



**Linnæus University**

Sweden

Independent project

# **Teaching and learning of mathematics in Sweden**

*Methods, resources and assessment in  
Mathematics*



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## Abstract

The idea of this research paper is to study how mathematics is taught and learnt in Swedish schools, with an emphasis on the methods and resources used and how the learners are assessed in Mathematics. The findings of this research are analysed on the basis of previous research conducted on the fields of methods, resources and assessment in mathematics in Sweden and other parts of the world for instance Kenya.

The research was carried in a compulsory school in southern Sweden. Both pupils and teachers were interviewed. This was followed by observations of various mathematics lessons with different grades. The school was well equipped with modern resources. The teachers have a rich experience in teaching of mathematics and thus make use of variety of methods in a bid to cater for different needs of the learners. Assessment is paramount and a bonified part of the mathematics curriculum hence it is greatly upheld. Mathematics is a core subject according to the Swedish education system of 2012 and a pass grade in it is a requirement for entry into higher levels of education.

## Keywords

Bruner's three modes of representation, Constructivism, learners/pupils materials/resources

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# 1 Introduction

“Mathematics is by its nature a creative, reflective, problem-solving activity that is closely linked to societal, social and technological development” ( Lgr 11, p.59)

The above statement is a summary from the curriculum for the compulsory school, preschool class and the recreation centre 2011 for Swedish schools. It is of interest to know how the above statement is implemented in the actual teaching and learning of Mathematics in the class.

Mathematics is a compulsory subject at the preliminary and fundamental levels of education, namely the primary and secondary levels of education. By the twentieth century, mathematics was part of the core curriculum in all developed and most developing countries. Mathematics is a core subject according to the Swedish system of education. In Kenya mathematics is a compulsory and core subject in the primary and secondary school levels (Kenyan Ministry of Education, 2007). Mathematics forms a basis for further studies and careers both mathematical-oriented and even non mathematical- oriented. It is a practical subject which requires a lot of activities to make it meaningful and easily understood especially by the learners. A mathematics teacher is thus endorsed with the role of being a representative of a mathematical community, a task which involves them making the subject as interesting and utilitarian as possible.

The methods used to teach and learn various mathematical contents vary depending on objectives and goals to be met . “It is not appropriate for a teacher to commit to one particular method. A teacher should adopt a teaching approach after considering the nature of the children, their interests and maturity and the resources available. Every method has certain merits and few demerits and it is the work of a teacher to decide which method is best for the students” , Merchant, (2007-09, p. 1)

At different times and in different cultures and countries, mathematics education has attempted to achieve a variety of different objectives. Among the outlined goals that mathematics teaching seeks to achieve are that pupils should be given an opportunity to develop their ability to:

- choose and use appropriate mathematical methods to perform calculations and solve routine tasks,
- apply and follow mathematical reasoning” (Lgr 11 p.59-60).

Technological advancements in many developed and developing countries have led to a situation where everything becomes easy to tackle and more interesting, learning being inclusive. In Kenya and other emerging economies, technological advancement is still taking root hence it has not affected the learning process to a great extent. Learning of mathematics is still abstract with the course books being the widely used resources and with little or no real life application at the elementary levels of education. The learning of mathematics is thus a boring experience since learners at these levels do not find a meaning in studying a subject which does not seem applicable in the day to day activities. The learning is more of theory than practise, with the text book as the major resource. Most of mathematical concepts hence seem abstract and most learners form negative attitudes towards mathematics which leads to failure in their examinations.

“Resources have an important role to play in allowing teachers to model or demonstrate representations of Mathematical ideas and in supporting children’s developing Mathematical understanding and thinking” (Drews, 2007, p.29). This is among the summary of key points of a research which focused to explore the role that a wide range of resources could play in effective Mathematics teaching and learning in the primary years.

Upon our arrival in Sweden, the first impression was a highly developed country with a lot of technological advancements. What this meant to us is that learning and the education system should be fully impacted by the technology in the methods being used and the resources. We argued that the learning of subjects like mathematics should be interesting and more utilitarian. This led to us carrying out a research to identify how teaching and learning of mathematics is conducted in developed countries, Sweden being our representative of developed countries. Our focus is on various aspects of the teaching and learning of mathematics which include the methods of teaching used, the resources applied in and out of classroom to teach mathematics, the evaluation and assessment criteria used.

“Mathematics is an important part of our culture and the education should give pupils an insight into the subject's historical development, its importance and role in our society. The subject aims at developing the pupil's interest in mathematics, as well as creating opportunities for communicating in mathematical language and expressions. It should also give pupils the opportunity to discover aesthetic values in mathematical patterns, forms and relationships, as well as experience satisfaction and joy in understanding and solving problems” (Swedish National Agency for education, 2011 p. 23)

The Swedish education system is a goal steered system with a high degree of local responsibility. Among the admission requirements for a learner to be admitted to the upper secondary school for vocational programmes and higher education preparatory programmes is a pass grade in mathematics according to the Swedish Education System (2012). To make the learning of mathematics interesting and meaningful, various aspects of the learning process should be considered. The learning of mathematics should be learner friendly and help the learner to discover the unknown from the known, and also apply the knowledge acquired to solve day to day challenges.

