GOOD MATHEMATICS TEACHING AND CLASSROOM NORMS

– VIEWS OF SECONDARY SCHOOL STUDENTS –

Kristín Bjarnadóttir

Senior lecturer, University of Iceland – School of Education

This article describes a research on students' views of what constitutes good mathematics teaching. A questionnaire with open ended questions was given to 106 students in six different mathematics classes, with five different teachers, in four different upper secondary schools in Iceland. The questions were designed to get at students concerns and opinions of what constitutes good mathematics teaching and where the strengths of their particular teacher lie.

The students of all the teachers considered 'clear explanations of the content' as the teachers' main advantages as well as thorough mathematical knowledge and incisive teaching, while they also appreciated highly personal qualities such as patience, cheerfulness, and care for their students' progress. Remarks on the characteristics of good teaching witnessed different societal norms in the groups as well as different beliefs about students' own roles, the roles of others, teachers included, and the general nature of mathematical activity in school.

INTRODUCTION

The goal of this study is to contribute to an increased knowledge of the Icelandic upper secondary school, which has been subject to radical development during the last 40 years. The first part of that period was characterized by great expansion, while the second part has been characterized by coordination of curricula, adjustment to a different clientele and subsequent decentralization.

This article describes a study of students' view of what constitutes good mathematics teaching. Some teachers have the reputation that they are 'good', while others are, as most people, favoured by some, with others ignoring them or even blaming them for their own low achievement.

It is not easy to define good mathematics teaching, as the working habits of each teacher depend on the social norms and traditions dominant in the country, the specific school and in the interplay between the teacher and the individuals in each group. The assumed qualities of the teaching appear to be flavoured by how the teacher succeeds in forming traditions and social norms in interaction with the group.

THE ICELANDIC UPPER SECONDARY SCHOOL

The Icelandic upper secondary school has transformed during the last 40 years from being an elite school to become a school for all. Historically, the school rests on a Danish Latin School tradition and it was adjusted to Danish curriculum guides, at least in mathematics, until the 1940s or even the 1960s (Bjarnadóttir, 2010, pp. 100–102, 133–139, 163–168). Due to domestic circumstances the academic year in Iceland was only eight months. To account for the same syllabus as the Danes in addition to one more foreign language, Danish, the Icelandic students graduated one year later than Danish students, at the age of 20. In spite of gradually

shorter summer breaks, presently three months, graduation with a matriculation examination is still at the age of 20. Certainly, a few students graduate earlier, while a considerable number of them a year or two later.

Until 1953, the number of non-vocational upper secondary schools in Iceland was only three, all classical grammar schools. Their purpose was generally considered to produce competent candidates for professional university studies (Bjarnadóttir, 2010, pp. 132, 193, 318–330). During 1966–1985 a number of new schools were established, many of them comprehensive schools, including a variety of vocational and technical education in addition to the traditional grammar school syllabus. Each operated based on their separate legislative act until 1988 (Law no. 107/1988; no. 72, 1989).

In 1989 and 1999 national curriculum guides were published (Ministry of education, 1989; 1999), comparable to a leaving certificate syllabus, while no standardized examinations were established. The leaving certificate mathematics syllabus for the natural science stream is historically chosen as to be a suitable preparation for engineering studies. It contains enumerative combinatorics; introduction to vector geometry; trigonometry, polynomial, trigonometric, exponential and logarithmic functions; sequences and series; and introduction to calculus. Schools may offer elective courses in more advanced courses of those and other topics, such as number theory. Following new legislative act no. 92/2008, a new curriculum guide was published (Ministry of education, 2011), which will provide the schools with considerably more freedom to organize their courses and study streams than previous guides.

Only few researches have been made on teaching in Icelandic upper secondary schools. A. Macdonald, E. Lárusson and M. Thórólfsson (2007) researched the views of five lower secondary school teachers on learning and teaching sciences. It concerns a different school level, a different school subject, and the views of teachers, not students. Studies on mathematics teaching are missing. It is therefore of interest to learn about students' views on good mathematics teaching in Icelandic upper secondary schools. If the new legislative act of 2008 and the national curriculum guide of 2011 are to lead to reforms, researching its function and degree of success would be valuable.

THEORETICAL BACKGROUND

It is a task of general didactics, and mathematics didactics in particular, to research the environment that creates favourable conditions for mathematics learning, both for individuals and in study groups, such as a classroom. Cobb and Yackel (1996) suggest that conditions for learning depend both on individual psychological factors and social norms. The theories of Cobb and Yackel will be further explored below.

