedure described in Section 5.2.8 failing to categorize these teachers. It is notable that the large majority of teachers, a little more than four out of five, have not changed their beliefs about the goals of school mathematics to include competency goals in a meaningful and comprehensive way. This means that the large majority of teachers do not have a functional knowledge of the competency goals, do not consider them to be central, and do not prioritize to include them in their teaching. Therefore one can say that the reform of introducing the competence message in the syllabi and national tests has had a small effect when it comes to changing teachers' belief about the goals of the students learning.

Table 10

<table>
<thead>
<tr>
<th>Belief Change</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No belief change</td>
<td>31</td>
<td>25</td>
</tr>
<tr>
<td>Assimilation</td>
<td>69</td>
<td>56</td>
</tr>
<tr>
<td>Accommodation</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>NA</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>100</td>
</tr>
</tbody>
</table>

6.2 Results - Research question 2

**Research question 2:**
Why have teachers accommodated the competence message, assimilated the competence message, or made no belief change in relation to the competence message?

As outlined in Section 5.2.9.3 the examination of if the CAMCC can explain the variation and covariation in data is first done group-wise, and after that these results are considered in relation to the model as a whole. The
grouping of teachers is based on whether the teachers have or have not perceived the competence message as entailing an important and non-trivial change. The group of teachers who have perceived this is studied in Section 6.2.1. After that, in Section 6.2.2, the group of teachers who have not perceived this is studied. Lastly, in Section 6.2.3, a summary of the results from the study of the different groups together with a conclusion is presented.

6.2.1 Results - group N

When studying group N (i.e. the group of teacher who have not perceived the competence message as entailing an important and non-trivial change) (N=63) it is investigated if the relationships, on the right hand side, highlighted in Figure 11 below can explain the variation and covariation in the CAMCC-data.

![Figure 11](image)

*Figure 11. Illustration of what constructs of the CAMCC that are focused on in this study and how they relate to each other. Right route highlighted.*

For clarity (as in Section 5.2.9.3.1) the highlighted part of Figure 11, is presented separately in Figure 12 below (again, as already stated in Section
5.2.9.3.1, it should be noted that the depiction in Figure 12 does not represent a regression model).

![Diagram](image)

Figure 12. Right route of the CAMCC.

The first relationship, relevant to group N, to be investigated is that the teachers of group N are predicted to not systematically process the competence message. As can be seen in Table 11 below, this relationship appears to explain the distribution of answers on the variable of Systematic processing. In group N the distribution of answers is heavily skewed towards a low degree of systematic processing. 75 percent of the teachers in the group have made no systematic processing and 19 percent have in part systematically processed the competence message. 6 percent of the teachers in the group have made a systematic processing.

Table 11

<table>
<thead>
<tr>
<th>Systematic processing</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>47</td>
<td>75</td>
</tr>
<tr>
<td>Partly</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>Yes</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>100</td>
</tr>
</tbody>
</table>

The second relationship relevant to group N to be investigated is that between Systematic processing and Belief change. The model stipulates that those who have made a systematic processing of the competence message have the possibility to accommodate the competence message (but also to not alter their beliefs). For those who have not made a systematic processing, assimilation or no belief change are the only outcomes. From the contingency table below (Table 12) one sees that the Systematic processing categories No and Partly are associated with No belief change and Assimilation on the variable Belief Change. Also, the Systematic processing category Yes is associated with Accommodation on the variable Belief change. That the total number of teachers only adds to 61 is because two teachers (of group N) could not be categorized on the variable Belief change.
Table 12

Crosstabulation of the variables Systematic processing and Belief Change

<table>
<thead>
<tr>
<th>Systematic processing</th>
<th>Accom.</th>
<th>Assim.</th>
<th>No change</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Partly</td>
<td>1</td>
<td>8</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>27</td>
<td>17</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>36</td>
<td>20</td>
<td>61</td>
</tr>
</tbody>
</table>

In Table 13 below, the results of Fisher’s exact test of statistical significance (on the contingency table above) are displayed. That \( p < .05 \) indicates that the observed association between the two variables is unlikely to have arisen by chance. The interpretation of this is that the aspect of the CAMCC that predicts Belief change to depend on Systematic processing, gives an explanation of why the data for Group N in this study is distributed in the way it is.

Table 13

Test of association between the variables Systematic processing and Belief change

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Exact Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fisher’s Exact Test</td>
<td>13.518</td>
<td>.003</td>
</tr>
<tr>
<td>N</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

Because both relations stipulated by the CAMCC can be said to give an explanation to the observed variation and covariation in data, the conclusion for group N (i.e. those teachers who have not perceived the competence message as entailing an important and non-trivial change) is that the these aspects of the CAMCC explains why teachers do not accommodate the competence message.

6.2.2 Results - group Y

When studying group Y (i.e. the group of teachers who have perceived the competence message as entailing an important and non-trivial change) (N=61) it is investigated if the relationships of the CAMCC pertinent to teachers who have perceived the competence message as entailing a change can explain the variation and covariation in the CAMCC-data. Again, the whole model is presented (see Figure 13 below), though this time with the relationships relevant to group Y highlighted. After that, in Figure 14, the relationships are also here presented separately.
Figure 13. Illustration of what constructs of the CAMCC that are focused on in this study and how they relate to each other. Left route highlighted.

For clarity (as in the previous section, and in Section 5.2.9.3.2) the highlighted part of Figure 13 is presented separately in Figure 14 below.

Figure 14. Left route of the CAMCC.
Figure 14 above illustrates that Belief Change depends on Systematic processing, and that Systematic processing depends on Intention. Lastly, Intention depends on the motivational factors Value, Expectancy, and Interaction effect (between Value and Expectancy). All relationships in the part of the CAMCC depicted in Figure 14 are supposed to be positive.

As detailed in Section 5.2.9.3.2, the investigation, of whether the theoretically predicted relationships of the CAMMC (relevant to group Y) can account for the variation and covariation in the CAMCC-data, is made with path analysis. The path analysis starts with a model specified as the one illustrated in Figure 14 above. Then, depending on model fit and how estimated coefficients might be interpreted, re-specification of the model is done to eliminate unnecessary paths, and to see if a model with better fit can be found. The procedure of re-specifying and testing different models terminates when a theoretically sound model with good fit and no unnecessary paths is arrived upon, or when the CAMCC does not appear to be able to explain the variation in data. The steps described above results in four models being tested before arriving at a model that has good fit, is theoretically sound, and does not have any unnecessary paths in it.

One teacher in this group was categorized as having made no belief change (in accordance with the procedure described in Section 5.2.8) in such a way that indicates that this teacher had systematically processed the competence message. This teacher had a functional knowledge of the competency goals, but did neither show signs of considering them to be central nor of consciously prioritizing the competency goals. The interpretation of this is that the teacher has acquired a functional knowledge of the competency goals by having systematically processed the competence message, but that the teacher did not find the competence message “...intelligible, plausible, and fruitful for promoting students’ learning...” (Gregoire, 2003, p.168), which is posited to also play a part of if teachers yield to a message or not, and therefore show no signs of considering the competency goals to be central or of consciously prioritizing the competency goals. This teacher is therefore (i.e. because the teacher is assumed to have made a systematic processing of the competence message) recoded as having accommodated the competence message before path analyses were made.

In Table 14 below the fit indices calculated for the four models tested are presented and this table will be referred to when each model is presented. The path coefficients in each figure displaying a fitted model are standardized. This means that they are comparable with each other and that the size of them can be interpreted as one would interpret the size of a correlation coefficient. Each model tested is described and a short account of why the model is or is not satisfactory is made after the fitted model has been presented.
Table 14

Fit indices for Model 1-4

<table>
<thead>
<tr>
<th>Model</th>
<th>df</th>
<th>$\chi^2$ (N=61)</th>
<th>RMSEA</th>
<th>CFI</th>
<th>TLI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>11.101</td>
<td>.098</td>
<td>.949</td>
<td>.913</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>5.002</td>
<td>.000</td>
<td>1.000</td>
<td>1.025</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3.577</td>
<td>.056</td>
<td>.980</td>
<td>.954</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>0.755</td>
<td>.000</td>
<td>1.000</td>
<td>1.020</td>
</tr>
</tbody>
</table>

Note: no Chi-square test was significant.

The first model to test is the one in displayed in Figure 14 above and also described above. In Figure 15 below the fitted model is presented.

![Model 1 Diagram](image)

Figure 15. Model 1 with standardized coefficients. *p < .05. **p < .01

According to the fit indices associated with Model 1 (seen in Table 14), the first fitted model does not have a good fit; RMSEA > .06, CFI < .95 and TLI < .95. This means that there is covariation between one (or several) of the variables of the CAMCC-data that is not sufficiently accounted for by Model 1. Furthermore Figure 15 shows that the path coefficients between Interaction effect (between Expectancy and Value) and Intention, between Expectancy and Intention, and between Intention and Systematic processing are not significant. This differs from the predictions of the CAMCC. Path coefficients between Value and Intention, and between Systematic processing and Belief change are in line with theoretical predictions positive and significant. Because the model does not account for covariation in data satisfactorily (i.e. there is covariation between variables, that is not accounted for) and because the paths predicted theoretically were not all significant, Model 1 cannot be considered to explain why or why not the teachers who have perceived the competence message as entailing an important and non-trivial change have accommodated or assimilated the competence message, or made no belief change. As explained in Section
5.2.9.1, the statistical software used in this study can (based on modification indices) give suggestions of what relationships that, if added, would improve model fit. For Model 1 the only suggestion for an added relationship that makes theoretical sense is to add an arrow between Systematic processing and Value. This modification index makes sense because: 1) the observation made a priori (in Section 5.2.6) that there is some uncertainty of if the variable of Intention accurately captures the essence of the construct of approach and avoidance intention, and 2) the relation suggested by the modification index is chronologically in the right direction (according to the model). The first reason might indicate that it would be better to exclude the variable of Intention and view motivational factors as influencing Systematic processing directly. However, before deciding whether to remove Intention a new model is specified and tested based on the suggestion above.

The second model (Model 2) to test is illustrated (with fitted path coefficients) in Figure 15 below. Model 2 is specified as the first model with the exception that there in Model 2 is an additional path between Value and Systematic processing. This means that this model posits Systematic processing to depend on both Intention and Value.

![Figure 15: Model 2 with standardized coefficients](image)

Figure 16. Model 2 with standardized coefficients. *p < .05. **p < .01

As seen in Table 14, Model 2 has a good fit (i.e. CFI > .95, TLI > .95, RMSEA < .06, and the Chi-square test is not statistically significant). This means that the fitted model does account for the covariation between variables in data in a good way. However, only paths between Value and Intention, between Value and Systematic processing, and between Systematic processing and Belief change are significant. On one hand then, the model can in some sense explain why teachers have made a certain type of belief change, because the model accounts for the covariation in the CAMCC-data. However, on the other hand, the explanation given by the fitted model is not the same as predicted beforehand by theory (i.e. several
No modification index was higher than 4.000, which meant that there were not any additional relations between the variables that would have improved the model fit by much. A conclusion from this analysis is that the variable of Intention does not seem to capture the essence of the construct of approach and avoidance intention. Because questions about this, as already mentioned, had been raised a priori, this variable is removed from the data set and new set of path analyses are conducted on this reduced data set. That Expectancy and the Interaction effect (between Value and Expectancy) do not have significant paths to Intention might be because of the variable of Intention not capturing the construct of approach and avoidance intention accurately. Although no modification index suggest regressing Systematic processing on Expectancy or the Interaction term, these variables are kept for the new path analysis. The re-specification of the model is done by excluding the variable of intention and assuming a direct relation between the motivational factors and Systematic processing.

The third model (Model 3) to be tested is illustrated (with fitted path coefficients) in Figure 17 below. Model 3 is specified so that Belief change depends on Systematic processing, and that Systematic processing in turn depends on the three motivational factors: Value, Expectancy, and Interaction (between Value and Expectancy).

Figure 17. Model 3 with standardized coefficients. *p < .05. **p < .01

As seen in Table 14 above, the third fitted model has a good fit (i.e. CFI > .95, TLI > .95, RMSEA < .06, and the Chi-square test is not statistically significant). The path diagram in Figure 17, displaying the fitted model, however shows that not all path coefficients are significant: the path coefficients between Interaction effect and Systematic processing, and between Expectancy and Systematic processing are not significant. One
could conclude from this that the theoretical model (CAMCC) does give an explanation to why teachers accommodate or assimilate the competence message, or make no belief change, but that certain relations predicted by the model do not apply to the data analyzed. At least two possible but different reasons can explain why this is the case: either the lack of significant paths is due to variables not correctly capturing the constructs of the model or it is due to shortcomings or limitations of the theoretical model (e.g. the theory being wrong about relationships or the theory not being applicable to this situation). Since this is not an experimental study designed to test the theory, it seems unreasonable to argue based on the present data that the theory is at fault. However, the interaction term has been proven difficult to identify within small samples (Nagengast et al., 2011) and also there are suggestions that expectations of success, contrary to what the CAMCC proposes, might have no or a reversed effect on subsequent constructs (Pintrich, 1999; Sinatra, 2005). One could be satisfied here, but to get better estimates, and because there is theoretical and empirical justification for it, variables with non-significant paths are removed.