## 2 Aim and Purpose

The purpose of this research is to find out how the learning and teaching of mathematics is conducted in Swedish schools. Our emphasis in this research was on the methods, resources and assessment in the teaching and learning of mathematics. The research was carried out in a compulsory school located in a small town in southern Sweden. The research questions were thus formulated as follows:

- Which methods are used in the teaching, learning and application of mathematics in real life situations?
- Which resources are used in the teaching and learning of mathematics and what are the impacts of their use, both positive and negative?
- How are learners assessed in mathematics to know if the set objectives have been achieved?



## 3 Background

This section presents known literature and previous research that has been done in the field of teaching and learning of Mathematics, but with a focus on teaching and learning methods in mathematics, resources used in the teaching and learning of mathematics and how achievement of set objectives is evaluated. Various theories of learning are also highlighted in this part.

### 3.1 Research on Resources

Understanding mathematics includes counting, sorting, matching, seeking patterns, making connections and recognizing relationships according to *Foundation Stage Curriculum* (QCA, 2000, p.68). To achieve the above stated objectives, it is necessary to make use of teaching resources.

There are various definitions of teaching and learning resources. Teaching resources also known as teaching aids are materials that the classroom teacher uses to help students understand the concepts she introduces during her lesson. These teaching aids can take numerous forms, from the beans students might count while learning simple math in kindergarten to the photos of famous people and places teachers might display during a history lesson (Susan Rickey, 2010)

Teaching learning resources can also be defined as a range or variety of educational materials that teachers use in the classroom in order to support specific learning objectives, as outlined in the lesson plans. (Lewis, 2015). Some examples of these teaching learning resources by Lewis include story books, manipulatives, blocks, samples of student writing, videos, games, flashcards, model clay and overhead projector transparencies.

A number of researches on teaching and learning resources have been conducted before and various findings from such researches are hereby highlighted. “Teaching and learning resources aids contribute to achievement in mathematics.” (Mbugua, 2011, p.116). This was among the conclusions of a research which was done in secondary schools in Kenya. The objective of the research was to determine the availability and adequacy of mathematics teaching and learning resources in secondary schools in Kenya, their quality, the extent to which these teaching and learning resources are used or made available to students by mathematics teachers during mathematics lessons, and whether there is a relationship between students’ achievement in mathematics and availability of teaching and learning resources.

Barrett et al., (2007); Chiu and Khoo, (2005); Hanushek and Wobmann, (2007); UNESCO, (2004, 2008) quoted in Lingam and Lingam (2013, p.2160) argued that “many factors, apart from teachers, are internationally recognized as enabling the learning process. One other significant factor is school resources, for example, teaching and learning materials, and physical infrastructure and facilities”. The aim of the research in this journal was to explore the state of rural primary schools in Fiji with regard to the availability and adequacy of resources that are assumed to allow enriching learning experiences to flourish. From their findings it was concluded and implied that “Availability of resources for teaching and learning is recognized as vital in providing

more and better learning opportunities to children. Without suitable resources, it is difficult for teachers to implement the curriculum effectively to improve what and how well the children learn” Lingam and Lingam (2013, p.2167)

According to Burns (2010), resources for teaching mathematics can be categorized into various groups. Among them include manipulative, which are tools used to make abstract concepts more real. They help children understand mathematics by looking at it from different views. Manipulatives include color tiles, pattern blocks, interlocking cubes and a variety of measuring tools, all of which learners can easily handle. These materials serve in several ways like to introduce concepts, to pose problems and to use as tools to figure out solutions. Burns recommends using manipulatives in all mathematics classes from kindergarten to high school.

Electronics and media are also other types of resources recommended by Burns. In this case the teacher uses interactive white boards, tablets and computers to stimulate the learners and hold their attention with visuals. An interactive whiteboard connects the teacher’s computer to a projector, which they can use to show the lesson on a touch screen to the class. The interactive lesson allows the learners to manipulate objects on the screen. They become participants in active learning, rather than spectators in a passive process.

### 3.2 Research on Teaching and Learning Methods

According to Bluedorn (2001), the term **teaching method** refers to the general principles, pedagogy and management strategies used for classroom instruction. Your choice of teaching method depends on what fits you — your educational philosophy, classroom demographic, subject area(s) and school mission statement. Teaching theories primarily fall into two categories or “approaches” namely teacher-centered and student-centered.

In the teacher centered approach, also known as direct instruction, teachers are the main authority figure in this model. Students are viewed as “[empty vessels](#)” whose primary role is to passively receive information (via lectures and direct instruction) with an end goal of testing and assessment. It is the primary role of teachers to pass knowledge and information onto their students. In this model, teaching and assessment are viewed as two separate entities. Student learning is measured through objectively scored tests and assessments.

In the student-centered approach, also known as inquiry based learning, teachers and students play an equally active role in the learning process. The teacher’s primary role is to coach and facilitate student learning and overall comprehension of material. Student learning is measured through both formal and informal forms of assessment, including group projects, student portfolios, and class participation. Teaching and assessment are connected; student learning is continuously measured during teacher instruction.