The question of good mathematics teaching has been widely considered, not the least in connection with the international comparative studies, TIMSS and PISA. Many articles thereof in international journals discuss comparison of teaching to South-East and East Asia, where performances in the comparative studies have been higher than in Europe and North-America. Groves (2009) has provided an overview of research papers of that kind. Groves' conclusion is that what is considered as good mathematics teaching is deeply rooted in cultural values and beliefs. Furthermore, many factors influence teaching habits and

possibilities to alter them, such as teachers' social status, in addition to stability in curricular matters and pedagogy.

Y. Shimizu (2009) has studied what characterizes exemplary mathematics instruction in Japanese classrooms from the learner's perspective. Shimizu analyzed learners' views on what constitutes a 'good' mathematics lesson in post-lesson video-stimulated interviews with 60 students in three 'well taught' eight-grade mathematics classrooms. The most frequent response (45%) referred to students' understanding and thinking in the classroom. Other frequent responses referred to whole class discussion (26.7%), students presenting their ideas in the classroom (16.7%), other students' presentations and explanations (6.7%) and to teacher's explanation (16.7%).

COBB AND YACKEL'S FRAMEWORK

Cobb and Yackel (1996) have outlined an interpretive framework, where psychological factors, such as students' beliefs about their own roles and the role of others in the classroom, are coordinated with general social norms in the group. They analyzed classroom processes by using a framework of three layers in which psychological constructivist analyses of individual activity are coordinated with interactionist analyses of classroom interactions and discourse. The coordination of interactionism and psychological constructivism is the primary defining characteristic of the version of social constructivism that Cobb and Yackel refer to as the *emergent approach* or the *emergent perspective*. The framework is illustrated in Table 1.

SOCIAL PERSPECTIVE	PSYCHOLOGICAL PERSPECTIVE
1. Classroom social norms	2. Beliefs about own role, others' roles, and the general nature of a mathematical activity in school
3. Sociomathematical norms	4. Mathematical beliefs and values
5. Classroom mathematical practices	6. Mathematical conceptions and activity

Table 1. An interpretive framework for analyzing individual and collective mathematical activity at the classroom level (Cobb & Yackel, 1996, p. 177).

Each layer in Table 1 embodies a conjectured relation between an aspect of the classroom microculture and the activity of the individuals who participate and contribute to it. The three layers concern the norms and beliefs which matter in a group learning mathematics; the norms, beliefs and values in direct connection with mathematics as a school subject; and the specific manners to do mathematics and the conceptions and beliefs which the student develops.

For example, Cobb and Yackel take individual students' beliefs about their own role, others' role and the general nature of mathematics to be the psychological correlates of general classroom social norms. The conjectured relation between classroom social norms and individual beliefs then implies that a teacher, who initiates and guides the recognition of classroom social norms, is simultaneously supporting individual students' reorganization of the corresponding beliefs. Cobb and Yackel consider that this explanatory power makes the framework particularly relevant to engaging in classroom-based research.

An example of the uppermost layer could be the ways of communication between the students and between themselves and the teacher (Skott, Jess & Hansen, 2007). For example a norm could be that the students work independently and ask the teacher to assist them when they need help, that they work together on a task in groups or that they observe what happens at the blackboard and are prepared to be questioned there.

Similarly, students' beliefs and values concerning mathematics and mathematical activity are mutually related to socio-mathematical norms which shape the mathematics teaching to the group. The socio-mathematical norms could for example be what may be counted as a sufficient explanation and what may be considered as a complete solution to a mathematical task. Such norms emerge to students and their teachers in their interactive communication.

The third layer concerns the subject content in a more narrow sense, while also there, students' beliefs on mathematics concepts are related to mathematical norms which have been shaped in the group on what are accepted truths in the topic concerned.

THE SEARCH FOR GOOD MATHEMATICS TEACHING

In order to seek answers to the question on the characteristics of good mathematics teaching, a survey was made. Five teachers (A1, B1, C1, D1 and D2) in four upper secondary schools, A, B, C and D respectively, were chosen as a convenience sample. The four schools are different and they have different roles.

- ✓ School A is a classical grammar school with a centuries-long history and it can select its students from a number of applicants.
- ✓ School B is called 'college bridge'; it builds a bridge for those who have not completed at the normal age a matriculation examination into a university college.
- ✓ Schools C and D are modern modular based comprehensive schools offering a variety of courses and streams, a number of them leading to a matriculation examination.