The fourth model (Model 4) to be tested is illustrated (with fitted path coefficients) in Figure 18 below. It is specified so that Belief change depends on Systematic processing, which in turn depends on Value.

As seen in Table 14, the fourth fitted model has a good fit (i.e. CFI > .95, TLI > .95, RMSEA < .06, and the Chi-square test is not statistically significant). From Figure 18 one also sees that all path coefficients are significant and show strong and positive relationships between the variables. The interpretation of this is that the aspects of the CAMCC measured in this study - after removing a variable of questionable quality, and with explanations and suggestions of why the predicted interaction effect and the effect of expectancy was not observed in this data set - can explain why or why not teachers who have perceived the competence message as entailing an important and non-trivial change for them accommodate it, assimilate it, or make no belief change. The teachers of group Y’s belief change is depending on the degree of systematic processing, which in turn depends on if they value processing and implementation of the competence message.
6.2.3 Synthesizing results of group N and Y

The CAMCC explains both why teachers who have not perceived the competence message as entailing an important and non-trivial change predominantly do not accommodate the competence message and why teachers who have perceived the competence message as entailing an important and non-trivial change accommodate or assimilate the competence message, or make no belief change. Taken together this means that the answer to Research question 2 is that the CAMCC with the constructs focused on in this study explains why or why not teachers accommodate or assimilate the competence message, or makes no belief change. More specifically, why teachers make a certain belief change is dependent on whether the message is perceived as entailing an important and non-trivial change to them or not. If the message does not do that, then the teachers will not systematically process the message, which in turn only leads to assimilation or no belief change. If the message is perceived to entail a change, then whether teachers will systematically process the competence message, which makes accommodation possible, will depend on if they value the processing and implementation of the competence message or not.
7 Discussion

The discussion of this study and its results is arranged into three sections. Each section reflects one of the three fundamental properties discussed by Schoenfeld (2007), which quality of research can be evaluated upon. These properties are: importance, generality, and trustworthiness, and Schoenfeld (2007) characterizes these to be about: 1) why one should care about the research (importance), 2) to whom and in what situations the research apply (generality), and 3) why one should believe the claims made in the study (trustworthiness). Under the heading Importance (Section 7.1) this study’s results are discussed in relation to previous research on similar topics, and in relation to practical implications of this research. Under the heading Generality (Section 7.2) it is discussed how far the results of this study extend in the sense that they apply to other situations than the specific context of this study. Under the heading Trustworthiness (Section 7.3) it is discussed how some possible threats to this study’s trustworthiness was dealt with methodologically.

Before turning to the discussion, a recapitulation of the results of the study is given. This study suggests that only a small fraction (15%) of the Swedish upper secondary teachers have accommodated the competence message. This in turn suggests that one of the intended effects of the reform introduced through the syllabi and national tests, of changing teachers’ beliefs about the goals of school mathematics to include competency goals, have been small. Furthermore the results of this study suggest that the Cognitive-Affective Model of Conceptual Change can explain why the intended effect of the reform has been small. The small effect of the reform is due to only few teachers having systematically processed the competence message, which in turn is explained by two things. One is that teachers have not perceived the competence message as implying that they need to change their goals for the students or their teaching (which is predictive of no systematic processing). The other thing is that those teachers, who have perceived the competence message as implying that they need to change their goals for the students, or their teaching, often have not valued the processing and implementation of the competence message highly enough. A third potential factor, expectancy of success with processing and implementing the competence message did not explain why teachers, who had perceived the competence message as entailing an important and non-trivial change to them, did or did not systematically process the competence message.
7.1 Importance

It is a value judgment whether one considers a study to be important or not. Two things that in part can influence how one values a study's importance is what contributions the study makes to existing research, and what practical implications that the study has. These two features of a study do of course only contribute to the importance of the study if the problem studied (itself) is considered important. As stated in the introduction of this thesis, the governing of education is an important issue in most countries, which potentially makes this topic important. If it were trivial how governing of education (through policy documents and assessments) functions, then this study would not be very interesting. However, as concluded from the review of literature, the reasons for why policy has an effect or not on teachers and their teaching is not well understood. So, if this study contributes to the existing research on policy implementation, and if it also has practical implications, this would imply that this study is important. Below the contributions of this study in relation to existing research (in Section 7.1.1), and also what practical implications this study has (Section 7.1.2) are presented.

7.1.1 Present study's contributions in relation to other studies

As a first general description of this study's contributions, the study is put into the context of the temporal phases of curriculum implementation, stretching from a written curriculum to student learning. Stein et al. (2007), describes these phases and illustrates their description with a figure, which (slightly simplified) is reproduced below (see Figure 19). The schematic representation of the temporal phases of curriculum implementation displays how the written curriculum (e.g. a policy document, or a textbook) influences the intended curriculum (i.e. what the teacher intends to do in the classroom with the students). The intended curriculum influences the enacted curriculum (i.e. what the teacher actually does in the classroom), which in turn influences what students learn. The dotted arrows from student learning and enacted curriculum directed back to the arrow between written curriculum and intended curriculum, are a representation of that these two things also influence how a teacher forms intentions of how and what to teach based on the written curriculum.
With reference to Figure 19 this study then can be said to add a piece to the knowledge of how written curriculum affects student learning, in that it contributes to the knowledge of properties of the relation between the written curriculum and intended curriculum. To be more specific, this study contributes to the understanding of how competency goals of school mathematics communicated through a national curriculum and national assessments, affect teachers' beliefs about the goals of school mathematics. Before going into the specific implications of the results of this study, research wise, the results of this study are on a general level positioned in relation to previous research on similar topics.

Studies of implementation of educational reform where the reform is communicated through policy documents and/or assessments (and sometimes in combination with other policy means) show that it is possible to successfully exert an influence on teachers (see e.g. Barnes et al., 2000; Hufferd-Ackles et al., 2004). Commonly though, studies demonstrate that there are considerable difficulties of instilling the intended change in teachers, through policy means (see e.g. Charalambous et al., 2010; Spillane, 1998; Boesen et al. 2014; Cohen and Ball, 1990). The results of this study fall into the latter category of studies by showing that a reform that is centrally communicated through both a national curriculum and national assessments over an extended period of time still might have only a small (intended) effect on the teachers' beliefs about the goals of school mathematics. In addition to this the results of this study also contribute to existing knowledge by suggesting why educational reform sometimes only has a small impact. It does so in a novel way by showing that a model of conceptual change (the CAMCC) can be used as an explanation of why teachers change their beliefs about the goals of school mathematics in certain ways or do not do this when confronted with a reform message. Several of the features of the CAMCC that can be used to explain why teachers have changed or not can be related to results of other studies, which can be seen as corroborating results from these studies. However, because the model explains how these features are connected to each other, this study extends the existing knowledge on how
policy influences teachers. This is the novel contribution of this study. Next the details of the results and their implications, for how the effects of efforts of instilling change with teachers through policy means can be understood, are presented.

7.1.1.1 Similarities and differences regarding the effects of reform through policy means

That the study shows that a reform, that is centrally communicated through both policy documents and national assessments, over an extended period of time, still might have only a small effect on the teachers’ beliefs about the goals of school mathematics corroborates the findings of Charalambous, and Philippou (2010) that alignment between different sources (in Cyprus between national curriculum and textbooks) communicating the same message (see e.g. also Cohen and Hill, 2000; Cohen and Ball 1990), although important (Webb, 1997), alone does not ensure successful implementation. There are however, different ways in which reforms might not succeed. Although the general conclusion that a reform’s effect on teachers, in both Charalambous and Phillipou’s (2010) study (and several other studies as shown in Section 2.2) and the present study, has not been the intended, the specifics of the teachers’ responses to the reforms differ between the two studies. Charalambous and Phillipou (2010), who studied teachers’ concerns about the Cypriote reform in which problem solving had a primary role, found in their quantitative analysis that teachers’ concerns about the reform mostly were first-level concerns, indicating that teachers mostly had concerns related to how the reform was supposed to be understood (in contrast to e.g. second-level concerns, which can be thought of as concerns of how the reform can be implemented). Their qualitative analysis corroborated the findings from the quantitative analysis, i.e. also revealed a low awareness of the Cypriot reform. Furthermore the qualitative analysis suggested that some teachers shallowly and wrongly interpreted key aspects of the reform. In contrast to Charalambous and Phillipou (2010), the present study found that teachers to a large extent had assimilated the competence message introduced in the Swedish reform. Although the object of analysis are different in the two studies, the present study’s results (that a majority of the teachers had assimilated the competence message) can be seen as indicating that most teachers did not have serious first-level concerns, second-level concerns or third-level concerns (e.g. concerns about the consequences of the reform), but rather had adapted the reform to fit with their existing beliefs and practices. One possible explanation for this might be that whereas the Cypriot reform had been in place for 5 years, the Swedish reform had been introduced some 15 years before present study was
conducted. Teachers might thus, given the time frame, have found ways to deal with the reform.

Without listing all studies reviewed in Section 2.2 with sub-sections that have obtained similar or differing results regarding the effect of reform, two studies that capture the effects of policy in partly the same wordings as this study are given as examples. In Coburn’s (2005) study it was found that deep changes (in part described as accommodation) were rare, with around ten percent of the responses to messages being accommodated, and that superficial responses to messages were common (in around 50% of the cases assimilation was the response). Although Ball (1990) does not use the term assimilation, when describing how the teacher of her case study perceives a reform to fit with existing practices, this description closely resembles how assimilation is conceived in the CAMCC (Gregoire, 2003). In the sections that follow the results on Research question 2 are related to existing knowledge.

7.1.1.2 Implicates self
In this study one of the factors found to greatly contribute to that most teachers either had assimilated the competence message or had made no belief change, was that the competence message as communicated through the national curriculum and national assessments was not perceived as implying an important an non-trivial change for the teachers, and their professional identity. The usefulness of this idea in the CAMCC, incorporated from Schlenker’s (1982) idea that threat to ones identity can motivate change, and similar to Dole and Sinatra’s (1998) construct of personal relevance, thus gets support from this study. Also the shift of focus, when understanding educational change, to identity learning as discussed by Geijssel and Meijers (2005) might be supported by this study, which furthermore can be seen as connected to the review of research on reception of reform messages by Spillane et al. (2002). In their review it is concluded that these messages can lead to loss in positive self-image, and that this can be avoided by reinterpreting the reform proposals to fit with existing practices. That more than half of the teachers in this study did not perceive the competence message as entailing an important and non-trivial change, which generally resulted in little systematic processing, obviously has to do with teachers’ interpretations of the message. Because of this, present study can be seen as corroborating aspects of findings of other studies where the issue of interpretation have been found to be important when it comes to which influence policy might have (see e.g. Graybeal, 2010; Spillane and Zeuli, 1999; Hill, 2001; Ross et al., 2002; Fullan, 1999; Dole and Sinatra, 1998; Charalambous et al. 2010; Ball, 1990; Cohen, 1990; Fullan, 2001). Besides showing how one’s initial interpretation of a policy message affects
whether one will systematically process the message or not, the usefulness of
the model demonstrated in this study might also imply that aspects of the
CAMCC not examined in detail can give further explanations of how
teachers’ interpretations affect the outcomes of non-systematic processing.
As exemplified in the last part of the previous section, the concept of
assimilation can describe a common response to reform messages found in
other studies. That teachers assimilate the message is by the CAMCC posed
to depend on both a lack of systematic processing, and of teachers’ previous
knowledge, beliefs, and experiences. The latter supposedly influences
whether teachers, who have not systematically processed a message, will
assimilate a reform message or make no belief change with regards to the
message (Gregoire, 2003). If teachers’ prior beliefs affected teachers to
initially make a positive appraisal of the message, the model states that they
likely will assimilate the message, and if teachers’ initial appraisal was
neutral the model states that they likely will make no belief change.

That teachers’ initial interpretations of a reform message heavily
influences the degree of processing might suggest a qualification of the
recommendations made by many studies that time and support of various
kinds should be given in order for implementation to happen (see e.g.
Swanson and Stevenson, 2002; Spillane and Zeuli, 1999). In this study,
teachers who do not perceive the competence message as entailing a change
for them do not systematically process the competence message, because
they do not see the need for this. If these teachers were only given more time
to process the competence message, and not the opportunity to see how the
message entails an important and non-trivial change for them, their
processing would not become more systematic, but rather one could foresee
only an extended time allocated on heuristic processing still leading to
assimilation (or no belief change) or not grasping that the message might
concern themselves. The support directed at teachers then, perhaps should
at least in part be aimed at clarifying how the message differs from teachers’
previous conceptions. Hill (2001) identifies a problem with the meanings
given to specific words as *construct* and *concept* in mathematics and
suggests that examples with videos of teaching might be needed to make
clear the differences of the message and previously held conceptions, and the
finding of this study that many teachers do not perceive the competence
message as implying a change for them might point in the same direction.
With this caveat, one could still surmise that the ideas of giving time,
resources and opportunities to learn (e.g., Borko et al., 2003; Hill, 2001;
Cohen, 1990), still hold true. Although this study did not find an influence
from teachers’ expectations of success with processing the competence
message (which included teachers’ perceptions of what resources they had)
on their degree of systematic processing, one could still surmise that how
successful teachers will be in their systematic processing, if they try to do this, is influenced by what kind of support they have to systematically process the competence message (as suggested in Eagly and Chaiken, 1993).