Hollingsworth, Lokan and Mc Crae`s (2003), quoted in Nyroos and peng (2012) argued that there is no one specific teaching method that results in successful teaching of mathematics, and that a variety of methods of teaching are employed in the high achieving countries. In another research conducted in Sweden findings revealed that different teaching approaches in mathematics can be used in different classes depending on the sizes of the classes. For instance, large classes with over thirty pupils perform

better with traditional direct instruction methods. On the other hand, progressive methods are suit for smaller classes. Traditional direct instruction methods are teacher-centred, where a teacher for instance shows the learners the procedure on how to reach a solution of a problem, then gives the students to tackle by themselves, (Chapko and Buchko, 2004) .Examples of these traditional methods of instruction include lecturing, dictation, drill, teacher led discussion and explanation, as highlighted in a blog of education in 2010 “Education is life itself so let’s preserve it” on the topic Traditional teaching methods: how are they used in education system. The same blog defines progressive methods of teaching and learning as a learner centred and a dynamic method, where the learner is responsible for their learning. Examples of progressive methods of instruction given include problem solving, experimentation, demonstration, group work and use of tools such as computers, just to mention but a few.

However, from a paper on teaching mathematics effectively to primary students in developing countries, various recommendations for teaching mathematics were arrived at from a research from neuroscience and psychology of mathematics by Soendergaard and Cachaper (2008), who say that when using problem solving, the limits of the working memory of the learners should be taken into account, memorization of multiplication tables and frequent additions to the point of fluency is also recommended. Moreover, the teacher should structure the lesson in a manner that he/she begins by reviewing the content of the previous lesson, followed by introduction of a new topic, in which the teacher should allow the learners time to have individual or group practice. It is also recommended that the teacher should solve examples and also show and tell at the same time, explanations for the concepts should also be provided for the learners by the teacher. Group work is also recommended when the problems to be solved are challenging, and these groups should constitute a mixture of good and poor learners (heterogeneous groups).

### 3.3 Research on Assessment

According to Black and William (1998), assessment refers to all those activities undertaken by teachers and by their students in evaluating themselves that provide information to be used as feedback to modify teaching and learning activities. It is formative assessment when the evidence is actually used to adapt the teaching to meet student needs

Stiggins (2004) suggests that educators should replace their assessment of learning with a more balanced approach, using not only assessment *of* learning but also assessment *for* learning. That is, teachers should use assessment not only to actively and continuously measure a learner’s progress but also to acquire useful data to inform their own instructional practice

Moreover, Harper, (1966) quoted in Zinsser, (1993) recommends making writing part of math learning by emphasizing that communication in mathematics learning should include writing as well as talking. Writing is how we think our way into the subject and make it our own. When children write in a mathematics class, they have to revisit their thinking and reflect on their ideas. By writing, the learner gives the teacher a way to assess how they are thinking and what they understand.

Torrance and Pryor (1998) contend that there is disagreement in research over whether formative assessment is mainly teacher-controlled or if the student can also be invited to take part as an active subject. In this regard, the authors emphasize the importance of students being an active part of classroom assessment. Zuza and Furman (2004) present findings from an action research project in mathematics classrooms. Their study suggests that students' self assessment, when learners really are involved in the process, can add reflection and meta-cognition to rote memory lessons, such as learning the multiplication tables. According to them, learners can be involved in the assessment via self-assessment.

From a research paper "How Students Should be Taught Mathematics" by Boaler, (2015) in which she describes what Mathematics classrooms should look like from her work in classroom and research in Mathematics education, mathematics classes should be places where students "Are assessed formatively-to inform learning-not summatively to give rank with their peers. Students should regularly receive diagnostic feedback on their work, instead of grades or scores. Summative assessment are best used at the end of courses" She also says that mathematics classes should be places where students "believe that mathematics will help them in their lives, not because they will see the same types of problems in real world but because they are learning to think quantitatively and abstractly and developing in inquiry relationship with math.

### 3.4 Theoretical Background of Learning

#### 3.4.1 Constructivism

Constructivism is a learning theory pioneered by Jean Piaget in 1967. The theory says that students learn by building, or "constructing," upon their previous knowledge and understanding.

Constructivism is applicable in any discipline. It is especially important in math education. According to the theory, Students need to construct their own understanding of each mathematical concept, so that the primary role of teaching is not to lecture, explain, or otherwise attempt to 'transfer' mathematical knowledge, but to create situations for students that will foster them in making the necessary mental constructions.

A central component of Piaget's developmental theory of learning and thinking is that both involve the participation of the learner. Knowledge is not merely transmitted verbally but must be constructed and reconstructed by the learner. Piaget asserted that for a child to know and construct knowledge of the world, the child must act on objects and it is this action which provides knowledge of those objects (Sigel, 1977).

The mind organizes reality and acts upon it. The learner must be active; he is not a vessel to be filled with facts. Piaget's approach to learning is a readiness approach. Readiness approaches in developmental psychology emphasize that children cannot learn something until maturation gives them certain prerequisites. The ability to learn any cognitive content is always related to their stage of intellectual development. Children who are at a certain stage cannot be taught the concepts of a higher stage (Brainerd, 1978).

According to Educational Broadcasting Corporation (2004), in the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure she understands the students' preexisting conceptions, and guides the activity to address them and then build on them.

Dewey, (1916) in his landmark *Democracy and education* rejected the notion that schools should focus on repetitive, rote memorization. Instead he proposed a method of "directed living" in which students would engage in real-world, practical workshops in which they would demonstrate their knowledge through creativity and collaboration. Students should be provided with opportunities to think from themselves and articulate their thoughts.

