

## **Investigating the construction of the problem-solving citizen**

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Similar to other curricula, the Swedish mathematics curriculum emphasises problem solving both as an end in itself and as a means to becoming a competent citizen. Thus, a goal for mathematics is the creation of a problem-solving citizen. In this paper, I explore how critical discourse analysis, and parts of social activity theory can be used to operationalise Bernstein's pedagogic device in relation to the construction of the problem-solving citizen. It is proposed that critical discourse analysis can be used for a linguistic analysis of official documents, like the curriculum whilst social activity theory's different domains, mainly public and esoteric, can be used to analyse the national tests. These tests assess students' problem solving both as a means and an end in two different senior secondary programmes, an academic orientated one and a vocational one. In this exploration, two examples are given to show how these methodological tools can be used.

**Keywords: Pedagogic device, critical discourse analysis, social activity theory, curriculum, problem solving**

### **Background**

This paper is part of a larger project about how the goal of problem solving is recontextualised in the Swedish mathematics curriculum and in national tests for two upper secondary school programmes, vocational and academic orientated. These programmes have similar curricula and the same grading criteria but different national tests.

Sweden can be seen as following an international educational trend in the way competences are emphasised in the curriculum (Dahl and Johansson, 2013). For example, problem solving is strongly emphasised both as a means to develop other mathematical competences but also as a competence in its own right that should be assessed and graded (Skolverket, 2011c). It is also stated that students should become employable citizens and participate in democratic processes through sharing a common "civic reference framework" (Skolverket, 2011d: 13). Thus, the goal of mathematics problem solving in schools can be considered to be the creation of the *problem-solving citizen*. Although it is unclear how mathematics education contributes to the creation of this citizen, mathematics is highlighted as important in this process (Skolverket, 2011d). Giving this as a reason for including mathematics in school, therefore, seems to have become common sense without any need to question it. Consequently, my research question for the larger project is: How is the problem-solving citizen constructed and recontextualised in the curriculum and other official documents?

In this paper, I explore the research methodologies of critical discourse analysis (Fairclough, 2001) and social activity theory (Dowling, 2005) as means for questioning this common sense assumption. Both theories share similarities on an ontological and epistemological level which enables them to be related to Bernstein's

pedagogical device, explained in the next section and which provides the theoretical framework for the main study. In this paper, two examples are provided as part of the exploration. The first example uses critical discourse analysis on the Swedish mathematics curriculum. The second example is an analysis of the national test.

### **The pedagogic device**

Bernstein (2000) described the pedagogic device as illustrating how education acted as a filter for ensuring that class distinctions were reproduced. The pedagogic device consists of three sets of interdependent rules: *the distributive rules* regulate the power relationship by distributing different forms of knowledge to social groups; *the recontextualising rules* regulate the formation of pedagogic discourse; *the evaluative rules* constitute pedagogic practices that are realised in instructional and regulative texts (Bernstein, 2000). In relation to the problem-solving citizen, the distributive rules can be considered as controlling how the discussions of politicians, education bureaucrats and educational researchers are relayed to those formulating the curriculum. The recontextualising rules control how the distributed knowledge about problem solving is incorporated into the curriculum and national tests which then control the ways that educators in schools and the wider education sector come to discuss problem solving. The evaluative rules control how teachers teach problem solving in classrooms. In the wider project, it is the operation of the recontextualising rules that are in focus around the construction of the problem-solving citizen.

Bernstein identified a difference between forms of knowledge in the *vertical* and *horizontal discourse*, both of which are regulated by the distributive rules (Bernstein, 2000). The horizontal discourse includes mundane (common sense) knowledge. Abstract, conceptual (esoteric) knowledge is a form of vertical discourse and “the process of acquiring vertical discourse is through induction into that strongly classified and insulated body of knowledge” (Wheelahan, 2007: 3).