Connected to teachers’ interpretations is also how the message is communicated. Polikoff (2012) suggested that more focused standards (in the sense less topics and more depth) are difficult to implement without sufficient support. In this study there is no measure of focus of the Swedish syllabus, but it can perhaps be concluded that when a standard communicated through the syllabus (and national tests) is open to very different interpretations, change will be difficult to instill. That the competency goals communicated in the syllabus are open to interpretation is (at least in part) a function of that the syllabus is short, without definitions of the competency goals, and with no special emphasis placed on the competency goals (Bergqvist and Bergqvist, 2014). This openness in interpretation also seems to apply to the national tests. Although the tests explicitly connected tasks to excerpts from the syllabus, since the syllabus is open to very different interpretations, this connection does little in helping teachers make accurate interpretations of what competencies the national tests assess.

Besides corroborating findings that teachers’ interpretations are crucial when it comes to what influence policy might have, this study also extends the existing knowledge of how teachers’ interpretations of reform messages are an important factor mediating teacher change. It does so by putting teachers’ interpretations into the context of the CAMCC, which explains how teachers’ interpretations are connected to other constructs of importance for whether teachers change or not. Above it has shortly been described how teachers’ interpretations are connected to systematic processing, which this study suggests is crucial for accommodation to happen. Furthermore, the often found phenomenon that teachers themselves seem to believe that they are implementing the reform, while little evidence for this is found in teachers’ beliefs, is when put in the context of the CAMCC captured by the concept assimilation, and of course why assimilation is a common response from teachers. The present study also shows why teachers who have perceived the message as implying a change for them do, or do not, change in the, by the reform, intended way. These results are in the next section connected to other studies reporting on related things.
7.1.1.3 Perceiving that the message entails an important and non-trivial change is not enough

For teachers who had perceived the competence message as implying an important and non-trivial change it was in this study found that the degree of systematic processing of the competence message was influenced by to what extent they valued the processing and implementation of the competence message. Teachers’ expectancy for success with processing and implementation of the competence message did however not explain why these teachers systematically processed the message or did not do this. The latter could be thought of as contradicting the recommendations of giving more support to teachers to enable implementation as mentioned above, but as will be seen below another interpretation is possible.

7.1.1.3.1 Valuing of the processing and implementation of the competence message influences the degree of systematic processing

That the teachers’ valuing of the processing and implementation of the competence message was positively associated with degree of systematic processing suggests that the message and the sources communicating the messages should be perceived as useful for teachers if they are to systematically process the message. Furthermore it suggests that it is important that teachers find the goals for the students to be sound, and also that teachers have an interest in their subject for teachers to be motivated to systematically process the message. The usefulness and soundness of the goals connect to at least two different things. One possible way to see this is that the results suggest that teachers’ opportunities to learn is an important factor influencing change, as suggested by others (e.g. Spillane and Zeuli, 1999; Innabi, and Sheik, 2007). As discussed above, the syllabus is short and without definitions of the competency goals, and as concluded by Polikoff (2012) focused standards are difficult to implement without support. A way to enhance the documents’ usefulness could then be by providing support (e.g. through in-service training or by providing supplementary material) in how to interpret them. Although one should still remember the caveat formulated above, that teachers first must perceive the message as implying a change for them, before it is meaningful to provide support to process the message, one could surmise that support of different kinds, both can have the effect of changing teachers’ perceptions of the message (so that they possibly will see that it entails a change for them), and the effect of enhancing the usefulness of the policy documents. These things further suggest that the formulation of the syllabus and national tests, and what supportive material that might accompany them, plays an important part in whether teachers will be motivated to systematically process the competence
message. It is thus suggested that the formulation of a syllabus and accompanying tests, both influence if teachers at all perceive that they imply a change for them (discussed above) and that if they perceive the policy documents as implying a change, whether they will systematically process the message in part hinges on how useful and sound they find the documents to be. Although teachers’ interest, as a part of the value construct, is suggested as influencing systematic processing of the reform message, it is difficult to relate this to the formulation of the policy documents. It can however be noted that Pang (2012), similarly suggests teachers’ interest in their subject, as being important for whether teachers will change or not. One could also note here, that support of various kinds in this step is especially important if the CAMCC is right in that the motivational factors help one to cope with the stress that the message has aroused.

7.1.1.3.2 Expectation of success does not seem to influence the degree of systematic processing

In this study no effect on systematic processing was found from the construct expectancy (of success with processing and implementing the competence message). Gregoire (2003) posited efficacy beliefs (as e.g. self-efficacy, which in this study was construed as being a part of expectancy for success) to be predictive of the subsequent construct of systematic processing. Even though this study cannot be considered to test the model, the results of the study together with literature on how self-efficacy might function might suggest that the CAMCC is in need of more specificity. The model states that those with strong beliefs of being capable to implement the reform will be able to handle the stress, feel challenged, and proceed to process the message systematically. This rests on the results of Jerusalem and Schwarzer (1992), which show that strong self-efficacy can act as a buffer against stress. However, considering the discussions in Pintrich et al. (1993), Pintrich (1999), and Sinatra et al. (2005) about how self-efficacy influence subsequent constructs in conceptual change models, where both a positive and negative effect of high self-efficacy is deemed conceivable, complicates the notion of high self-efficacy always being better (motivation wise) than low self-efficacy, it might be appropriate to rethink the function of self-efficacy in the CAMCC. Perhaps it has to do with how being capable to process and implement the reform should be interpreted, or rather how self-efficacy should be understood in this case. Pintrich et al. (1993) describes two different ways of construing self-efficacy:

First, in the bulk of the research on self-efficacy, the construct is used to represent students’ confidence in their ability to do a particular task. In applying this construct to conceptual change, this could translate into students’ confidence in their own ideas
and conceptions. In this case, higher levels of self-efficacy or confidence in one's own beliefs would be a hindrance to conceptual change. /.../ A second way to conceive of the relation of self-efficacy to a conceptual change model is the confidence students have in their capabilities to change their ideas, to use the cognitive tools necessary to integrate and synthesize divergent ideas. /.../ In this sense, self-efficacy would refer to students' confidence in their own learning and thinking strategies. (Pintrich et al., 1993, p.186)

The present study did not find an influence from expectation of success (in which self-efficacy in the first sense of the quote above was included). When this is considered in connection to the questions raised above about how self-efficacy influences motivation, this suggests that the CAMCC would benefit from using the second meaning of self-efficacy. Alternatively, it could possibly be an even further improvement of the models usefulness if one could use the different meanings of self-efficacy to predict the outcome on subsequent constructs. In studies of the expectancy and value constructs – constructs, which in this study has been used to conceptualize motivational factors – these constructs effect have been found to be somewhat different. Value beliefs have been found to positively predict intentions to do things that one values, and also the actual descisions about choice of task to become engaged with (Wigfield and Eccles, 2000), which squares nicely with the results of this study, where the value construct have been found to give an explanation to data in the way that value positively predicts degree of systematic processing. Expectancy beliefs on the other hand have been found to be more related to actual achievement (Wigfield and Eccles, 2000), which does not explain the variation in data of this study (but perhaps is explained by the reasoning about self-efficacy above).

7.1.1.4 Systematic processing
In this study it is shown, as already mentioned above and as predicted by the CAMCC, how systematic processing strongly influence the types of belief changes teachers make. This corroborates the findings from several studies, with the caveats made above in mind, that teachers’ opportunities to learn is an important factor for whether the intended changes will (or will not) come about.

7.1.2 Practical implications
This study has several possible implications for stakeholders in educational change, such as policy makers trying to influence teachers and teaching, and ultimately what students learn. Before giving advice based on the results of
this study, it is perhaps good to be reminded of the complexity of bringing about change in schools, and that this study gives one type of explanation of why the reform introduced in Sweden in 1994 have had a small intended effect. Fullan’s (2001) words that: “Research findings on the change process should be used less as instruments of “application” and more as means of helping practitioners and planners “make sense” of planning, implementation strategies, and monitoring” (p.49) might serve as a caveat to the implications presented here for policy makers. Another caveat is that this study’s contribution to the knowledge of how educational change come about considers some factors facilitating or hindering change, but that there of course are other factors not considered in this study that also are of importance (e.g. how the social context, and the social interaction affects ones reception of a message (Spillane et al., 2002)).

Although the national curriculum is a legally binding document that teachers have to adhere to, and the national tests are aligned with the syllabus, this does not seem to be enough to instill change in teachers’ beliefs and conceptions of the goals of school mathematics, and therefore neither to ultimately improve student learning. Furthermore, as have been suggested by others, coercion and stakes alone seem to be uncertain levers for change (e.g., Mehrens, 1998; Cimbricz, 2002). The present study suggests that it is very important how the message is presented, because this has to do with whether teachers perceive the message as implying a change for them or not. The national syllabus of 1994 (revised in 2000) stated what the goals for students’ learning were in different mathematics courses, both in terms of different topics and concepts, and in terms of competencies that the students should develop during the courses. These documents do however not specify how the teacher is supposed to help the students reach those goals. In addition to this the documents also were short (around 5 pages for each course, with 2-3 pages being the same for every course), without definitions of the competencies, and with no special emphasis placed on them (Bergqvist, and Bergqvist, 2014). As mentioned this study suggests that the presentation of the message is important, and more specifically it suggests that the features just mentioned might have impeded the effect of the reform of implementing competency goals in the national curriculum. More than half of the teachers had not perceived the competence message as communicated through the national curriculum, the national tests, or some other source, as entailing an important and non-trivial change for them. This means that many teachers in this study had not made a reasonable initial interpretation of the curriculum and national assessments. Because the competence message (and similar messages) is complex (Niss, 2007; Cohen and Ball, 1990; Fullan, 2001), and with consequences for teachers’ practice (Gregoire, 2003; Jacobs et al. 2006), which in itself is a property that makes
change difficult (Fullan, 2001), the features of the national curriculum (being short, without definitions of the competencies, or guidance on how to teach them) might be an important factor hindering the teachers to perceive that the competence message entails an important and non-trivial change for them. This factor connects to what Fullan (2001) calls clarity (of a message), which is characterized as a major problem hindering change to be achieved. So, if policy makers want to change teachers and the teaching with the curriculum as a mean, it would be beneficial if the curriculum was extended with for example definitions or explanations of concepts that the teachers have very different interpretations of. Most teachers would come to similar conclusion of what “methods for solving linear equations” entails but when it comes to formulations about the non-procedural competencies this does not seem to be the case. The concept of problem solving, for example, are attributed very different meanings by teachers (Bergqvist and Bergqvist, 2014; Boesen et al. 2014), which sometimes mean that these words do not signify a change for the teachers. At least it seems less likely that teachers’ initial interpretations of the competence message would result in a benign/positive appraisal of the message; i.e. less likely that they do not recognize the message as something implicating themselves. The curriculum is written with the intention that teachers should make their local interpretations of them, so that there is some extent of freedom for the teachers in arranging their teaching. Furthermore the curriculum documents are not to prescribe certain methods of teaching. This does however not contradict that the goals for the students’ learning are stated clearly. One can again consider that there is large agreement between what teaching students how to solve linear equations entail, which then is not thought to restrict teachers’ freedom in choosing how to arrange their teaching. The types of freedom that result in an assimilation of the competence message, were probably not intended.

It is of course not only the features of the curriculum that has impeded change, but also in what context the curricular documents exist. If one would imagine that all teachers had perceived the competence message as implying a change for them, the results of this study still suggest that most teachers would not have accommodated the competence message. Approximately half of the teachers perceived the competence message as entailing a change for them, and of these teachers only about a fourth had accommodated the competence message. This suggests that even if all teachers had perceived the message as entailing an important and non-trivial change them, the proportion of teachers who would accommodate the message still would not be very large some 15 years after the reform had been introduced. The other component, apart from if the teachers perceive the competence message as implying an important and non-trivial change for them, that is important for
systematic processing according to the CAMCC is that of if teachers value the processing and implementation of the competency goals, because this influences whether teachers will systematically process the competence message. This study suggests that teachers mostly did not do this to a large enough extent. A way to improve teachers' valuing of processing and implementation of the competence message could be by improving the usefulness of the syllabus (because the teachers' perceptions of how useful the syllabus is were one component of the value-construct). Had there been extensive supplementary materials extending the descriptions of the goals of the national curriculum, with examples and definitions, and perhaps also contrasting the notion of competencies with traditional curricular goals, there might have been a different reception of the curricular documents, because teachers might have found these more useful for processing and implementing the competency goals. This could of course also be used as a means to more clearly communicate that the competence message entails an important and non-trivial change for the teachers, and conversely the suggestions made above also could influence the teachers' perception of the value of processing the syllabus. With the above in mind, one could also arrange in-service training that remediates unwanted effects of not very specifically formulated policy documents.