Two teachers, A1 and B1, were chosen for their reputation of being 'good' mathematics teachers, and C1 for a reputation for being a progressive teacher applying information technology. Two teachers, D1 and D2, were added to the research group upon a request from the headmaster of school D. All the teachers were teaching a typical syllabus of a natural science stream; polynomial, trigonometric and logarithmic functions. References to the teachers are written in masculine form, while the teachers were both men and women.

The teachers were visited in 2–5 lessons each. The researcher observed the lessons and a short questionnaire with open-ended questions was given to the students. This article concerns the results of two questions from the questionnaire, making some use of observations of teaching methods by the researcher and using replies to three other questions as background information. The two questions were:

- ✓ Which do you consider your teacher's main strength as a mathematics teacher?
- ✓ Anything you would like to add.

The students were thus not required to list the teacher's perceived negative qualities, while they had an opportunity to express themselves freely to the second question.

In three more questions the students were asked to which stream they belonged and how they had been doing in mathematics until and in the present course. The students in the groups in concern were either attending natural science stream, economy stream or preparing for higher technical education. Students in Schools A, C and D had generally been doing above average in earlier studies in mathematics.

All the five teachers participated willingly in the research as did the students, who had reached the age of 18 so their parents did not have to be contacted for permission. The students were informed that they could skip the questions if they chose to do so. All the students in the five groups replied willingly to the questionnaire, except two foreign exchange students, one by Teacher A1 and one by Teacher C1. A total of 106 students replied to the questionnaire (A1, 23 replies; B1, 34 replies; C1, 12 replies; D1, 17 replies; D2, 20 replies).

School A was visited in autumn term 2008. This classical grammar school has fixed classes where all the students in each class have the same programme in all subjects. All students attending this particular class were taking nature-science stream. They had generally been doing well in mathematics, according to answers to the questionnaire. The students were 'questioned at the board', where they wrote their solutions to exercises, prepared at home. The teacher advised them and commented as needed. The other students were expected to follow and correct their own papers if necessary. They were seldom assisted in their seats during the observation and the rooms were too small for the teacher to approach individuals easily.

School B was visited in spring term 2009. It offers a general preparatory programme for university college studies. The students, who were older than the normal 18–19 year age and some were former drop-outs. They had returned to school to improve and add to their knowledge in mathematics to prepare for higher technical or economics studies. Many felt that they had not been doing well in mathematics earlier, while presently it was going better. Although the students were divided into two groups, they studied the same syllabus with the same teacher. They were therefore recorded as one group. The students were attended to as a group, not as individuals in their seats.

School C, a modern modular-based comprehensive school, mainly accepting students from a particular urban area, was visited in spring term 2010. Most students were attending nature-science or economy stream and their performance in the lower-secondary compulsory school and first years in the present school had been above average. The teacher, C1, made extensive use of information technology with confidence. The teacher conducted the class from an electrical board, turning towards the students and asking them as a group, where some students responded more actively than others. Afterwards, the teacher walked around the room and assisted the students in their seats.

School D, a modern modular-based comprehensive school, accepting students from a certain semi-rural area, was visited in spring term 2010. Also there, most students were attending nature-science or economy stream and their performance in the lower-secondary compulsory school and first years in the present school had been above average. Teachers D1 and D2

taught the same syllabus in parallel. D1's teaching was characterized by a presentation at the board, trying to assist individuals in their seats as time allowed afterwards. Teacher D2 rearranged the syllabus in different order from the textbook and from what D1 did. The syllabus was to be covered swiftly to allow time for recap. The teaching was characterized by very short presentations at the board while most of the time was devoted to walking around the room, allowing plenty of time to each student reached for assistance.

RESULTS

As the questions were open-ended, the students could give as long replies as they pleased. The replies contained varying numbers of items, differently phrased. In reviewing, the same or similar items emerged in many replies in all the schools. After consideration, the researcher chose ten categories and counted how often they occurred in some form or another concerning each teacher. The total results of the most frequent categories of remarks were gathered into Table 2 on the relative frequency of the remarks in percentages.