### **3.4.2 Bruner's Three Modes of Representation**

Hunnam, (2005) explains that Jerome Bruner viewed people as active in the process of learning, and that people can perceive various aspects in their immediate environment, then internalize them and finally act on them. A child's cognitive development can be represented in three modes of representation which include enactive, iconic and symbolic modes as explained by Bruner, and this holds true even for adult learners. These modes of representation explains the way knowledge is stored and encoded or arranged in a format, as described by McLeod, (2008). Hunnam, (2005) argues that for the mode of instruction to be successful, it should match the mode of the child's development.

In the enactive mode of representation, knowledge or information is encoded and stored in the memory, in the iconic stage, external information or images are stored visually in the memory and in the symbolic mode of representation, which is the last stage, information is stored in form of a symbol, as explained by McLeod, (2008).

Cabahug, (2012) in his article argues that mathematics teachers could use different teaching aids reflected in Bruner's theory, to teach unfamiliar and abstract concepts, in order to enable learners make sense of these concepts.



## 4 Methodology

To find answers to our research questions, various methods of data collection were used in the field. The following section presents the methods used for data collection and arguments for using the methods while laying focus on the merits and demerits of using the methods.

### 4.1 Research Instruments

The choice of methods used in this research was a result of various factors. To begin with, interviews were conducted with various participants so as to get varied responses on the same issues. Observations followed in order to identify if the information offered during the interviews matched with what happened in the actual classroom teaching.

### 4.2 Interviews

The interview is a flexible strategy and instrument for data collection and research. It enables multi-sensory questions (Cohen et al., 2011).channels to be used, for instance verbal, non-verbal, spoken and heard (Cohen et al., 2011). There are various types of interviews, for our research, we chose to use standardized open-ended interviews to collect data. A standardized open-ended interview is one in which the questions to be used during the interviews are formulated before carrying out the interview and are asked in a specified sequence. The same questions are asked to all the interviewees without changing the order of the

Standardized open-ended interviews are however associated with various merits and demerits when used. The advantages of using standardized open-ended interviews are that; since all the interviewees are asked the same questions, it allows comparison of responses. It also reduces effects and bias by the interviewers when several interviewers are used, which is applicable in this research since it entailed collection of data by two different researchers. The organization and analysis of data is also facilitated (Cohen et al., 2011).

The disadvantage of using standardized open-ended interviews is that “standardized wording of questions may constrain and limit naturalness and relevance of questions and answers”. (Cohen et al., 2011, p.413).

### 4.3 Observations

Observation as a method of data collection enables the researcher to obtain first hand information from natural social set ups. Observation’s unique strength is that “the use of immediate awareness, or direct cognition, as a principle mode of research has the potential to yield more valid or authentic data than would otherwise be the case with mediated or inferential methods” (Cohen et al., 2011, p.456).

Observation can be of facts, for instance the availability and number of teaching learning resources in a mathematics class, the number of practise questions given by the teacher to the learner. It could also be of events as they unfold in the class, for example,

the structure of the lesson from the introduction, lesson development to the conclusion, group activities in the class. Moreover, it can also focus on behaviours or qualities, for instance, the interaction between the teacher and the pupils (Cohen et al., 2011).

Our research entailed structured observation of mathematics lessons. Structured observations are systematic in which the observer is not active, does not intrude but merely notes down the incidence of the factors being studied (Cohen et al., 2011). From these structured observations the observer gets numerical data which enhances making of comparison between settings and situations, patterns and frequencies. An observation schedule was followed. However, we were not limited to what we had planned to observe but we were open and noted any other information which was connected to our research and which could enable us get answers to our research questions.

#### 4.4 Sampling

The school from where the data was collected was chosen as a basis for the research because we had been in contact with them before, during our internship. The learners who took part in the interviews were selected by random sampling. This was to ensure that each learner had an equal chance of being part of the interview. The ethical considerations were adhered to by giving the participants an opportunity to freely decide or volunteer to be part of the interviews. Six pairs of learners took part in the interview. All these learners were from grade nine and each class had a total number of twenty three to twenty five learners, in four different streams.

The teachers who were interviewed had to be mathematics teachers. However, they were informed earlier about the interviews and requested if they were willing to take part. Those who volunteered to take part also chose the times they were comfortable with so as to not interfere with their schedule. A total of five teachers took part in the interviews.

The observed mathematics lessons were also chosen by random sampling and various grades were considered with equal magnitude so as to eliminate bias. Majority of the interviewed teachers were observed while in class with the learners. Other mathematics teachers were also observed. A total of five mathematics lessons were observed.

#### 4.5 Validity and Reliability

Reliability is the degree to which a research study produces dependable, consistent and replicable results over time, instruments and groups of respondents (Cohen et al., 2011). We used the inter-rater type of reliability in our study. This a type of reliability which evaluates the degree to which different raters agree in their assessment decisions (Phelan and Wren, 2005-06). The usefulness of this type of reliability as argued by Phelan and Wren is that different human observers interpret answers in their own different ways. For a test or study to be reliable, there is need for it to be valid.