Sometimes the idea that what you test is what you get, abbreviated to the acronym WYTIWYG, is put forward as a reason for why tests can be used as levers for change (given that there are high stakes attached to the tests). In the review of influence from assessment on teachers, made in this study, this seems not to be a simple fact, but rather (as can be concluded from the reviews by e.g. Cimbricz, 2002, and Mehrens, 1998) this idea often does not hold true. The belief in WYTIWYG is further contested by the results of this study, and although one can argue about whether the stakes attached to the national assessments are high or not, this is not the primary reason for why the idea is contested by the results of this study. Instead it has to do with that this study suggests that teachers do not clearly perceive that the national tests assess students' competencies. At least in the sense that teachers' interpretations of what the national tests measure differs among the teachers (similarly to teachers' interpretations of the syllabus). That tasks themselves thus do not communicate the competence message clearly can be seen in the present study, and of course in studies based on the same data (see e.g. Boesen et al., 2014). After all, the interpretations one makes of what demands there are on students for successfully solving a task largely depends on what preconceptions one already has of mathematics and the goals of school mathematics (Spillane et al., 2002). The tests do however come with grading instructions that categorized each task in relation to different excerpts of the national curriculum, where for example a task could have
been categorized as testing reasoning with reference to the syllabus. This have not caught most teachers’ attention, in the sense that they have found the tests to entail a change for them concerning what goals they have for their students. Perhaps this is not that surprising when one considers the difficulties for teachers when interpreting the syllabus. The tasks of the national tests are explicitly connected to competencies in the syllabus, which one could think would help teachers interpret what the tasks are testing. However, since the syllabus is difficult to interpret, this connection between task demands and the syllabus probably is of little help, or even hinders a reasonably accurate interpretation of tasks’ demands on students. Alignment in this case does not seem to help teachers, because the curriculum provides little guidance, and because the concepts used when describing what the assessments measure often are interpreted in terms of prior knowledge and beliefs. An implication of this seem to be that recommendations made in relation to the national curriculum also might apply here: clarity of the message should be improved and resources enabling teachers’ opportunities to learn should be given as recommended by researchers before me (see e.g. Cohen and Spillane, 1992).

7.2 Generality
The question of generality can, as mentioned, be conceived of as being about how far the results of a study extend. This (the extension of the results) can be thought of in different ways. Schoenfeld (2007) suggests that it can be useful to think of generality of a study's results as: warranted generality, claimed generality, implied generality, and potential generality, which represent differing degrees of certainty of the generalizations. These different kinds of generality will be returned to at the end of this discussion.

Given that the results of present study are trustworthy, how far do they extend? Do the results for example apply to other teachers than those in the sample? If this is the case, do the results apply to mathematics teachers teaching other grades, to teachers in different countries, or even to teachers of other subjects? This study is based on a representative sample of Swedish upper secondary mathematics teachers, and therefore it seems reasonable to consider the results to at least apply to Swedish upper secondary mathematics teachers in general. But do the results apply to other groups of teachers? Although the structure and governing of both Swedish compulsory school and upper secondary school is highly similar, and that for example teachers of grades precluding the upper secondary grades do not have a very different background when it comes to teacher training, it does not exclude the possibility that teachers in compulsory school and their situation somehow is different in important aspects, and that the results of this study
would not apply to them. However, the SSI did two quality reviews of mathematics teaching (one in compulsory and one in upper secondary, where the latter provided data for this study) which rendered two reports with very similar results (see Bergqvist et al. 2010a; 2010b). Based on the data collection (and in parts the analysis) made for those reports, Boesen et al. (2014) shows that the result of a low impact of the reform was evident in both compulsory and upper secondary school. Furthermore, Boesen and colleagues’ (2014) study also suggests that the CAMCC on an aggregate level can give an explanation of why the reform had had a low impact on the teaching. The reports by Bergqvist et al. (2010a; 2010b), and the study by Boesen et al. (2014), together indicates that the results of the present study also apply to Swedish compulsory teachers of mathematics. Expanding the boundaries of where the results of this study applies, one could as suggested above, ask if the results apply to teachers outside of Sweden that might be in a similar situation with regards to being confronted with a policy message intended to change their beliefs and conceptions of school mathematics. It is due to the sometimes wide differences between educational systems in different countries difficult to with certainty say that this generally would be the case, but rather it is left to the reader to determine whether these results could apply in a setting of the reader’s interest. It can however be noted that the description of the CAMMC does not imply that the phenomena accounted for by the model are limited to certain countries or at what levels a teacher teaches, which might imply that the results of this study extend both across countries and grade levels (given that there is a message of similar type that the teachers are confronted and that the context is sufficiently similar). Another possible extension of the results could be that they hold true in other subjects than mathematics. The present study is concerned with a reform of the goals of upper secondary mathematics, and also the CAMCC is described in relation to the types of goals communicated in the Swedish reform. However, although the CAMCC is described in relation to a message similar to the one introduced in the syllabus and national tests in Sweden in 1994, the model is derived from theories on conceptual change that more generally considers conceptual change. Therefore this study’s results also potentially extend across subjects. Again the context must of course be sufficiently similar with for example policy communicating an important and non-trivial change, which at least in some instances seem to be the case in for example studies on reform of language teaching (Coburn, 2001; 2005).

So, returning to the notions of warranted, claimed, implied, and potential generality of this study. It is here suggested that this study’s warranted generality, for which there has been “...provided trustworthy evidence...” (Shoenfeld, 2007, p.88), is that it applies to Swedish upper secondary mathematics teachers. What “...set of circumstances...” (Shoenfeld, 2007,
p.88) that the results are claimed to apply to is all Swedish mathematics teachers in compulsory and upper secondary school. This claim is, as described above, based on a comparison of the results of Boesen et al. [2014], with this study’s results. The implied generality, i.e. a suggestion of to which contexts the results of this study applies (Schoenfeld, 2007), is suggested to be that it applies to mathematics teachers in any country and at any grade level, given that conditions are sufficiently similar (e.g. with a difficult message communicated to them through policy intended to change them in some non-trivial way). This suggestion is, as mentioned above, based on that the CAMCC does not specify that the change process is restricted to certain grade levels or countries. The potential generality, i.e. in what contexts it might be reasonable to believe that the results apply (Schoenfeld, 2007), of this study is that the results might extend to other subjects (again given that conditions are sufficiently similar). This is shortly argued for by noticing that the CAMCC builds on theories not specifically developed with the changes described in relation to the CAMCC in mind.

7.3 Trustworthiness
The issue of a study’s trustworthiness is a question of why one should believe the claims made in the study. The discussion that follows of the soundness of the claims made in this study is far from exhaustive, and only a selection of all the possible things relating to the data collection and the analysis of data are considered. The choice of what to highlight is based on what seems to be crucial aspects that a reader could object to, and that could be considered to put this study’s trustworthiness into question.

7.3.1 The SSI data collection
A possible reason to question the results of this study has to do with that data used in this study was collected during the Swedish Schools Inspectorate’s quality review of upper secondary school mathematics teaching. Because of this, one could wonder if teachers would not have been prone to arrange very different lessons than they used to, or that they during the interview, and when taking the survey, would try to second guess what the SSI wanted to hear. If this were the case data would be a poor source to base ones conclusions from. However, there are several reasons for why one should believe that data was not affected by the SSI’s presence in such a way that the results of this study cannot be trusted. One minor but important aspect of the data collection during SSI’s quality review, which at least to some degree might remediate the risk of teachers trying to second guess what they thought the SSI wanted to see and hear, is that teachers were thoroughly informed of that the SSI was not there to make an evaluation of the specific teacher, but rather that the SSI mainly wanted to get a sense of
teachers’ thinking and teaching on aggregate levels, such as the whole of Sweden or in a municipality. There were thus no sanctions connected to individual teachers that the SSI would enforce based on the data collection described in this study. The stakes for the individual teacher were therefore low, which might have let them speak more freely and not feel that they had to do something very special during the observed lesson. Although stakes were low for teachers, one could still wonder if they did not adjust their answers to what they thought the SSI wanted to hear. Another, and indirect reason not to believe this, is that it was found that the reform had had a low intended impact on teachers (i.e. few teachers had accommodated the competence message). This indicates that teachers did not second guess what they thought the SSI wanted to hear in a way that would have made it seem as the reform had had a large impact. A more specific and concrete example taken from the interviews of that teachers did not seem to adjust their answers in the interview because of the SSI’s presence, is that teachers only in few cases (on a direct question of what their goals for the students was) stated explicitly that their goal was that students should develop their ability to for example solve problems (or their ability regarding any of the other non-procedural competencies). If the teachers had thought the SSI wanted to hear that they had competency goals for their students it would be easy for the teachers to say this when asked of what goals they have for the students. Furthermore, it was even more unusual that teacher qualified such a general statement (e.g. I want my students to become good problem solvers) with specifications of what a good problem solver was. In relation to the observations it can be concluded that teachers did not seem to enact a very different teaching than usual, and especially the teachers did not seem to focus on the competencies very much, despite the SSI’s presence (Boesen et al. 2014). Although not presented in this study, all analysts asked a couple of students during each observed lesson about whether the lesson was an ordinary lesson. Anecdotally it can here be noted that students only in a handful out of all observations, said something indicating that the lesson was different as compared to lessons when the SSI was not visiting. Although these examples lend support to that data collected by the SSI was not unduly influenced by the SSI’s presence, they could of course only be made after the study had been conducted, and therefore they do not suffice as a basis for the choice of collaborating with the SSI.

Precautionary measures were therefore taken beforehand. These measures were assumed to ensure that data would be useful for the SSI, and not unduly influenced by the SSI’s presence. A note that can be made, before the precautionary measures are described, is that although teachers would have second guessed what they thought the SSI wanted to hear and see, and if they then had guessed that it had to do with the competency goals, it still would have been difficult to fake knowledge of the competency goals, both in
terms of how they can be conceived and in terms of how they can be expressed in the teaching. However, although difficult to fake knowledge, the data collection was constructed from the perspective that the notion of competencies would not be brought up before the third part of the interview, in which a shared understanding of these goals was established. This means that the observation and most parts of the interview did not reveal that the SSI was going to focus on competencies. This means that it was difficult for teachers to second-guess what answers they thought the SSI wanted. The survey, which was distributed after the interview had been conducted, depended on that teachers had taken part of the interviewer's presentation of the competency goals.

Besides the above mentioned precautionary measure one can also view the multiple sources of data, as a precautionary measure taken by the SSI. Schoenfeld (2007) shortly discusses the issue of context under the heading *Multiple sources of evidence (Triangulation)* (p.87). The issue of context is the issue that that people respond in different ways depending on the context (e.g. when the SSI is present), and that some responses therefore solely might be an artifact of the context. In connection to this Schoenfeld (2007) writes:

> For this reason, the use of multiple lenses on the same phenomena is essential. In some cases, that means employing multiple methods to look at the same phenomena. Thus, observations, questionnaires, and interviews can all be used to challenge, confirm, or expand the information gathered from each other. (p.87)

The SSI's choice of using interviews, surveys, and observations when collecting data can be seen in the light of this. Also when one considers how data obtained from the SSI is analyzed in this dissertation, it can be noted that it oftentimes is the case that indications of what is of interest often are derived from at least two of the sources. For example, whether teachers can be thought of as having systematically processed the competence message in the syllabus both relies on interview data and on survey data. Furthermore, the analysis of data in this study also sometimes rely on reasoning of how teacher-answers to different questions (in e.g. the interview) can be used to deduce an answer to a question that might be difficult to ask directly and get an accurate answer on (as is the case with above mentioned systematic processing). Although not necessary triangulation by considering different types of data this still can be seen as a sort of triangulation in the sense of “using multiple lenses on the same phenomena” (Shoenfeld, 2007, p.87).
7.3.2 Several persons involved in data collection and the many layers of analysis

A second, and a third, possible reason to question the results of this study has to do with that data was collected, and in parts analyzed, by several different persons, and that analysis made exclusively for this study often has been conducted in several steps. Data used in this study, as described in Section 5.2.3, was both in raw forms such as transcribed teacher-answers to interview questions, and in a processed form, such as analysts’ conclusions drawn from interview data. One could therefore wonder whether the data obtained was reliable, in the sense that each analyst would have gotten the same data if for example observing and analyzing the same lesson. If this would not be the case, this would severely damage the trustworthiness of this study. Although no tests of inter-rater reliability was made on data collected, it is argued that data can be considered to be inter-rater reliable in the following. The argument for why data can be considered inter-rater reliable is that the procedures for how data was to be collected and in part analyzed, by the analysts, were thorough, specific, and explicit, and that training in the procedures was provided to each analyst. The procedures for collecting and analyzing data were constructed so that they to a low extent would rely on the analysts’ judgments, and instead on the analysts’ ability to follow the procedures given to them. Without going into all details of how data was collected and analyzed (since this already has been done in Chapter 5), and from which the reader can form their own opinion of the claims made here, some examples are given to highlight how data collection and analysis made by analysts to a small extent relied on the analysts’ judgment. This is done through examples that lend support to the idea that data obtained from the SSI was reliable.