Mundane, common sense mathematics tasks that emerge from the horizontal discourse, into the institutional and regulative texts of the evaluative rules, can be used to ‘hook’ students and introduce or inspire them into mathematics (Whitty, Rowe and Aggleton, 1994). Bernstein (2000) stated “to make specialised knowledge more accessible to the young, segments of the *horizontal discourse* are recontextualised and inserted in the contents of school subjects” (Bernstein, 2000: 169). Including examples of these mundane tasks in the curriculum or national tests contributes to them being passed on through evaluative rules into teachers’ classroom practices.

However, putting mathematics in a real-world (mundane) context is, according to Bernstein to treat mathematics, which is a vertical discourse, as if it were a horizontal discourse. This is more common in vocational programmes, generally designed for low achieving students from the working class (Dowling, 2005). Therefore recontextualisation is used to “exclude[s] the working class and other disadvantaged social groups from access to powerful knowledge, because it denies students access to the structuring principles of disciplinary knowledge” (Wheelahan, 2007: 1) as it is only “esoteric knowledge [that] has the potential to challenge the social distribution of power” (ibid. p. 3). An analysis of the national tests can provide information on whether problems are from the vertical or horizontal discourse and how knowledge, and therefore power comes to be unequally distributed to students in the different courses.

Nevertheless, the pedagogic device is not about *what* is transformed, the content, but *how* the general rules control the transformation of knowledge into pedagogic communication. In order to understand how the problem-solving citizen is constructed and its effect on mathematics education in upper secondary education, there is a need for tools to analyse these transformations. *Critical discourse analysis* (Fairclough, 2001) and *social activity theory* (Dowling, 2005) are investigated as research methodologies for identifying how the problem solving citizen discourse has become a regulative discourse in distributing different forms of mathematics, mundane and esoteric, to groups of students from different social classes.

### **Critical Discourse Analysis**

Critical discourse analysis (CDA) highlights what is not obvious, by questioning and problematising the taken-for-granted, or dominant ideology (Winther Jørgensen and Phillips, 2000), such as the belief that students should become problem-solving citizens and that school mathematics is the path to achieve this goal. It contains three dimensions: a socio-cultural practice; a discursive practice; and text (Winther Jørgensen and Phillips, 2000). The analysis on the level of the socio-cultural practice is about the relations to other discourses and non-discursive practices. The analysis on the level of the discursive practice is about how texts are produced, distributed and consumed. This division opens up the possibility to analyse the dialectic interplay between social and discursive practices:

Unlike other forms of discourse analysis, [critical discourse analysis] also involves theorising the social processes and, in particular, the power structures, which give rise to, and are maintained by, discourse. (Oughton, 2007: 261)

At the macro level of the socio-cultural practice, the global economy, the national infrastructure or the ‘neo-liberal political trend’ provide an overarching structure in which there are schools and in schools there is a subject called mathematics. Within the discourse of school mathematics, a curriculum and national tests are produced. To construct the problem-solving citizen, these texts draw on different discourses, for instance the horizontal and vertical discourses of Bernstein.

The curriculum is produced on the level of discourse practice, the micro level, which is part of a socio-cultural practice. Thus these texts are produced within the recontextualising field, in which Bernstein (2000) distinguishes “between an *official recontextualising field* (ORF) created and dominated by the state and its selected agents and ministries, and a *pedagogic recontextualising field* (PRF). The latter consists of pedagogues in schools and colleges, and departments of education, specialised journals, private research foundations” (p. 33, italics in original). Between and within these fields there is a struggle over the pedagogic discourse, in regard to what should be included and emphasised. CDA is a way to analyse the connection and interplay between the micro and macro level and hence the tensions or struggle within the recontextualising field. It requires a linguistic analysis of the text and a sociological analysis of the macro level. The analysis on the micro level is then the connection between the text and the socio-cultural practice (Winther Jørgensen and Phillips, 2000).