	Characteristics	**A1**	**B1**	**C1**	**D1**	**D2**
S1	Explains well, communicates well, reaches out to students, knows how to deliver the content.	78	59	25	63	47
S2	Is knowledgeable, interested in the content and mathematics in general.	43	18	42	37	12
S3	Incisive teaching, is well organized, returns homework promptly.	35	15	42	11	0
S4	Patient, reacts positively to queries and requests for assistance.	35	59	8	11	12
S5	Keen on everyone understanding, shows goodwill to all, sympathetic, fair.	22	53	25	37	12
S6	Funny, cheerful, jolly, in a good mood, relaxed.	13	26	25	0	6
S7	Keeps discipline, strict, firm.	30	0	25	0	6
S8	Talks fast, is in a hurry.	0	0	17	11	0
S9	Few, no advantages.	0	0	0	0	24
S10	Disorganized, confusing, complicates matters.	0	0	0	11	12

Table 2. A summary of the most frequent remarks by 106 students on their teacher's strengths, percentages.

Table 2 indicates that the 23 students of teacher A1 valued primarily the teacher's clear explanations, extensive knowledge, incisive teaching, patience and good discipline, but also keenness on everyone understanding. Other remarks on A1's teaching:

> "Possesses deep understanding of the content" (3 remarks), "... tries to widen students' understanding and insight into mathematics in general", "... questions students also at the

board, which encourages one to do the homework" (2 remarks), "... wants everyone to be questioned at the board and solve a problem, but is slightly flexible, if you could not do the problem you are to solve, you can take another that you were able to do", "... I like also how well the teacher is prepared to help us with the problems we were to solve as homework if someone is very confident at the board meanwhile", "... solutions of tests and homework are good, clear", "... runs tests suitably often", "... tries to connect the syllabus to reality and make it practical", "... adds extra knowledge, which I appreciate", "... sometimes the teacher starts talking outside the syllabus which is always rewarding!", "... excellent teacher", "very competent teacher", "quality teacher" "... simply teaches well."

Table 2 reveals that the 34 students of Teacher B1 appreciated most the teacher's clear explanations, patience and goodwill to all. Other remarks on Teacher B1' teaching:

"... one is encouraged to ask if one does not quite understand", "... the main point is that the teacher never assumes students' knowledge so that one never has inferiority feeling for the sake of lack of knowledge in math and dares to pose silly questions and make mistakes", "... talks to you as an equal, speaks in an understandable language, uses good metaphors", "... is a top-quality copy of a beautiful person in every understanding", "... good, excellent, the very best teacher (18 remarks) I have ever had during my whole schooling."

The 12 students of Teacher C1 valued most the teacher's knowledge and incisive teaching, in addition to clear explanations, cheerfulness, fairness and good discipline. Other remarks on Teacher C1's teaching are:

"Treats the material sometimes thoroughly and is most often ready to treat it more closely if one does not understand what the matter is", "... keeps the plan well, could however treat the content better and more thoroughly ...", "Very good and cheerful teacher."

Table 2 indicates that the 17 students of Teacher D1 appreciated their teacher's clear explanations, knowledge and keenness on everyone understanding, while there were some remarks on hurriedness. Other remarks on Teacher D1' teaching are:

"... tries to let you understand what you are doing", "... tries hard to explain so that everyone should understand", "... takes care to assist everyone", "... does not have enough time to assist everyone, is far too stressed", "... spends too much time at the board instead of assisting everyone for a while", "... does not respect an upright arm", "... goes often away without completing to assist you."

Teacher D2 earned some praise from his 20 students for clear explanations, while a considerable group did not give the teacher any credit. Other remarks on Teacher D2's teaching:

"I understand what the teacher is ... explaining", " ... gets to the heart of the matter", "... allows us to do the tasks ourselves", "... explains the material in his own way, not just directly from the book", "... tries to plunge deeper into the material and wants the students to understand the core of the matter and why all this works", "Does not explain well and twists one's questions, does not use good teaching methods. Treats all methods in several

lessons and everything becomes mixed in your head", "… I find the teacher too disorganized, ... does not allow us to compute ourselves, switches topics, etc.", "... I find [Teacher D2] and Teacher D1 the best teachers."

DISCUSSION

Table 2 indicates several general points. Students appreciate clear explanations from their teacher, even if their content cannot be determined from the survey. They are also impressed by their teacher's wisdom, knowledge and understanding of the syllabus and organizing skills. Besides that, they appreciate the teacher be patient, cheerful, sympathetic and fair; react positively to questions and requests about assistance, show goodwill and being keen on everyone understanding. Keeping good discipline or even being strict is also counted as an advantage.