Both how the interviews and the observations were to be conducted were guided by extensive instructions given to the analysts. For example, the interviewer followed a highly structured interview guide in which everything the analyst needed to convey and ask was written down word for word. This was to ensure that all analysts asked the teachers the same questions, and that teachers had gotten the same information from each interviewer. By doing it this way, one could be reasonably assured of at least obtaining similar information from all teachers. For the observation, each analyst was provided with a guide specifying what data to collect (see Section 5.1.2 for the specific instructions). Regarding the observations it seems as the field notes are the weak point. There were however also written instructions for how they were to be taken, and furthermore it was largely a question of managing to make a written account of what happened when for example a teacher lectured. All analysts can of course not be equally apt in capturing all conversation in field notes, and lessons varied with respect to what demands
were on the one making field notes. However, in the collected experience of the research group hired by the SSI, this type of data collection (guided by principles stated in written documents) functioned reasonably well.

Now, focus is turned to the analysis of data during the SSI’s quality review of mathematics teaching in upper secondary school. Also when it came to analysis the analysts were given extensive instruction with directions for how data was to be analyzed (as described in Section 5). Of course the analysts had to make judgments when collecting and analyzing data, but to a high extent, also the analysis of data, was based on procedures developed to minimize the influence of variations in analysts’ judgments. Furthermore, the analysis procedures given to the analysts often were accompanied with examples of how for example teacher statements should be analyzed. In addition to mentioned support given to the analysts, all analysts also received one day of training in the procedures for collecting and analyzing data. Lastly, one person from the research group was assigned as a contact person that analysts could turn to if they had difficulties relating to either the collection or analysis of data.

So far, short notes on the reliability of the data obtained from the SSI have been discussed. That analyses made in this study, on raw forms of data and on analysts’ conclusions made from for example interview transcripts, to generate the CAMCC-data, could be problematic also has to do with validity. To be more specific: it has to do with the validity of the measures obtained through the analysis of data obtained from the SSI. One could perhaps worry that the analysis is done in too many layers, and that it therefore is room for errors that might affect both the validity and reliability of the measures. Regarding the reliability it is claimed that if the data used as input is reliable (as argued for above), then the output is reliable. This claim is based on the fact that the procedures of Sections 5.2.4-5.2.8, describing how CAMCC-data was obtained from raw forms of data and analysts’ conclusions based on for example interview data, are very much rule based, and there is only one person making this analysis. This means that the question of inter-rater reliability only depends on whether data obtained form the SSI, can be considered inter-rater reliable (which is argued for above that it can). The question of the validity of the measures obtained is however a question that has to be argued for in another way. As the validity of the measures relies on the inferences made in each step of the analysis generating the CAMCC-data, it is a question of how sound these procedures are. The answer to the objection that there are too many layers then lies in the arguments made for how data obtained from the SSI was used to produce the measures of the CAMCC-data. Regardless of how many steps of analysis that have been made, the measures will be valid if the arguments for why a certain inference can be made are sound. Because these arguments in great detail have been
described when presenting the analysis procedures, these arguments will not be revisited. Although there always is a limit to how far one explicitly can argue for each and every inference, there still are very good opportunities for the reader to scrutinize these procedures and the arguments for them, due to (as mentioned) their explicitness. Obviously the procedures failed to validly produce a measure of one of the constructs (the variable *Intention*) of the CAMCC. Thus, this construct was excluded from the study.
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Appendix A: The interview guide

Att göra inför intervjun:

- Kontrollera att inspelningsutrustningen fungerar som den ska.
- Tänk igenom den besökta lektionen så att du kan beskriva den kort och neutralt.
- Titta på den använda läroboken så att du kan diskutera den med läraren.
- Ha ett anteckningspapper och penna till hands för att kunna notera svar på fråga 1a ii).

Instruktioner för genomförandet av intervjun:

- Alla frågor som ska läsas upp är i fet stil, markerade med romerska siffror.
- Alla frågor ska läsas upp ordagrant.
- Följdfrågor står i direkt anslutning med normal stil. Text i normal stil ska läsas upp.
- Följdfrågor markerade med "I så fall" läses endast upp i förekommande fall.
- Kursiverade avsnitt och rubriker är information till intervjuaren och ska ej läsas upp.
- Tidsangivelserna är självklart uppskattningar. Om det står 45/10 vid ett avsnitt så betyder det att det bör ha gått ca 45 minuter av intervjun och att detta avsnitt bör ta ca 10 minuter. Totaltid enligt tidsangivelserna är 73 minuter.

- Två typer av svar ska följas upp:
  - När man inte förstår svaret ber man om ett förtydligande (endast en gång).
  - När läraren använder ord som är kompetensindikatorer (se instruktionen för intervjuanalysen). Dessa ord följs upp genom att man ber läraren förklara vad han/hon menar med ordet.
Del 1
a. Uppfattningar och intentioner. [0 min / 10 min]

Innan själva intervjun är det naturligtvis fritt för intervjuauren att säga t.ex. något om att det är trevligt att vara på skolan och att det var intressant att besöka lektionen.

Inledning: Syftet med intervjun är att vi vill lära oss hur undervisningen går till på din skola, men även att genom att intervjua ett hundratals lärare under hösten få en bättre uppfattning om undervisningen i Sverige.


Om jag frågar om något som du inte har funderat över, eller om du av något annat skäl inte tycker att du kan svara på frågan, så är det helt okej att säga det. Tveka inte att säga till när som helst om det är något du tycker är oklart.

Beskriv kort lektionen som besöktes på ett neutralt deskriptivt sätt, och framför allt ej utmanande, värderande eller analyserande:

På lektionen vi besökte så hade du först en genomgång av multiplikation med decimaltal, där du ställde en del frågor till eleverna. Därefter gjorde eleverna uppgifter ur läroboken och du gick runt och hjälpte dem (det kursiva ersätts med en liknande kort beskrivning av den aktuella lektionen).

i) Var det en vanlig lektion vi besökte?
I vilken utsträckning tycker du att lektionen påverkades av vår närvaro?

ii) Vad vill du att eleverna ska lära sig under matematiklektionerna?

iii) Hur arbetar du för att eleverna ska uppnå det du vill?

iv) Anser du att dina mål nås?
v) Upplever du att dina mål för elevernas lärande och dina undervisningsmetoder har sett likadana ut länge, eller att de har förändrats över tid?

I så fall: På vilket sätt har de förändrats? Varför har de förändrats?

b. De källor som lärarna anser sig ha varit påverkade av vad gäller att bilda sin uppfattning om 1a i) och ii). [10 min / 6 min]

i) Vad har främst påverkat dig beträffande dina mål för elevernas lärande?

Vad har främst påverkat dig beträffande dina undervisningsmetoder?

ii) Eventuell komplettering:

Om läraren inte tar upp nedanstående så frågar vi:

Har dina mål och undervisningsmetoder även påverkats av ...

- lärarutbildning
- styrdokument
- nationella prov
- läromedel
- kollegor

iii) Ungefär hur stor del av ditt och elevernas arbete under lektionerna vägleds av läroboken?

Anser du att läroboken är i linje med kursplanen?
Anser du att läroboken är i linje med Nationella Prov?
Vem väljer lärobok?
På vilka grunder väljer ni lärobok?

iv) Anser du att det är lätt eller svårt att tolka kursplanen?

Eventuell följdråga: På vilket sätt?
I så fall vilka? *Relatera till kursplanens olika delar.* Hur påverkas undervisningen? Kan du ge exempel?

v) Är det något i kursplanen som du har funnit problematiskt beträffande vad eleverna bör lära, och i så fall vad?  
*(eventuellt förtydligande)*  
T.ex. något som eleverna har särskilt svårt att lära sig, eller som du inte tycker att de behöver lära sig?

d. Tolkning och värdering av Nationella prov. [22 min / 5 min]  
i) Vilken tillgång har du till Nationella prov?

ii) Hur många gånger har du varit med om Nationella prov?

iii) Anser du att det finns något i Nationella prov som du och din undervisning påverkas av?  
*I så fall:* Kan du beskriva hur?  
*(Om läraren bara tar upp bedömning och betygssättning, frågar vi om det används till något annat, t.ex. att uppgifterna testar vissa saker som därför behandlas i undervisningen)*.

iv) Är det något i Nationella prov som du har funnit problematiskt beträffande vad eleverna bör lära, och i så fall vad?  
*(eventuellt förtydligande)*  
T.ex. något som testas som eleverna har särskilt svårt att lära sig, eller som du inte tycker de behöver lära sig?

Del 2.  
a. Tolkning av uppgifter från Nationella prov. [27 min / 8 min]  
*Till lärarna:* Du ska nu få se några uppgifter från Nationella prov för Matematik A. Jag undrar vad du anser att eleverna behöver kunna för att lösa uppgifterna. Jag vet att det finns många sätt att beskriva vad som krävs och det handlar inte om vilket sätt som är rätt eller fel, utan om att vi vill få en överblick över hur lärare ser på Nationella prov.
Läs respektive uppgift högt för läraren och ställ sedan frågan.

**NP-uppgift 1 (sid 2 i lärarens häfte).**

*Ej till lärarna: kommunikation, representation*

När en frysbox stängs av stiger temperaturen. Följande formel kan användas för att beräkna temperaturen \((y)\) i grader Celsius då en frysbox har varit avstängd i \(x\) timmar.

\[ y = 0,2x - 18 \]

a) Vilken är frysboxens temperatur då den varit avstängd två timmar? 

b) Hur länge har frysboxen varit avstängd då temperaturen är 0 °C? 

c) Förklara med egna ord vad formeln innebär.

i) Titta på deluppgift c. Vad anser du att eleverna behöver kunna för att lösa uppgiften?

**NP-uppgift 2 (sid 3).**

*Ej till lärarna: problemlösning, resonemang, samband*


ii) Vad anser du att eleverna behöver kunna för att lösa uppgiften?
**NP-uppgift 3 (sid 4).**

*Ej till lärarna: resonemang, procedurhantering*

Martin och Johanna ska köpa en ny bil. Johanna fastnar för en bil som kostar 194 000 kr. Martin påstår att värdet på denna sorts bil sjunker med ungefär 17 % per år. De funderar på hur mycket den bilen skulle vara värd om 3 år och var och en beräknar på sitt sätt.

**Martins beräkning**

\[
\begin{align*}
17\% & + 17\% + 17\% = 51\% \\
100 - 51 & = 49\% \\
49\% & \cdot 194 000 = 95 060 \text{ kr}
\end{align*}
\]

**Johannas beräkning**

\[
\begin{align*}
1 - 0.17 & = 0.83 \\
0.83^3 \cdot 194 000 \text{ kr} & = 110 927 \text{ kr}
\end{align*}
\]

Vem har tolkat problemet rätt? Hur kan Martin och Johanna ha resonerat?

---

iii) Vad anser du att eleverna behöver kunna för att lösa uppgiften?
I badhuset finns fyra bassänger A, B, C och D. Dessa fylls med vatten som rinner med samma hastighet.

Diagrammet nedan visar hur vattendjupet ändras med tiden för påfyllningen i bassängerna A, B och C.

a) Markera bassäng A och B i diagrammet. *Endast svar krävs.*

b) Beskriv med ord hur den bassäng ser ut som motsvaras av graf C.

c) Bassäng D fylls med vatten på samma sätt. Beskriv med ord och graf hur vattendjupet ändras.

iv) Vad anser du att eleverna behöver kunna för att lösa uppgiften?

v) Är lätt eller svårt att i förväg bedöma vad eleverna behöver kunna för att lösa en matematikuppgift?
Ev. förtydligande: Dvs. innan du har sett elevernas lösningar.
År det svårare för uppgifter från Nationella prov än för läroboksuppgifter?
I så fall: På vilket sätt?

vi) Har din uppfattning om vad eleverna behöver kunna för att lösa uppgifter i Nationella prov förändrats över tid?
Ev. förtydligande: Dvs. uppgifter av den typ vi har tittat på ovan.
I så fall: Hur har den förändrats? Varför har den förändrats?

b. Tolkning av kursplanen. [35 min / 15 min]

Till lärarna: Vi ska titta på några utdrag ur kursplanen för Matematik A som vi kommer att be dig tolka. Vi vet att det finns många sätt att tolka dokumenten och det handlar inte om vilket sätt som är rätt eller fel, utan om att vi vill få en överblick över hur lärare ser på kursplanen.
Läs utdragen högt för läraren. Låt läraren svara och ställ sedan följdfrågan/frågorna.

Ej till lärarna: Problemlösning/procedurantering

---

Utdrag A (sid 6).
Eleven använder lämpliga matematiska begrepp, metoder, modeller och tillvägagångssätt för att formulera och lösa olika typer av problem.
(Kriterier för betyget Väl godkänt, Matematik A)

---

i) Hur tolkar du den här formuleringen?
Hur tolkar du ordet ”problem”?  
Hur tolkar du orden ”metoder” och ”modeller”?

Ej till lärarna: Resonemang
Läs utdraget högt för läraren.