Chouliaraki and Fairclough (1999) emphasise that Bernstein is a critical theorist “concerned to trace the embeddedness of social practice within [and between] social relations of power” (p. 98) and therefore conclude that Bernstein’s theory and CDA share the same ontological and epistemological basis. Following Bernstein, Chouliaraki and Fairclough (1999) understand the pedagogic discourse to be “a

recontextualising principle which removes discourses from the practices they primarily belong in and relocates them within its own practice” (p. 109). To understand *what* is relocated, they consider that something more is needed and proposed the CDA element of intertextuality, particularly interdiscursivity.

Intertextuality provides an understanding about how texts, which are in focus, have connections to and are dependent on other texts (Chouliaraki and Fairclough, 1999). Skolverket (The Swedish National Agency for Education) (2011b) as the writer of the curriculum, draws on national and international studies, to emphasise that problem solving should be viewed both as a means for learning other topics or subjects and as an end that should be assessed and graded. The distribution of the discourses about the double role of problem solving through the curriculum produces a ‘blurriness’ within which there are tensions about how to interpret what mathematics is and its relationship to citizenship. An intertextual analysis could highlight the differences and similarities between texts in order to place the curriculum in a context and indicate how the problem-solving citizen is constructed.

One form of intertextuality is interdiscursivity “concerned with the way in which a text appears to subscribe to one or more discourses” (Locke, 2004: 43). An interdiscursive analysis is useful in seeing whether vertical or horizontal discourses are drawn upon in representations of problem solving in the curriculum and in tasks in the national tests.

### ***An example***

As the example is used to explore the relevance of CDA, it was decided to do an initial intertextual analysis of the similarities and differences between the academic and vocational programmes. According to Dowling (2005), differences between these programmes result in different discourses (vertical/horizontal or esoteric/ mundane) being utilised. Thus, it should be possible to use an intertextual analysis see if and how vocational students come to be excluded from the esoteric domain and hence from power associated with being a problem-solving citizen.

### ***An intertextual analysis***

To exemplify how intertextual analysis can be used, the Swedish curriculum (Skolverket, 2011d) (from now on called Gy11), launched in 2011, is analysed with the old curriculum from 1994 (Skolverket, 2006) (from now on called Lpf 94). The curricula documents analysed are for Gy11: *Curriculum for upper secondary school* (Skolverket, 2011a), which has the fundamental values and overall goals and guidelines; and *Upper Secondary School 2011* (Skolverket, 2011d), which describes the purpose and structure of the upper secondary school. For Lpf 94 the comparable document is: *Curriculum for the non-compulsory school system Lpf 94* (Skolverket, 2006), about purpose and structure of the upper secondary school.

The two documents, *Curriculum for upper secondary school* (Skolverket, 2011a) and *Curriculum for the non-compulsory school system Lpf 94* (Skolverket, 2006) are similar in content and in the way ideas are stated and expressed. Consequently, I analyse *Upper secondary school 2011* as a complement to *Curriculum for upper secondary school*. This approach stresses the differences with the older curriculum and highlights the structure and purpose of upper secondary school that was not provided in Lpf 94.

There is also a point in comparing the two documents textually. For Lpf 94 there was no official document, similar to *Upper secondary school 2011*, so teachers

had to rely on *Curriculum for the non-compulsory school system Lpf 94*. As Gy11 was supposed to overcome problems in Lpf 94 (Skolverket, 2011d), the construction of the problem-solving citizen in Gy11 could be considered a response to Lpf 94.

*Upper secondary school 2011* is 258 pages but only discuss the same topics as *Curriculum for the non-compulsory school system Lpf 94* in the first 60. *Curriculum for the non-compulsory school system Lpf 94* is 22 pages.