Phelan and Wren (2005-06) describe validity as the extent to which a research study measures what it intends to measure. Construct validity was used to ensure that the instruments measured what they were suppose to measure and not other variables. This was done in consultation with our supervisor.

Wiersma and Jurs (2008, p.264) claim that, “The validity of research involves the interpretation of research results with confidence and the generalizability of the results. The former is called internal validity and latter external validity.” In this research, external validity was also used since only a sample of the learners was interviewed and observed.

Various measures were put into consideration to ensure that validity and reliability were enhanced. For instance, different methods of data collection were used to see if they could yield same results, and also to minimize bias.

## 4.6 Implementation

The process of data collection was done using a qualitative method. The learners who volunteered to take part in the interviews were interviewed in pairs in a different room in the school and not in the classes. The learners chose to be interviewed in pairs due to the fact that the interviews were conducted in English and their language of instruction is Swedish. The learners would thus help each other in expressing their ideas in English when one of them got stuck or found it difficult to explain their answers in English. The interview guide for learners was used during the interviews which contained questions on methods, resources and assessment in Mathematics (see appendix B).

The interviews with the teachers were done with the help of an interview guide which contained questions for the teachers that were asked systematically. All the questions were similar for all the teachers (see appendix A). These interviews were conducted to get a deeper insight into the teaching and learning of mathematics in Swedish schools, and also to see if there could be a basis for comparing and contrasting different ideas on the same questions from the teachers. It also provided a ground for identifying the comparability between the opinions of both teachers and learners on the same ideas of the methods, resources and assessment as used in teaching and learning of Mathematics.

Moreover, observations were carried out in mathematics lessons with different teachers in grades seven, eight and nine with each class having twenty three to twenty five learners. These observations were important as they gave a much better understanding of the way the lessons are organized, and also gave a basis to establish a link between information obtained in the interviews and what was seen. During the observations, a structured observation schedule was used (see appendix C).

### 4.6.1 Ethical Aspects

#### 4.6.1.1 Demand on Information

Demand on information requires that the researcher informs the participants of the study, their part in the research and the terms of their participation. (The Swedish Research Council, 2002).

Participants were made aware of the purpose of the research, by explaining to them what the project was all about, and that the information they would offer would be of help in achieving this purpose. They readily agreed to offer any information that would be relevant.



#### *4.6.1.2 Requirement of Consent*

Informed consent is defined as, “the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions”, Diener and Crandall, (1978, p. 57), quoted in Cohen et al (2011, p. 78).

Before the interviews and observations, the participants were informed of the procedures to be followed and the purpose for following these procedures. For instance, the teachers and pupils were informed that there would be no interruptions from the observers during the lessons. The participants also signed a letter at the start of the interviews which stated that the interview was voluntary and they were free to withdraw consent and discontinue participation in the interview.

#### *4.6.1.3 Demand on Confidentiality*

Cohen et al., (2011, p. 92) describe confidentiality as “not disclosing information from a participant in any way that might identify that individual or that might enable the individual to be traced”.

In our research, confidentiality was adhered to in a number of ways which includes the following: The interviewees were not asked their names during the interviews and neither were the names of the known interviewees published in the results. The name of the school where the data was collected is not disclosed. The recorded interviews were deleted after transcribing the information to avoid access by other people.

#### *4.6.1.4 Demand on Utility*

Demand on utility requires that the information obtained in the process of data collection should only be used for the purpose of the research, (The Swedish Research Council, 2002).

The data collected during this research was used only for this project and not for anything else. The recordings were deleted upon completion of transferring the information obtained, into a written text.

## **5 Results and Analysis**

This part presents the findings of our research, which is as a result of the interviews with both teachers and learners and also the lesson observations.

### **5.1 Methods Used in Teaching and Learning of Mathematics**

Various methods of teaching and learning were evident from the research. These methods are discussed below, one at a time:

#### **5.1.1 Teaching in Special Groups**

The methods used in teaching and learning of mathematics depend on various factors. For instance, one of the teachers said that he teaches a very small group of learners between four to ten in number, and these learners lack confidence in mathematics. He said that almost all the time he picks a suitable task and write it on the board, then asks the learners to attempt solving it. Afterwards he with the learners talk a lot about the problem and one of his key methods is that he tries to motivate his learners by using words such as 'that was good', 'very good'. He also does not show his learners that they are poor in mathematics than the other group of learners who are taught in large numbers by another teacher. He argued that teaching a small group a good 'bouncing method' between the teacher and pupils because you can make pupils who would have been totally silent in large groups of over twenty eight to be active and speak in class.

#### **5.1.2 Lecture Method**

When we asked the teachers which methods they use in the classroom teaching of mathematics and their effectiveness, 60 percent of the teachers told us that they mostly use lecture method where they stand in front of the class and explains concepts on the whiteboard after which they go to specific learners and assists them with their work. One of the interviewed teachers said that he reviews on the white board while teaching mathematics, where he explains and writes the content being taught, in a specific order, so that learners can be able to follow also from the board.

Majority (82 percent) of the pupils reported that their teachers usually use the lecture method. One pupil said they like the teacher-based learning (lecture) method since it is quite easy for them to follow. Another one added that the lecture method works well for her since she reads ahead of the teacher so when the teacher goes through what she already learnt it becomes more understandable. 18 percent of the pupils who were interviewed also said that it is good when the teachers explain and write on the white board, but also when they themselves can work with mathematics in their books on their own afterwards so that they can learn from their teacher and go and learn by themselves. From the observed lessons, it was also evident that the lecture method dominated, with 90 percent of the teachers using explanation and reviewing on the board when teaching.