---

Utdrag B (sid 7).
Eleven utvecklar sin förmåga att följa och föra matematiska resonemang samt redovisa sina tankegångar muntligt och skriftligt
(Mål att sträva mot)

---

ii) Hur tolkar du den här formuleringen?
Hur tolkar du ordet ”resonemang”?  

---

200
Ej till lärarna: Representationer

Utdrag C (sid 8).

Skolan skall i sin undervisning i matematik sträva efter att eleverna utvecklar sin förmåga att tolka, förklara och använda matematikens språk, symboler, metoder, begrepp och uttrycksformer.
(Mål att sträva mot)

iii) Hur tolkar du den här formuleringen?
Hur tolkar du ordet ”uttrycksformer”?

Ej till lärarna: Samband

Utdrag D (sid 9).

Eleven utvecklar sina kunskaper om hur matematiken används inom informationsteknik, samt hur informationsteknik kan användas vid problemlösning för att åskådliggöra matematiska samband och för att undersöka matematiska modeller.
(Mål att sträva mot)

iv) Hur tolkar du den här formuleringen?
Hur tolkar du ordet ”samband”?

Ej till lärarna: Kommunikation

Utdrag E (sid 10).

Utbildningen skall leda till förmåga att kommunicera med matematikens språk och symboler, som är likartade över hela världen.
(Ämnets syfte.)

v) Hur tolkar du den här formuleringen?
Hur tolkar du ordet ”kommunicera”?

201
vi) Hur tolkar du denna formulering?
Hur tolkar du ordet ”förstår”?

vii) Anser du att det är lätt eller svårt att tolka de utdrag vi har diskuterat?
*Eventuell följdfråga:* På vilket sätt?

viii) Har din tolkning av kursplanen förändrats över tid?
*I så fall:* Hur har den förändrats? Varför har den förändrats?

---

Här kan det passa med fem minuters paus.

---
Del 3.
a. Beskrivning av kompetenserna. [50 min / 10 min]

Förslag på introduktion som vi läser upp:
"Jag skulle nu vilja diskutera en särskild typ av lärandemål. Det finns ett sätt att se på lärandemål i matematik som kan kallas för kompetensmål. Poängen med det synsättet är att man vill lyfta generella kompetenser om vad det innebär att arbeta med matematik, som ett komplement till att specificera vilket matematiskt innehåll som t ex aritmetik, algebra, geometri, statistik, som skall behandlas.

De kompetenser jag särskilt vill diskutera är
1) problemlösningsförmåga
2) resonemangsförmåga
3) förmåga att hantera procedurer
4) förmåga att representera matematiska objekt och idéer
5) förmåga att koppla samman olika objekt och idéer, samt
6) förmågan att kommunicera matematik.

Jag vill särskilt diskutera hur dessa sex kompetensmål framträder i kursplanen för Matematik A och i nationella prov.

Innan jag ställer fler frågor tänkte jag först ägna 10 minuter åt att tydligare förklara vad jag menar och exemplifiera kompetensmålen. Det är viktigt att notera att det som beskrivs som sex kompetensmål inte kan ses som den korrekta tolkningen, utan bara som en tolkning av många möjliga.

Det är också viktigt att poängtera att det finns flera andra viktiga mål i styrdokumenten som jag inte berör. De handlar om t.ex. demokrati, miljö och jämställdhet. Fråga gärna om du tycker något är oklart."

**Problemlösningsförmåga (sid 12 i lärarhäftet).**
Problemölösning innebär att man försöker lösa en uppgift utan att från början veta vilken metod man ska använda för att lyckas. En sådan uppgift kallas ett *problem* och uppgifter som inte är problem kallas ofta för *rutinuppgifter*.

**Citat ur kursplanen som kan tänkas syfta på problemlösningsförmåga:**
"Eleven använder lämpliga matematiska begrepp, metoder, modeller och tillvägagångssätt för att formulera och lösa olika typer av problem."
(Kriterier för betyget Väl godkänt, Matematik A)

*Nytt:* "Utbildningen syftar även till att eleverna skall uppleva glädjen i att utveckla sin matematiska kreativitet och förmåga att lösa problem samt få erfara något av matematikens skönhet och logik"
(Ämnets karaktär och uppbyggnad)

**Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva problemlösningsförmåga:**

**Motivering:** Uppgiften kräver problemlösning om eleven inte har träffat på så många liknande uppgifter.


Jag vill påminna om att alla påståenden ovan utom själva citaten speglar några av många möjliga uppfattningar, och kan inte ses som rätt eller fel.

**Kommentar:** Det gäller inte bara definitionen av problemlösning, utan även att citaten ur kursplanen har med vår definition att göra och att uppgiften kräver kompetensen.

Ställ gärna någon fråga efter varje definition huruvida läraren har förstått, t.ex. "är det något som är oklart?". 

204
**Resonemangsförmåga (sid 13).**
Att resonera är att utveckla och utvärdera matematiska argument, till exempel att motivera varför man använder ett visst räknesätt eller att motivera varför en utförd beräkning är korrekt.

**Citat ur kursplanen som kan tänkas syfta på resonemangsförmåga:**
"Eleven utvecklar sin förmåga att följa och föra matematiska resonemang samt redovisa sina tankegångar muntligt och skriftligt."
(Mål att sträva mot)

**Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva resonemangsförmåga:**

**Motivering:** I denna uppgift är argumentationen central. Eleven måste argumentera för att Johannas beräkning är korrekt.

---

Martin och Johanna ska köpa en ny bil. Johanna fastnar för en bil som kostar 194 000 kr. Martin påstår att värdet på denna sorts bil sjunker med ungefär 17 % per år. De funderar på hur mycket den bilen skulle vara värd om 3 år och var och en beräknar på sitt sätt.

**Martins beräkning**

\[
17 \% + 17 \% + 17 \% = 51 \%
\]
\[
100 - 51 = 49 \%
\]
\[
49 \% \cdot 194 000 = 95 060 \text{ kr}
\]

**Johannas beräkning**

\[
1 - 0,17 = 0,83
\]
\[
0,83^3 \cdot 194 000 \text{ kr} = 110 927 \text{ kr}
\]

Vem har tolkat problemet rätt? Hur kan Martin och Johanna ha resonerat?
Förmågan att hantera procedurer (sid 14).
En matematisk procedur är en följd av matematiska operationer, till exempel en algoritm för att multiplicera tvåsiffriga tal, som löser en uppgift. Det kan även vara en enda regel, t.ex. att hastighet = sträcka / tid.

Citat ur kursplanen som kan tänkas syfta på förmåga att hantera procedurer:
"Eleven använder lämpliga matematiska begrepp, metoder, modeller och tillvägagångssätt för att formulera och lösa olika typer av problem."
(Kriterier för betyget Väl godkänt, Matematik A)

Nytt: "Eleven skall kunna tolka och hantera algebraiska uttryck, formler och funktioner som krävs för problemlösning i vardagslivet och i studieinriktningens övriga ämnen"
(Mål som eleverna skall ha uppnått efter avslutad kurs – Matematik A)

Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva förmåga att hantera procedurer:

Motivering: Här måste eleven ha kännedom om hur man hanterar beräkningar och procedurer som rör procentbegreppet.

| Martin och Johanna ska köpa en ny bil. Johanna fastnar för en bil som kostar 194 000 kr. Martin påstår att värdet på denna sorts bil sjunker med ungefär 17% per år. De funderar på hur mycket den bilen skulle vara värd om 3 år och var och en beräknar på sitt sätt. |

<table>
<thead>
<tr>
<th>Martins beräkning</th>
</tr>
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<tbody>
<tr>
<td>17% + 17% + 17% = 51%</td>
</tr>
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<tbody>
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<td>1 - 0,17 = 0,83</td>
</tr>
<tr>
<td>0,83^3 · 194 000 kr = 110 927 kr</td>
</tr>
</tbody>
</table>

Vem har tolkat problemet rätt? Hur kan Martin och Johanna ha resonerat?

Kommentera: Denna uppgift är ett exempel på att uppgifter kan testa flera kompetenser.
Förmåga att representera matematiska företeelser (sid 15).
När man tänker på matematiska objekt och andra företeelser (t.ex. tal, funktioner, ekvationer eller metoder) så tänker man oftast på en representation av det.
- När barn arbetar med matematik använder man ofta konkret material, t.ex. klossar eller knappar, för att representera talen och göra matematiken mer konkret. Omvänt så kan symboler representera det konkreta, t.ex. kan uttrycket ”5 kr” representera en verklig femkrona.
- En ritad rektangel kan representera en verklig fotbollsplan, och omvänt så kan en verklig fotboll representera det abstrakta matematiska objektet klot.

Citat ur kursplanen som kan tänkas syfta på förmåga att representera matematiska företeelser:
"Skolan skall i sin undervisning i matematik sträva efter att eleverna utvecklar sin förmåga att tolka, förklara och använda matematikens språk, symboler, metoder, begrepp och uttrycksformer."
(Mål att sträva mot)

Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva förmåga att representera matematiska företeelser:

Motivering: I denna uppgift får eleven arbeta med olika representationer av vattendjup, som text, bilder och grafer.
I badhuset finns fyra bassänger A, B, C och D. Dessa fylls med vatten som rinner med samma hastighet.

Diagrammet nedan visar hur vattendjupet ändras med tiden för påfyllningen i bassängerna A, B och C.

![Diagram](image)

a) Markera bassäng A och B i diagrammet. *Endast svar krävs.*

b) Beskriv med ord hur den bassäng ser ut som motsvaras av graf C.

c) Bassäng D fylls med vatten på samma sätt. Beskriv med ord och graf hur vattendjupet ändras. (0/2)

**Förmåga att koppla samman olika företeelser (sid 16).**

Genom att koppla samman matematiska objekt och idéer är det möjligt att skapa förståelse för nya fenomen med hjälp av gammal kunskap. Exempel:
- Att multiplikation av heltal kan ses som upprepad addition (3·4=4+4+4) kan ses som en koppling mellan de två räknesätten.
- Ett annat samband är mellan längden på sidan av en kvadrat, kvadratens omkrets och kvadratens area.
- Det finns även samband mellan olika matematiska områden. T.ex. mellan
aritmetik och algebra där man använder liknande räkneregler, men i aritmetik räknar man med tal och i algebra med variabler (t.ex. x och y).

**Citat ur kursplanen som kan tänkas syfta på förmåga att koppla samman olika företeelser:** "Eleven utvecklar sina kunskaper om hur matematiken används inom informationsteknik, samt hur informationsteknik kan användas vid problemlösning för att åskådliggöra matematiska samband och för att undersöka matematiska modeller." (Mål att sträva mot)

**Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva förmåga att koppla samman olika företeelser:**

*Motivering:* Här finns flera olika representationer av samma sak och eleven måste se sambandet mellan dessa representationer.

**I badhuset finns fyra bassängers A, B, C och D. Dessa fylls med vatten som rinner med samma hastighet.**

Diagrammet nedan visar hur vattendjupet ändras med tiden för påfyllningen i bassängerna A, B och C.

![Diagram](image)

a) Markera bassäng A och B i diagrammet. *(Endast svar krävs)*.

b) Beskriv med ord hur den bassäng ser ut som motsvaras av graf C.

c) Bassäng D fylls med vatten på samma sätt. Beskriv med ord och graf hur vattendjupet ändras. *(0/2)*

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Förmåga att kommunicera matematik (sid 17)
Att kommunicera matematik är att utbyta information, tankar och idéer om matematik genom att prata, lyssna, skriva, läsa, rita och diskutera.

Citat ur kursplanen som kan tänkas syfta på förmåga att kommunicera matematik:
"Utbildningen skall leda till förmåga att kommunicera med matematikens språk och symboler, som är likartade över hela världen."
(Ämnets syfte.)

Nytt: "En viktig del av problemlösningen är att utforma och använda matematiska modeller och på olika sätt kommunicera om de matematiska idéerna och tankegångarna.
(Ämnets karaktär och uppbyggnad)

Exempel på en uppgift ur ett Nationellt Prov (Matematik A) som kan tänkas kräva förmåga att kommunicera matematik:

Motivering: Här måste eleven kommunicera vad formeln egentligen innebär.

När en frysbox stängs av stiger temperaturen. Följande formel kan användas för att beräkna temperaturen \( y \) i grader Celsius då en frysbox har varit avstängd i \( x \) timmar.
\[
y = 0,2x - 18
\]
a) Vilken är frysboxens temperatur då den varit avstängd två timmar? 
( )
b) Hur länge har frysboxen varit avstängd då temperaturen är 0 °C? 
( )
c) Förklara med egna ord vad formeln innebär. 
( )
b. Lärares värdering av kompetensmålen [60 min / 4 min]

En sammanställning av alla sex kompetensmålen finns i lärarhäftet sid 18.

i) Har du träffat på kompetensmål av det slag som jag har beskrivit tidigare?

  Har du träffat på idén att komplettera innehållsmål med kompetensmål tidigare?

ii) Hur viktigt tycker du att det är att eleverna får utveckla dessa sex kompetenser?

  Varför?

iii) Anser du att det är svårt att arbeta med kompetensmålen i undervisningen?