‘Vocational’ is mentioned 15 times in Lpf 94 and 162 times in Gy11. In Lpf 94, ‘vocational’ is either about the difference between vocational and academic programmes (five times) or about the need for students to be prepared for a (changing) vocational life (10 times). Out of the 162 times ‘vocational’ is mentioned in Gy11, only one could be categorised as being about preparation for vocational life. An alternative to ‘vocational’, the term ‘working life’ in Lpf 94 is mentioned 25 times and in Gy11 14 times. This indicates that there are differences in the two documents.

### *Differences in meaning*

Although tallying the number of times a term appears hints at differences, it is more crucial to identify how ‘vocational’ is expressed. In Lpf 94, the use of ‘vocational’ suggests similarities rather than differences between the programmes. For example:

The school shall strive for good co-operation with working life, which is important for all upper secondary education, but of particular importance for the quality of vocationally-oriented education (Skolverket, 2006: 7)

However, this changes in Gy11, with the differences between programmes being highlighted. Pages 20-21 list the differences between the programmes. The next four pages (22-25) describe the vocational programmes and another one and a half pages describe ‘Higher education preparatory programmes’, suggesting that they should be considered in contrast, rather than as complements, to each other.

How vocational programmes are discussed in Gy11 changed markedly to how they were discussed in Lpf 94. In Gy11, pages 9 to 13 give ‘A brief look backwards’ to earlier curricula and reforms and describe how vocational programmes first became a part of the upper secondary school. It states that with Lpf 94, the programme was extended to three years and stressed ‘civic competence’ and “all students in vocational programmes could automatically achieve basic eligibility for higher education” (Skolverket, 2011d: 11). The following section is ‘The problems of the school at the beginning of 2000’ and this suggests that the emphasis on civic competence and the right of all students to have the opportunity to continue to higher education could be seen as causing the problems of school:

Since the beginning of the current century, international studies Sweden has participated in have shown that the knowledge students leave school with is not as good as before. Many students drop out of their upper secondary studies. And Sweden has a high level of youth unemployment compared to other countries. These trends led to the reform of the upper secondary school and the compulsory school in 2011. (p. 11)

The proposed solution was to create larger differences between vocational and academic programmes so that “Vocational education should provide good preparation for working life so that students can start working immediately after upper secondary school” (p. 12). Thus, vocational and academic programmes in Gy11 are described as being more different than they were in Lpf 94.

Further, the context for Gy11 is described as:

The upper secondary school has a broader aim than merely preparing students for working life immediately after education or for further studies in higher

education. It should also give them a good foundation for personal development and active participation in society. (Skolverket, 2011d: 8)

This statement seems to indicate that this was not the fact in earlier curricula and seen in the light of the above analysis the ‘or’ in the quote must be interpreted as an exclusive or, suggesting the school either prepare students for working life or for further studies, but not both. Thus, there seems to be a wish that different discourses should to be drawn upon for the different programmes. Following Dowling (2005) this could result in different opportunities for ‘personal development and active participation in society’ for students.

Mathematics is highlighted as having an important role in the making of the future citizen (Skolverket, 2011d) whether or not this is a reality. To see what different discourses are drawn upon in the construction of the problem-solving citizen on the level of evaluation, an analysis of the national tests is conducted. In the next section, I add to the CDA analysis of the curriculum, by exploring Dowling’s social activity theory (SAT) as a means for analysing the national tests. Seen as a part of CDA, this analysis could be described as content analysis (Bergström and Boréus, 2005).

### **Social Activity Theory**

Dowling (2005) draws on Bernstein to build a language of description, which he calls social activity theory (SAT), to analyse mathematics tasks from textbooks. The analysis concentrates on differences between tasks in the esoteric domain equivalent to Bernstein’s vertical discourse, and tasks in the public domain, Bernstein’s horizontal discourse.

Dowling (2005) showed how access to the esoteric domain, through textbooks was unequally distributed to low and high achieving students. Low achieving students were very rarely provided with tasks from the esoteric domain. Instead they worked with mathematical tasks, for example, about shopping, often expressed in non-mathematical language. Tasks for high achieving students could start in the public domain, but quickly moved into the esoteric domain.