The research by Shimizu (2009) concerns students' experience of one particular lesson, while the current research concerns students' overall experience of the teacher and his qualities. The two surveys are therefore not fully comparable. They have, however, several traits in common. Japanese students appreciate being able to present their ideas in classroom (16.7%), which is also mentioned in Iceland but only in School A. Students' understanding has the highest score (45.0%) in the Japanese classroom. For the Icelandic teacher, the highest score is on clear explanations, also frequently mentioned in Japan (16.7%), and could be interpreted as leading to students' perceived better understanding. Furthermore, Icelandic students value highly that their teacher is keen on everyone understanding. One may therefore conclude that students' main expectations from a mathematics teacher and a mathematics classroom is their own 'understanding' by their teacher's 'clear explanations', a result that concerns the universal purpose of students attending schools. But how?

Surveying comments on individual teachers reveals different expectations and indications on different social norms in the classrooms. This may be discussed with reference to the Cobb's and Yackel's 1996 framework. We shall exclusively discuss social norms and students' beliefs presented in the uppermost layer in the framework, as the questionnaire did not offer opportunities to regard the two lower layers.

In School A students frequently mention their teacher returning homework and tests promptly and the good support from being questioned at the board. This encourages students to do their homework. They appreciate if the teacher is somewhat flexible and that a student, who could not solve the problem assigned, could take another that the student was able to solve. This may be considered as a social norm in the uppermost layer in Cobb and Yackel's framework, which furthermore is related to students' beliefs on the roles of themselves and others in the classroom and general mathematical activity on schools, here to prepare for the lessons and be called up to the board. Teacher A1 is credited for being prepared to assist students with their homework, while someone is working confidently at the board. The norm is that the student at the board has priority, while the teacher assists other students as possible.

The remarks from School B indicate that the role of the teacher is to explain and the role of the students to ask questions when they need. The students are encouraged to ask if they do not understand, and a norm has been established that they dare to ask silly questions and make

mistakes, presumably related to Teacher B1's good mood and goodwill towards the students which the teacher is highly credited for.

Teacher C1 is mainly credited with firm mathematical knowledge and organization, and secondly for being cheerful, fair and explaining well. The remarks do not cover teaching methods, while in visits to the classroom the researcher noticed the teacher's extensive use of information technology, which made it easier to face the students. The students did not mention this; they seemed to regard it as a norm of the classroom. Complaints concerned the teacher's hurriedness when covering the syllabus and explaining, but not lacking assistance in seats. Teacher C1 was observed helping students in their seats after presenting at the board. The norm seemed to be that the presentation had priority, while assistance in seats was secondary and that students were comfortable with that order.

The majority of Teacher D1's students mentioned clear explanations but there was some mention of hurriedness. Teacher D1 did not seem to reach all those who requested assistance in their seats, if a notice is taken of a remark that the teacher spends too much time at the board instead of helping individuals in their seats; that the teacher does not react to an upright arm and often leaves without completing to help the student. These remarks suggests that the students' beliefs about social norms in the classroom and their own and the teacher's roles, which have developed in the classroom, are that the students arrange themselves in a queue by their upright arms and that the teacher is to take care of individuals rather than explain at the board, while the teacher is possibly trying to avoid that role. A total of 17 students sat in Teacher D1's classroom. Even if the number is not large, one may assume that it is too much for the teacher to assist each student in one lesson. If such a norm has been developed, it may create a tension between the teacher and the students, and contribute to perceived hurriedness.

Similar norms were reflected in students' remarks about Teacher D2, while they did not mention hurriedness. The teacher allowed a plenty of time to explain when asked about particular problems. The remarks were mixed, nearly half the group found the explanations clear, while remarks on disorganization were observed.

In general, social norms and mathematical activity, as defined in the uppermost layer of Cobb and Yackel's framework, were that students receive teacher's explanations. The teacher's role was to explain, while students' role was to ask if they did not understand the teacher or the task they were working on. The students of School A, a classical grammar school, found it normal to deliver their knowledge at the board and receive individual assistance there if necessary. That implies that the teacher chooses who is called up. Students may ask for individual assistance if the teacher does not have to assist the student at the board. In School B, the bridge to college for mature students, a norm seemed to be established that students were able to take the initiative to pose even silly questions. In School D, a comprehensive school with a modular programme, students considered the role of the teacher to assist students individually in their seats. The students may then have to wait until the teacher reaches them and they may then sit passive while waiting.