  I så fall: På vilket sätt är det svårt? Varför är det svårt?

  Om läraren aldrig har träffat på kompetensmål tidigare kan man ställa frågan om läraren tror att det skulle vara svårt.

iv) Har din syn på kompetensmålen förändrats över tid?

  I så fall: Hur har den förändrats? Varför har den förändrats?

v) Hur tror du att dina kollegor ser på detta?

  Har du diskuterat detta med dina kollegor, t.ex. om kompetenserna är viktiga eller om de är svåra att arbeta med i undervisningen?

c. Lärares bearbetning av kompetensmålen [64 min / 4 min]

i) Har du på något sätt arbetat för att försöka tolka, förstå eller på annat sätt bearbeta kompetensmål av den typ som vi beskriver?

  I så fall: Hur har du arbetat?

  Var det något av dessa kompetensmål som du tyckte det var enklare eller svårare att förstå?

ii) Har Nationella prov på något sätt fungerat som ett stöd för dig att tolka kursplanen och de sex kompetensmål vi beskriver?

  I så fall: Hur då?

  iii) Är det någon/några av de sex kompetenserna som du tycker testas tydligare än andra i NP?

d. Lärares intentioner i relation till kompetensmålen [68 min / 5 min]

i) I början av intervjun pratade vi en del om vad du strävar efter i din undervisning. Vilken relation ser du mellan kompetenserna och dina mål för elevernas lärande?

  Om läraren inte kommer ihåg vilka mål han/hon angav kan dessa räknas upp.
ii) Anser du att dina elever utvecklar de sex kompetenserna?

iii) Går det att koppla någon undervisningsaktivitet som du organiserade under den lektion som jag besökte till någon av kompetenserna?
   *I så fall: Kan du ge exempel?*  
   *Har du aktiviteter vid andra lektioner som kan kopplas till kompetenserna? Exempel?*

iv) Skulle du ha andra mål om du hade andra förutsättningar?  
   *Ev. förtydligande: Till exempel mer tid och färre elever?*

---

**Den strukturerade delen av intervjun är slut.**

*Om det finns tid över kan denna ägnas åt improviserade frågor om intervjueraren bedömer det lämpligt.*

**Avslutande önskemål till läraren:**

*För att öka jämförbarheten beträffande hur du och dina kollegor besvarar intervjufrågorna vore jag tacksam om du inte diskuterade innehållet i intervjun med någon innan vi hunnit genomföra alla intervjuer på skolan. Visst går det bra?*

**Information om enkäten:**

*Som ett komplement till intervjun kommer vi be dig att fylla i en webbenkät. Det vore vänligt om du kunde skriva ned din e-adress (alternativt skriv in direkt i datorn) så kommer vi att skicka dig en länk till enkäten.*

**Insamling av prov:**

*Vi vill ha in kopior på de tre senaste proven eller diagnoserna som du har använt i matematik A (dock ej Nationella prov). Ange källan (t.ex. lärobok eller egen konstruktion).*
Appendix B: The survey

Välkommen att delta i denna enkät!


En del av frågorna i enkäten är formulerade i dåtid, t.ex. "I vilken utsträckning har du varit motiverad att..." eller "I vilken utsträckning har du känt dig..." Vi skulle i dessa fall vilja att du utgår från den tid du har undervisat i matematik, men att du som längst tänker tillbaka på de senaste 15 åren (under perioden som de nuvarande kursplanerna har varit i bruk), även om du har undervisat längre. Denna tidsaspekt gäller även om frågorna inte direkt behandlar din undervisning.

De flesta frågorna lyder "I vilken utsträckning...". Svarsalternativen är numrerade från 1 till 6 där 1 = i mycket liten utsträckning och 6 = i mycket stor utsträckning eller motsvarande.

Enkäten inleds med några frågor om demografiska data. Totalt omfattar enkäten 85 frågor.

Namn: __________________________________________
Skola : _________________________________________

1. Kön 
Kvinna □  Man □
2. Ålder
- □ < 30 år
- □ 30-40 år
- □ 41-50 år
- □ 51-60 år
- □ > 60 år

3. Har varit verksam som lärare i:
- □ < 5 år
- □ 6-10 år
- □ 11-15 år
- □ > 15 år

4. Har du en lärarexamen?  
   - Ja □  
   - Nej □

   *Om du svarat nej på fråga 4 så hoppar du till fråga 6. Har du däremot svarat ja, så fortsätter du direkt nedan med fråga 5.*

5. Inriktningen på min lärarexamen är mot:
   - □ Förskola
   - □ Grundskolans tidigare år
   - □ Grundskolans senare år
   - □ Gymnasiet
   - □ Annat (fyll i nedan)

   *(Om du inte har någon examen så hoppar du över denna fråga.)*

6. Jag har läst matematikkurser på högskolenivå i en omfattning av:
   - □ 0 akademiska poäng / 0 nya högskolepoäng
   - □ 1-10 akademiska poäng / 1-15 nya högskolepoäng
   - □ 11-20 akademiska poäng / 16-30 nya högskolepoäng
   - □ 21-30 akademiska poäng / 31-45 nya högskolepoäng
   - □ > 30 akademiska poäng / > 46 nya högskolepoäng
   - □ Vet ej

*Med 1 akademiskt poäng menas 1 veckas heltidsstudier. De akademiska poängen byttes ut mot högskolepoäng den 1 juli 2007. 1 akademiskt poäng = 1,5 högskolepoäng.*
7. Jag har läst kurser i matematikdidaktik på högskolenivå i en omfattning av:

- 0 akademiska poäng / 0 nya högskolepoäng
- 1-10 akademiska poäng / 1-15 nya högskolepoäng
- 11-20 akademiska poäng / 16-30 nya högskolepoäng
- 21-30 akademiska poäng / 31-45 nya högskolepoäng
- > 30 akademiska poäng / > 46 nya högskolepoäng

Vet ej

Kommentarer: ____________________________________________

8. I vilken utsträckning har du varit motiverad att noga tolka det som formulerats i kursplanen under rubrikerna:

a. Ämnets syfte?
   1 2 3 4 5 6

b. Mål att sträva mot?
   1 2 3 4 5 6

c. Ämnets karaktär och uppbyggnad?
   1 2 3 4 5 6

d. Mål som eleverna skall ha uppnått efter avslutad kurs?
   1 2 3 4 5 6

e. Betygskriterier?
   1 2 3 4 5 6

9. I vilken utsträckning har du varit motiverad att noga analysera vilka ämnesområden (t ex ekvationer, areor etc.) som testas i de nationella proven?
   1 2 3 4 5 6 Ej aktuellt

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10. I vilken utsträckning har du varit motiverad att noga analysera vilka typer av kunskaper (i meningen olika kompetenser som diskuterades på intervjun; t.ex kommunikation och resonemang) som testas i de nationella proven?
$\begin{align*}
1 & \bigcirc \\
2 & \bigcirc \\
3 & \bigcirc \\
4 & \bigcirc \\
5 & \bigcirc \\
6 & \bigcirc \\
\text{Ej aktuellt} & \bigcirc
\end{align*}$

11. I vilken utsträckning har du ägnat tid åt att tolka kursplanen?
$\begin{align*}
1 & \bigcirc \\
2 & \bigcirc \\
3 & \bigcirc \\
4 & \bigcirc \\
5 & \bigcirc \\
6 & \bigcirc
\end{align*}$

12. I vilken utsträckning upplever du att den mängd tid du har ägnat åt att tolka kursplanen har varit tillräcklig?
$\begin{align*}
1 & \bigcirc \\
2 & \bigcirc \\
3 & \bigcirc \\
4 & \bigcirc \\
5 & \bigcirc \\
6 & \bigcirc
\end{align*}$

13. Ange i varje ruta till höger hur många procent av den totala tid du ägnat åt kursplanetolkning som har gått till respektive del av kursplanen.

a. Ämnets syfte
b. Mål att sträva mot
c. Ämnets karaktär och uppbyggnad
d. Mål att uppnå
e. Betygskriterier

$\text{Summa: } 100\%$

14. I vilken utsträckning har du läst något kommentarmaterial om kursplanerna, t.ex. från Skolverket eller följt diskussioner om kursplanerna i Nämnaren?

Aldrig $\bigcirc$ Ett fåtal gånger $\bigcirc$ Många gånger $\bigcirc$

15. I vilken utsträckning har det varit tillräckligt för dina behov?
$\begin{align*}
1 & \bigcirc \\
2 & \bigcirc \\
3 & \bigcirc \\
4 & \bigcirc \\
5 & \bigcirc \\
6 & \bigcirc
\end{align*}$

16. I vilken utsträckning har du ägnat tid åt att analysera nationella prov?
$\begin{align*}
1 & \bigcirc \\
2 & \bigcirc \\
3 & \bigcirc \\
4 & \bigcirc \\
5 & \bigcirc \\
6 & \bigcirc \\
\text{Ej aktuellt} & \bigcirc
\end{align*}$

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17. I vilken utsträckning upplever du att den mängd tid du har ägnat åt att analysera nationella prov har varit tillräcklig?

1 □  2 □  3 □  4 □  5 □  6 □  Ej aktuellt □

Kommentarer: _______________________________________

18. I vilken utsträckning har du känt dig nöjd med det som står i kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

19. I vilken utsträckning har du känt dig irriterad över skrivningar i kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

20. I vilken utsträckning har du känt dig oroad över hur din undervisning förhåller sig till kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

21. I vilken utsträckning har du upplevt en känsla av utmaning när du läst kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

22. I vilken utsträckning har ovanstående känslor förändrats mellan gångerna du läst och tolkat kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

23. I vilken utsträckning har du känt dig nöjd över de olika typer av uppgifter som inkluderats nationella prov?

1 □  2 □  3 □  4 □  5 □  6 □  Ej aktuellt □

24. I vilken utsträckning har du känt dig irriterad över de typer av uppgifter som inkluderats i nationella prov?

1 □  2 □  3 □  4 □  5 □  6 □  Ej aktuellt □

25. I vilken utsträckning har du känt dig oroad över hur din undervisning förhåller sig till de typer av uppgifter som inkluderats i nationella prov?

1 □  2 □  3 □  4 □  5 □  6 □  Ej aktuellt □
26. I vilken utsträckning har du upplevt en känsla av utmaning när du sett vilka typer av uppgifter som inkluderas i nationella prov?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ Ej aktuellt □

27. I vilken utsträckning har ovanstående känslor förändrats mellan gångerna du sett eller tolkat nationella prov?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ Ej aktuellt □

Kommentarer: _______________________________

28. I vilken utsträckning har du haft följande skäl till att tolka kursplanen?

a. Det är intressant i sig själv att analysera vilken matematik som förs fram.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □

b. För att kunna anpassa undervisningen så att eleverna ska få bästa möjlighet att lära sig det som på nationell nivå anses som viktigt och/eller få så höga betyg som möjligt.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □

c. Jag har varit beordrad att göra det.

1 □ 2 □ 3 □ 4 □ 5 □ 6 □

29. I vilken utsträckning har du haft följande skäl till att analysera nationella prov?

a. Det är intressant i sig själv att analysera vilken matematik som förs fram?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ Ej aktuellt □

b. För att kunna anpassa undervisningen så att eleverna ska få bästa möjlighet att lära sig det som på nationell nivå anses som viktigt och/eller få så höga betyg som möjligt?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □ Ej aktuellt □
c. Jag har varit beordrad att göra det.

1  2  3  4  5  6

30. I vilken utsträckning upplever du att dina kollegor som undervisar i matematik har varit intresserade av att tolka kursplaner?

1  2  3  4  5  6

31. I vilken utsträckning upplever du att dina kollegor som undervisar i matematik har varit intresserade av att analysera nationella prov?

1  2  3  4  5  6

32. I vilken utsträckning upplever du att dina kollegor aktivt har arbetat med att utveckla sin matematikundervisning?

1  2  3  4  5  6

33. I vilken utsträckning har du deltagit i fornbildning om kursplanerna i matematik 1994/2000?

Aldrig □ Ett fåtal gånger □ Många gånger □

34. I vilken utsträckning har det varit tillräckligt för dina behov?

1  2  3  4  5  6

35. I vilken utsträckning upplever du att du har haft ett bra samarbete med kollegor kring tolkningen av kursplanerna?

1  2  3  4  5  6

36. I vilken utsträckning upplever du att du/ni i arbetet med kursplanetolkningen skulle ha behövt hjälp av någon extern expert på kursplaner i matematik?

1  2  3  4  5  6

37. I vilken utsträckning upplever du att du har haft ett bra samarbete med kollegor kring analysen av nationella prov?

1  2  3  4  5  6  Ej aktuellt □

38. I vilken utsträckning upplever du att du/ni i arbetet med analysen av nationella prov skulle ha behövt hjälp av någon extern expert?