#### **5.1.3 The Use of Theories and Practical Mathematics**

18 percent of the interviewed pupils explained that effective teaching methods in mathematics depend on the content being taught. For instance they said that theories

could be used in a topic such as equations, while practical mathematics is suitable for example when teaching geometry. These pupils added that when using theory to solve mathematics problems they like it when they learn the logic part and get to know why they are doing what they are doing or rather why they are using a certain way to solve a problem. One of them said that “If I get to know what I am doing and why I am doing it then it is easy to remember”.

#### **5.1.4 Discussion in Small Groups**

Another teacher disclosed to us that at first he was committed to the book and followed it systematically, explaining concepts on the board and then giving learners questions to do on their own. Later on after some pedagogic training, he started putting learners into groups of two or three and giving them tasks to perform together after which they would explain to the class the various methods they used for calculations as he led them. He added that it saves time when he assists learners in groups although it may not be as effective as when he assists them one on one since in groups some learners may shy away and not ask as many questions as they have while others may even lose concentration. In one of the observed lessons, learners were discussing in some groups.

#### **5.1.5 Learning by Oneself Through Use of Examples**

There was one pupil who had totally different opinion when it comes to teaching and learning of mathematics. He prefers learning by himself and does not like it so much when the teacher explains. He explained that it is so much better when a person learns by him/herself than when one listens to the teacher. He said that he learns by looking at examples given in the course books then understands and tries to get solutions to other similar problems by himself.

#### **5.1.6 Problem Solving and Questioning**

From observations, 92 percent of the pupils learned through problem solving whereby they worked out problems in their text books. There was a free interaction between learners and teachers, and the learners were given an opportunity to ask questions and seek for clarification during lessons. Teachers too at various points of their lessons asked questions to learners.

#### **5.1.7 Application of Mathematics to Real Life Situation**

One teacher told us that he tries to explain to learners where they can apply the concepts he is teaching them, usually at the beginning of a new topic while another one told us that when teaching she tries to remind learners on some cases where they can apply the concepts they are taught like when playing video games.

However, another teacher said that it is not easy to always make mathematics concepts applicable to the day to day activities but in some chapters she gives examples on real life situations where pupils have to calculate sums. She also insists that some topics like equations are hard to make applicable and even explain where the learners will apply them but she reminds her learners that they need these concepts for future studies.

On some of these topics which prove hard to apply, she tries to look for games the children can play using the knowledge acquired in the topic and bring the games to class in a bid to make the topic more fun.

Three quarters of the interviewed pupils said that they apply various mathematics concepts in their day to day activities but not all. One pupil retorted that, “you use mathematics all the time but not necessarily what you were taught in class ” Examples of areas where the learners apply the knowledge gained included when playing video games, when doing shopping to calculate offers and when deciding on whether to buy goods in small quantities or in bulk. However one learner complained that, “I do not really know why we learn some of these stuff.” Another pupil added that he learns mathematics only for grades so he may qualify to join a good school.

Another important aspect on application of mathematics to real life situations as reported by one of the interviewed teachers was where learners participate in a time travel project. In this time travel, learners are taken out of school to places like museums and in the country side, where they actively take part in activities that were done in the past, which made use of mathematical knowledge. We got an opportunity to take part in one of the time travel projects where learners were taken to a museum in the country side. Among the activities done was preparation of paints where learners measured various components using a weighing scale. They mixed the components in given proportions and in specified durations of time.

#### **5.1.8 Issues Arising from the Methods**

One teacher said that he does not like the method whereby you give learners a lot of tasks because “mathematics is not about doing as many tasks as possible, it is about understanding”. One pupil said that they prefer having a one on one discussion with the teacher, something which is not very common during their lessons. Unfortunately they feel that their teachers do not give them the opportunity to do that rather they dominate the class learning so much. She added that, “In a lesson of forty minutes, the teacher usually talks on the board for thirty minutes and then for the next ten minutes we are working on our books.” The pupil said that it is during these ten minutes that the teacher assists the ones with questions hence the pupil does not get enough time to voice their questions. The pupil wishes for a variation of teaching methods.

One teacher pointed out that some learners are limited by the lecture method since while assisting individual learners she may realize that half of the class mostly get stuck at the same point even after she had explained on the board. In such a case she goes back on the board to explain again the same concept. 99 percent of the interviewed teachers said that they advocate the use of various methods since all learners do not understand using the same method and also to avoid monotony. It was also noted that the teachers provided the learners with printed materials containing various mathematical formulae and conversion tables. The learners are allowed to carry these materials into the exam room hence it is not necessary for them to memorize the formulae.

#### **5.1.9 Analysis of Methods Used in Teaching and Learning of Mathematics**

From our research findings, there were various similarities and differences between our results and previous research done on methods used in teaching and learning of

mathematics. Among the similarities was that a large proportion (99 percent) of the teachers advocate the use of different methods of teaching . This is in line with the research findings of Hollingsworth, Lokan and Mc Crae's (2003), quoted in Nyroos and Peng (2012) who explained that for successful teaching of mathematics, various methods should be used.