None of the comments mention as a role of the teacher to provide hints but leave it to the students to elaborate on them. This may though be included in assistance at the board and in

the seats. Neither was there any remark about the type of mathematical activity to work together with other students and consult with other students before asking the teacher.

Students' remarks regarding Teachers A1 and B1, with whom the students were most content, lead to the conclusion that their classroom social norms were different. Both groups appreciated clear explanations highly. Second to that, students of Teacher A1 appreciated the teacher's knowledge and interest in mathematics, while the students of Teacher B1 appreciated most their teacher's patience and care to reach everyone. The student groups were also different, as the students of School A were selected into the school, while students in School B were returning back to school and were generally older than average. Both teachers seem, however, to have succeeded in creating such norms in cooperation with their students that both they themselves and their students are comfortable in their roles, and they are able to avoid tension, for example on covering the content too fast, or not being able to react to queries from individuals.

In relation to Groves' (2009) results that good teaching is deeply rooted in cultural values and beliefs, our research may indicate that this applies not only to different cultural geographical areas, such as South-East Asian and Western countries, but that different cultures may be created in different schools in the same country, not the least if the students' personal stories and the history and traditions of the schools are different.

Thus the values and beliefs of students in Schools A and B on own roles and the roles of their teacher differ considerably, as do their own personal stories and the stories and traditions of their schools. The personal stories of students in School B are different from the stories of others, as the students are returning back to school after a period of employment. They value patience and positive reactions to queries and requests for assistance considerably higher than students in other schools. School A differs from the other schools, being a selective classical grammar school with a centuries-long history and traditions, while Schools B, C and D are offspring of the expansion of the upper secondary level that began in 1966. Students in School A value most clear explanations and their teacher's knowledge. Their beliefs about their own roles are to prepare for the lessons and a social norm in their class is to be called up to the board to deliver the homework, which was not mentioned in remarks from students in other schools.

FINAL WORDS

The survey, described above, indicates that students value teacher's personal qualities and conduct, such as cheerfulness, patience and care for students, while what they appreciate most is that the teachers explain the syllabus in a way such that the students perceive that they understand it. The survey does not reveal fully what is needed to achieve that, but clear presentation, discipline in the classroom, absence of hurriedness and firm knowledge and interest in mathematics contribute to that perception.

The survey also indicates that good mathematics teaching is characterized by classroom social norms where the teacher is comfortable in his role and the students accept and know their own role in creating those norms. Highly positive norms have been created by Teachers A1 and

B1, even if they and their schools are different, and in various respects this applies also to the other teachers participating in the survey.

REFERENCES

Bjarnadóttir, K. (2010). *Mathematical education in Iceland in historical context – Socio-economic demands and influences*. Saarbrücken: Lap Lambert Academic Publishing. Available at http://rudar.ruc.dk/bitstream/1800/2914/1/Chapter0_IMFUFA.pdf.

Cobb, P. og Yackel, E. (1996). Constructivist, emergent, and sociocultural perspectives in the context of developmental research. *Educational Psychologist*, 31, 175 –190.

Groves, J. (2009). Exemplary mathematics lessons: a view from the West. *ZDM The International Journal of Mathematics Education, 41*(3), 385–391.

Law no. 107/1988, no. 72/1989, no. 92/2008. [Legislation on the Icelandic upper secondary school].

Ministry of education (1990). *Námskrá handa framhaldsskólum*: *námsbrautir og áfangalýsingar*. Reykjavík.

Ministry of education (1999). *Aðalnámskrá framhaldsskóla – Stærðfræði*. Reykjavík.

Ministry of education (2011). *Aðalnámskrá framhaldsskóla*. Reykjavík. Retrieved August 10, 2011 http://www.menntamalaraduneyti.is/utgefid-efni/namskrar/nr/3954,

Shimizu, Y, (2009). Characterizing exemplary mathematics instruction in Japanese classrooms from the learner's perspective. *ZDM The International Journal of Mathematics Education, 41*(3), 311–318.

Skott, J., Jess, K. and Hansen, H.C. (2007). *Matematik for lærerstuderende: Delta, fagdidaktik*. Frederiksberg: Forlaget Samfundslitteratur.

Thórólfsson, M., Macdonald, A. and Lárusson, E. (2007). Sýn fimm grunnskólakennara á nám og kennslu í náttúruvísindum. *Tímarit um menntarannsóknir, 4*, 83–99. Avaiable at http://www.fum.is/FUM_4_arg.pdf.