1  2  3  4  5  6  Ej aktuellt □
Kommentarer: _______________________________

39. I vilken utsträckning har du tyckt att formuleringarna i kursplanen under följande rubriker har varit förståeliga:

a. Ämnets syfte?
   1 □  2 □  3 □  4 □  5 □  6 □

b. Mål att sträva mot?
   1 □  2 □  3 □  4 □  5 □  6 □

c. Ämnets karaktär och uppbyggnad?
   1 □  2 □  3 □  4 □  5 □  6 □

d. Mål som eleverna skall ha uppnått efter avslutad kurs?
   1 □  2 □  3 □  4 □  5 □  6 □

e. Betygskriterier?
   1 □  2 □  3 □  4 □  5 □  6 □

40. I vilken utsträckning har du tyckt att den matematik som kursplanerna beskriver är ett bra val av skolmatematik?
   1 □  2 □  3 □  4 □  5 □  6 □

41. I vilken utsträckning har du tyckt att den matematik som testas i de nationella proven är ett bra val av skolmatematik?
   1 □  2 □  3 □  4 □  5 □  6 □
   Ej aktuellt □

42. I vilken utsträckning tycker du att uppgifterna i de nationella proven tydliggör vad som menas med olika formuleringar i kursplanerna?
   1 □  2 □  3 □  4 □  5 □  6 □
   Ej aktuellt □

43. I vilken utsträckning har du tyckt att det som står i kursplanen under följande rubriker har varit användbart för dig i din undervisning?

a. Ämnets syfte
   1 □  2 □  3 □  4 □  5 □  6 □
b. Mål att sträva mot
   1 □  2 □  3 □  4 □  5 □  6 □

c. Ämnets karaktär och uppbyggnad
   1 □  2 □  3 □  4 □  5 □  6 □

d. Mål som eleverna skall ha uppnått efter avslutad kurs
   1 □  2 □  3 □  4 □  5 □  6 □

e. Betygskriterier (frågan gäller inte betygsättning utan användbarheten för din undervisning)
   1 □  2 □  3 □  4 □  5 □  6 □

44. I vilken utsträckning har du känt dig säker på vilken användning det är tänkt att man som lärare ska ha av det som står i kursplanen under följande rubriker?

a. Ämnets syfte
   1 □  2 □  3 □  4 □  5 □  6 □

b. Mål att sträva mot
   1 □  2 □  3 □  4 □  5 □  6 □

c. Ämnets karaktär och uppbyggnad
   1 □  2 □  3 □  4 □  5 □  6 □

d. Mål som eleverna skall ha uppnått efter avslutad kurs
   1 □  2 □  3 □  4 □  5 □  6 □

e. Betygskriterier (frågan gäller inte betygsättning utan användbarheten för din undervisning)
   1 □  2 □  3 □  4 □  5 □  6 □

Kommentarer: _______________________________

45. I vilken utsträckning har du tyckt att en analys av vilka ämnesområden (t ex ekvationer, areor etc.) som ingår i nationella prov är användbar för dig i din undervisning?
   1 □  2 □  3 □  4 □  5 □  6 □  Ej aktuellt □
46. I vilken utsträckning har du tyckt att en analys av vilka typer av kunskaper (i meningen olika kompetenser som diskuterades på intervjun; t ex kommunikation och resonemang) som testas i de nationella proven är användbar för dig i din undervisning?

1 2 3 4 5 6 Ej aktuellt

47. I vilken utsträckning håller du med om följande påstående:
Det är ineffektivt att låta elever arbeta med uppgifter som det inte finns något klart och entydigt svar till.

1 2 3 4 5 6

48. I vilken utsträckning tycker du att matematik är ett intressant ämne?

1 2 3 4 5 6

49. I vilken utsträckning håller du med om följande påstående:
Forskare borde vid det här laget veta om lärargenomgångar eller smågruppsdiskussioner är den bästa undervisningsmetoden.

1 2 3 4 5 6

50. I vilken utsträckning har det varit viktigt för dig att din undervisning är samstämmig med de nationella proven?

1 2 3 4 5 6 Ej aktuellt

51. I vilken utsträckning håller du med om följande påstående:
Elever får ut mer av en lektion när deras lärare fokuserar på fakta och procedurer än när läraren pratar om idéer.

1 2 3 4 5 6

52. I vilken utsträckning tycker du att det är spännande att diskutera matematik utanför skolan (om det är på en nivå du klarar av)?

1 2 3 4 5 6

53. I vilken utsträckning håller du med om följande påstående:
Om man som lärare försöker relatera nya idéer i läroboken till kunskap som eleverna redan har om ett ämnesområde, så blir eleverna mer förvirrade än hjälpta.

1 2 3 4 5 6
54. I vilken utsträckning skulle du prioritera att se ett populärvetenskapligt program om matematik på TV om det visades ett sådant?

1 □  2 □  3 □  4 □  5 □  6 □

55. I vilken utsträckning håller du med om följande påstående:
Om en elev arbetar väldigt länge med att försöka lösa ett problem så är det troligare att eleven blir mer förvirrad än att han/hon till slut lyckas lösa problemet.

1 □  2 □  3 □  4 □  5 □  6 □

56. I vilken utsträckning har det varit viktigt för dig att din undervisning är samstämmig med alla delar av kursplanen?

1 □  2 □  3 □  4 □  5 □  6 □

57. I vilken utsträckning håller du med om följande påstående:
Om vetenskapsmän får tillräckligt med resurser kan de ta reda på sanningen om det mesta.

1 □  2 □  3 □  4 □  5 □  6 □

58. I vilken utsträckning har du känt att du har tillräckliga matematiska kunskaper för att undervisa på ett sätt som du är nöjd med?

1 □  2 □  3 □  4 □  5 □  6 □

59. I vilken utsträckning tycker du att matematik är ett roligt ämne?

1 □  2 □  3 □  4 □  5 □  6 □

Kommentarer: ____________________________________________

Hälften av frågorna besvarar du genom att kryssa i den ruta (1-6) som bäst motsvarar hur säker du känner dig på att kunna hjälpa dina elever på det område som citatet handlar om (1 = väldigt osäker och 6 = väldigt säker). Resterande frågor är ja/nej-frågor som du besvarar genom att kryssa i antingen ja- eller nej-rutan.

"Eleven utvecklar sina kunskaper om hur matematiken används inom informationsteknik, samt hur informationsteknik kan användas vid problemlösning för att åskådliggöra matematiska samband och för att undersöka matematiska modeller."

(Ämnesbeskrivningen, mål att sträva mot)

60. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla sin förmåga att åskådliggöra matematiska samband (med eller utan hjälp av informationsteknik)?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □

61. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla sin förmåga att åskådliggöra matematiska samband (med eller utan hjälp av informationsteknik)?

Ja □ Nej □

"Eleven utvecklar sin förmåga att följa och föra matematiska resonemang samt redovisa sina tankegångar muntligt och skriftligt."

(Ämnesbeskrivningen, mål att sträva mot)

62. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla förmågan att följa och föra matematiska resonemang?

1 □ 2 □ 3 □ 4 □ 5 □ 6 □
63. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla förmågan att följa och föra matematiska resonemang?

Ja □  Nej □

"Utbildningen skall leda till förmåga att kommunicera med matematikens språk och symboler, som är likartade över hela världen.”
(Ämnesbeskrivningen, ämnets syfte.)

64. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla förmågan att kommunicera med matematikens språk och symboler?

□  □  □  □  □  □

65. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla förmågan att kommunicera med matematikens språk och symboler?

Ja □  Nej □

"Eleven använder lämpliga matematiska begrepp, metoder, modeller och tillvägagångssätt för att formulera och lösa olika typer av problem.”
(Kursplanen, kriterier för betyget godkänt, Matematik A)

66. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla sin förmåga att lösa problem som inte är av rutinkarakter?

□  □  □  □  □  □

67. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla sin förmåga att lösa problem som inte är av rutinkarakter?

Ja □  Nej □
68. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla sin förmåga att använda lämpliga matematiska metoder?

1 2 3 4 5 6

69. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla sin förmåga att använda lämpliga matematiska metoder?

Ja Nej

"Skolan skall i sin undervisning i matematik sträva efter att eleverna utvecklar sin förmåga att tolka, förklara och använda matematikens språk, symboler, metoder, begrepp och uttrycksformer."

(Ämnesbeskrivningen, mål att sträva mot)

70. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla förmågan att representera olika företeelser med hjälp av matematiska uttrycksformer?

1 2 3 4 5 6

71. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla förmågan att representera olika företeelser med hjälp av matematiska uttrycksformer?

Ja Nej

Kommentarer: _______________________________

"kunna ställa upp...linjära ekvationer och enkla potensekvationer samt lösa dem..."

(Kursplanen, Mål som eleverna skall ha uppnått efter avslutad kurs, Matematik A)

72. Hur säker känner du dig på att kunna hjälpa dina elever att uppnå detta mål?

1 2 3 4 5 6
Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att uppnå detta mål?

Ja □ Nej □

Kommentarer: _______________________________


Hälften av frågorna besvarar du genom att kryssa i den ruta (1-6) som bäst motsvarar hur säker du känner dig på att kunna hjälpa dina elever att lära sig den kompetens som krävs för att lösa uppgiften (1 = väldigt osäker och 6 = väldigt säker). Resterande frågor är ja/nej-frågor som du besvarar genom att kryssa i antingen ja- eller nej-rutan.

UPPGIFT A

När en frysbox stängs av stiger temperaturen. Följande formel kan användas för att beräkna temperaturen (y) i grader Celsius då en frysbox har varit avstängd i x timmar.

\[ y = 0,2x - 18 \]

a) Vilken är frysboxens temperatur då den varit avstängd två timmar?  

b) Hur länge har frysboxen varit avstängd då temperaturen är 0 °C?  

c) Förklara med egna ord vad formeln innebär. (0/2)
74. Hur säker känner du dig på att kunna hjälpa dina elever att lära sig att kommunicera matematik, till exempel på det sätt som krävs för att lösa Uppgift A (deluppgift c)?

1 □  2 □  3 □  4 □  5 □  6 □

75. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att lära sig kommunicera matematik, till exempel på det sätt som krävs för att lösa Uppgift A (deluppgift c)?

Ja □  Nej □

Uppgift B


76. Hur säker känner du dig på att kunna hjälpa dina elever att utveckla sin problemlösningss förmåga, till exempel sådan som krävs för att lösa Uppgift B?

1 □  2 □  3 □  4 □  5 □  6 □

77. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att utveckla sin problemlösningss förmåga, till exempel sådan som krävs för att lösa Uppgift B?

Ja □  Nej □

78. Hur säker känner du dig på att kunna hjälpa dina elever att lära sig använda procedurer, till exempel på det sätt som krävs för att lösa Uppgift C?

1 □  2 □  3 □  4 □  5 □  6 □
79. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att lära sig använda procedurer, till exempel på det sätt som krävs för att lösa Uppgift C?

Ja ☐ Nej ☐

---

**Uppgift C**

Martin och Johanna ska köpa en ny bil. Johanna fastnar för en bil som kostar 194 000 kr. Martin påstår att värdet på denna sorts bil sjunker med ungefär 17% per år. De funderar på hur mycket den bilen skulle vara värd om 3 år och var och en beräknar på sitt sätt.

**Martins beräkning**

\[
\begin{align*}
\text{17%} \times 1.00 & = 1.17 \\
\text{100} - 1.17 & = 0.83 \\
\text{0.83} \times 194000 & = 159520 \text{ kr}
\end{align*}
\]

**Johannas beräkning**

\[
\begin{align*}
1 - 0.17 & = 0.83 \\
0.83^3 \times 194000 & = 110927 \text{ kr}
\end{align*}
\]

Vem har tolkat problemet rätt? Hur kan Martin och Johanna ha resonerat?

---

80. Hur säker känner du dig på att kunna hjälpa dina elever att lära sig argumentera för sina slutsatser, till exempel på det sätt som krävs för att lösa Uppgift C?

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐
81. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att lära sig argumentera för sina slutsatser, till exempel på det sätt som krävs för att lösa Uppgift C?

Ja ☐ Nej ☐

---

**Uppgift D**

I badhuset finns fyra bassänger A, B, C och D. Dessa fylls med vatten som rinner med samma hastighet.

Diagrammet nedan visar hur vattendjupet ändras med tiden för påfyllningen i bassängerna A, B och C.

![](diagram)

a) Markera bassäng A och B i diagrammet. *Endast svar krävs.*

b) Beskriv med ord hur den bassäng ser ut som motsvaras av graf C.

c) Bassäng D fylls med vatten på samma sätt. Beskriv med ord och graf hur vattendjupet ändras.
82. Hur säker känner du dig på att kunna hjälpa dina elever att lära sig tolka representationer, till exempel på de sätt som krävs för att lösa Uppgift D?

1 2 3 4 5 6

83. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att lära sig tolka representationer, till exempel på det sätt som krävs för att lösa Uppgift D?

Ja  Nej

84. Hur säker känner du dig på att kunna hjälpa dina elever att lära sig koppla samman olika företeelser, till exempel på de sätt som krävs för att lösa Uppgift D?

1 2 3 4 5 6

85. Känner du till någon annan lärare som på ett framgångsrikt sätt hjälper sina elever att lära sig koppla samman olika företeelser, till exempel på det sätt som krävs för att lösa Uppgift D?

Ja  Nej

Kommentarer: _______________________________

Enkäten är slut. Tack för din medverkan.