One of the methods used in the teaching and learning of mathematics was to link mathematics knowledge obtained in class to real life situations through use of time travels. During these time travels learners apply their mathematical knowledge to carry out given activities and solve various problems related to these activities. Dewey, (1916) advocated the use of a method of "directed living" whereby they engage in real world and practical workshops during which they demonstrate their knowledge through creativity and collaboration. This use of mathematics knowledge in the real world is also in line with Sigel, (1977) who asserted that the learner must actively participate in learning and not just be filled with facts. The learner should thus be offered with an opportunity for their minds to organize reality and act upon it.

On the other side from our research findings we noted that learners were provided with materials containing all necessary formulae thus they do not have to memorize the formulae. This was in contrast with Soendergaard's and Cachaper's (2008) recommendations for teaching mathematics in which they encouraged memorization to the point of fluency. It was also found that learners were placed into small groups depending on their learning abilities in which learners with same learning abilities were put in the same group (homogeneous groups). Contrary, Soendergaard and Cachaper (2008) advocated the use of heterogeneous groups which consist of both poor and good learners.

## 5.2 Resources Used in Teaching and Learning of Mathematics

A number of resources were made use of to enhance the teaching and learning of Mathematics as reported and observed. These resources are as explained below.

### 5.2.1 Electronics and Internet Based Materials

One of the interviewed teachers said that he uses various resources in the teaching and learning of mathematics such as you tube clips and computers more so when dealing with arithmetic to speed up the learners' thinking. Another commonly used electronic by the pupils was the calculator in three quarters of the observed lessons. The calculator was in most cases used for computational purposes. Each class was also fitted with a projector and a projector board on which information from the laptops would be made visible for the learners. In one lesson a teacher used his laptop to project a video clip on fractions and decimals for the learners.

### 5.2.2 Manipulatives

From the observations, each mathematics class was equipped with a protractor, one meter ruler, a pair of compass and a divider for use on the board by the teachers during lessons, which were strategically positioned at the left side of the writing board. Each

mathematics teacher had his/her mathematics tool box which contained the marker pens for use on the whiteboard, calculators, dices, thirty centimetre rulers, erasers and other resources for use by the learners. Moreover, one teacher said that she uses papers that pupils can fold into different shapes and work with them. Another teacher also used charts to show various pictorial representations of fractions.

### **5.2.3 Reading and Writing Resources**

Each of the learners in the observed lessons had their exercise books, pencils, course books and in some classes the teacher provided printed questions for the learners. The exercise books were used for solving mathematical problems obtained from the course books and other sources for instance printed questions on pieces of paper.

### **5.2.4 Extra Teacher as a Resource Person**

60 percent of the observed teachers said that in some lessons, they go to class with an extra teacher who acts as a resource person, assisting the pupils with special needs and those with learning problems. They argued that the presence of two teachers in a single class is helpful. One teacher quoted that, “maybe one teacher sees one thing and the other sees another thing so later on they can discuss them and come with better teaching approaches.”

### **5.2.5 The Role Played by Resources in Teaching and Learning of Mathematics**

The use of resources in teaching learning of mathematics were viewed as important by both the learners and teachers. One of the interviewed teachers said that according to him, the use of various resources or the variation in resources brings effect. He explained that the use of resources in mathematics visualize the content that one is working with and makes the learners eager to learn, makes them more motivated and makes it fun to learn mathematics, and this was also supported by the interviewed learners. 73 percent of the pupils also explained that the use of resources makes it easier to understand, by explaining concepts in a different way from the teachers way of explaining and gives them two different ways of viewing a problem in mathematics, and that starring in a course book in every lesson is boring. Another interviewed teacher added that learners get skills on how to use the resources if they are frequently used in the class.

A quarter of the pupils also reported that through video clips they get to see how other teachers explain the same concepts and at times the method used in the video is easier to follow. If they do not understand they can play the clip again and hence understand better

### **5.2.6 Challenges of Using Resources in the Teaching and Learning of Mathematics**

Despite the fact that resources aid in the teaching and learning of mathematics, their use is associated with various shortcomings. A teacher said that the time factor affects the use of resources in the teaching and learning of mathematics, in the sense that every

time one uses computers or teach practical mathematics, one has to plan specifically for that lesson and that may be time consuming. Another teacher added that the use of some resources in mathematics may not enhance learners' understanding in some areas in mathematics. He said that for instance when learners dwell so much on a calculator it may inhibit their thinking, and kill their ability to count without it, which he termed as "head mathematics".

Furthermore, a different teacher claimed that although learners find learning of mathematics more fun when various resources are available, some of them may tend to have a feeling that whatever they are doing is not real mathematics. It is also easy for the teacher to lose control of the class when learners are busy doing their own things

### **5.2.7 The Need for Knowledge on How to Use Resources**

The learners had a point of concern about the use of resources. 36 percent of them said that their school is equipped with a lot of modern resources but their teachers do not make use of them. They added that there was need for the teachers to know how to use the various resources in the class in order for them to benefit from their use, and that it is also important for the learners to have the knowledge on how to use the resources, for instance the calculator.