However, given the differences identified between the vocational and academic programmes, it is useful to see if these differences extend to the tasks for the different programmes being constructed differently as well.

### ***An example***

With the new curricula for the first time since 1994, there were different national tests (PRIM, 2012) for vocational and academic programmes. The problem-solving tasks reinforce differences between programmes identified in the curricula documents. For the vocational programme 7% of the problem-solving tasks were in the esoteric domain, while on the test for the academic programme 33% were in the esoteric domain. This is in spite of the fact that the two programmes have the same grading criteria (Skolverket, 2011c). Figure 1 and Figure 2 are tasks from the national test (spring 2012, course 1b). Figure 1 shows a task about the smallest positive integer and so can be considered as being situated in the esoteric domain. The content is mathematical and the language draws on the mathematics register. Figure 2, a task about a loan, is a typical public domain task. Both the content and the expression are weakly classified, as they refer to the outside world, a mundane context. Although numbers are used, the language is conversational.

What is the smallest positive integer that is divisible by all integers from 1 to 9? Explain your answer.

Figure 1 (from PRIM, 2012, p. 6)

An advertising flyer shows the following information.

Amount	Interest rate	Repayment (10 yr)	Repayment (12 yr)
300 000 kr	4.45 %	3 061 kr/month	2 644 kr/month
100 000 kr	6.85 %	1 121 kr/month	982 kr/month

BEST REGARDS LÅNEBANKEN

The repayments include amortization, interest etc.  
Renée is considering borrowing 100 000 kr and repaying over 10 years.

- Use the information in the flyer to calculate the total amount she will have paid back to the bank when the loan is paid off.
- What proportion of the first month's payment is interest?

Figure 2 (PRIM, 2012, p. 5)

This initial and brief analysis suggests that, in Gy11, differences between vocational and academic programmes are being promoted in regard to preparing for working life. Thus, there seems to be different possibilities for students to reach the main goal of school: to “give them a good foundation for personal development and active participation in society” (Skolverket, 2011d: 8). The analysis of task distribution in the national test supports the findings about different outcomes being promoted for different groups of students, by suggesting that access to the esoteric domain, and hence to active participation is unequally distributed.

## Conclusion

Bernstein (2000) suggested that school reproduces social inequalities. In this paper I have showed how CDA and SAT can be used as tools to see how this is done in the official documents for mathematics education in upper secondary school in Sweden.

This exploration of CDA and SAT suggest that both methodologies can illustrate how the rules governing the pedagogic device operate. CDA is used to analyse the curriculum to see what happens as a result of recontextualising rules. In this initial analysis, the tension between different discourses, vertical and horizontal is illuminated by a textual analysis. This is mainly done by looking for differences in vocational and academic programmes, and especially how the distinctiveness of vocational programmes is emphasised. Thus, CDA has helped to highlight what is not obvious, and to question and problematise the taken-for-granted (Winther Jørgensen and Phillips, 2000). Dowling's domains suggest that the distinctions found in the curricula are also present in the national tests.

To see how the problem-solving citizen is constructed, as a goal of mathematics education, an examination of other parts of the curriculum is needed. A larger intertextual analysis, for instance comparing the curriculum with the PISA framework will need to be a part of this since Gy11 draws heavily on PISA (Dahl and Johansson, 2013). In this paper I have used problem-solving tasks from one test, the first national test (course 1). A further analysis of the national tests needs to be done.

In this paper I have analysed the curriculum and national tests in a Swedish context. The Swedish curriculum, especially with its emphasis on competences and the highlighting of problem solving should be seen here as a typical example of a

'modern' mathematics curriculum. These features are characteristic in many mathematics curricula, standards and frameworks, for instance the influential international PISA-tests, emphasises competences instead of content-knowledge (OECD, 2009). The rationales behind this trend are also similar, emphasising the need for citizens to be available for the labour market throughout life (Nordin, 2012).

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