### **5.2.8 Analysis of Resources Used in Teaching and Learning of Mathematics**

Various similarities were noted between our research findings and the results of the past research on the use of resources in the teaching and learning of mathematics. It was clear that the teachers made use of numerous resources and said that these resources aid in the teaching and learning of mathematics. Similar to this, are the research findings of Mbugua (2011) and also Lingam and Lingam (2013), where they both supported the use of a variety of resources to enhance the teaching and learning of mathematics. Moreover, Hunnam, (2005) in his explanation of Bruner's three modes of representation encourages the perception of aspects in the immediate environment (which may entail resources), internalizing and finally acting on them since learners are viewed as active in the learning process.

The learners mentioned that through the use of resources they get to learn the same thing in a different way. In addition to that, resources enables in making abstract concepts concrete. Burns (2010) postulated that the use of resources like manipulatives make abstract concepts more real and help children understand mathematics through viewing it from different perspectives. Cabahug, (2012) also supports the use of different teaching aids to teach unfamiliar and abstract concepts.

## **5.3 Assessment in Mathematics**

From our research, so much information was offered on the assessment criteria used, feedback offered and the importance of carrying them out as outlined below:

### **5.3.1 Use of Formative Assessment**

Formative assessment was the type of assessment frequently used. One of the teachers said that he assesses the learners all the time in class and see what the learners manage in mathematics. He argued that one cannot evaluate the learner just around what they are doing in tests, but that one has to see how they work, think and so on, which may be hard to tell when only summative assessment is used. Apart from the tests the teacher added that he gives one homework every week in his class, and asks learners to formulate questions by themselves which fall in the subject matter or the content taught, which they discuss together in class. Another teacher said that he assesses after every two weeks and added that in a way it could be pressure to pupils because the tests are often but in other way it is not too much pressure for the learners because less content is covered in each test. A quarter of the pupils also added that tests should be spread throughout the term, so that each part of the syllabus is tested at a time. However, they argued that despite the fact that spreading out the tests enables them to tackle one part of the syllabus at a time, the negative thing is that they easily forget what they have learned after the tests. They added that summative tests on the other hand just makes learners read for the exams so that they can get good grades then forget about everything after the long tests.

### **5.3.2 Learners' Perception about the Tests**

Pupils were also given an opportunity to have their say on assessment. Three quarters of them supported the idea that being assessed is important so that they learn the right way, get help with that which they do not understand and learn better. However, a third of the pupils also argued that tests should not be done in the case of small classes where the teacher can just give tasks to pupils in class and let them solve in groups then discuss with them later. They added that tests should be done in bigger classes where the teacher may not get to know how each pupil work.

One student said that he likes the short math questions where they are supposed to only offer the right answer instead of the long ones where they need to show the method and steps followed toward getting the answer. He also wishes if the teachers could introduce these types of questions in the lower grades so that they can familiarize themselves early enough. Another pupil said that he likes both short and long questions equally

### **5.3.3 Importance of Giving Feedback in Learning**

Feedback on the tests and any other form of assessment was viewed as of much importance by both teachers and pupils. One of the teachers said that he gives feedback by reviewing the test on the white board with the pupils then discuss with individual pupils on the questions that they miss in the tests. The teacher also added that he motivates the pupils on paper through the comments he gives depending on the performance of the pupils. Another teacher said that he does not comment on paper but talks to the pupils about their performance. One teacher also reported that when marking the exams, he writes comments on the pupil's paper on the question they got wrong advising them on what to do so as to get it correct then advice them to do corrections and bring them to him for marking. He however finds himself guilty of being biased and concentrating more on the poor and average performers while ignoring the very good performers



On the other hand, majority (99 percent) of the learners said that it is very important to get feedback because if they do not get it, it may be more difficult to do another test without the knowledge on what needs to be changed or revised. Feedback also helped them to know what to practise and improve. 36 percent of the learners added that both positive and negative feedback is needed so that they get to know what they are doing right and what they are doing wrong. Another pupil added that he prefers immediate and verbal feedback, to be told where he is strong and where he needs to put more focus on. He added that this helps them to know the level where he is at that moment and what he should do to go forward. He remarked that “if you get feedback fast you can assess the problem faster and if you get a lot of feedbacks a lot of times you can easily fix problems you have and go on to get better grades and results.” They also preferred when the teachers talked to them frequently about their academic progress instead of just waiting for the final grade at the end of the term.

#### **5.3.4 Learners’ Self Assessment**

Although we did not manage to observe a lesson in which the learners were doing a test, it was observed that questions were given to learners during the lessons, which the learners were required to solve then the teacher would go round checking the progress of the learners. There was also a lesson in which learners were revising in preparation for a national test which was to be done in a while. The teacher had provided printed questions from different sections of the syllabus and learners tried to assess themselves and get to revise on some parts which they could not manage to get solutions.

#### **5.3.5 Analysis of Assessment in Mathematics**

Both formative and summative assessment were used according to the information obtained during our research. For instance teachers give tests to their learners once a month throughout the term while national tests are conducted at the end of the ninth grade. Boaler (2015) affirmed that both formative and summative assessment should be conducted with the summative assessment being conducted at the end of the course.

Learners’ self assessment was adhered to whereby, the learners were given questions on previously taught content in mathematics and were required to work them out by themselves then check if they are correct later. This assertion was reinforced by Zuza and Furman (2004) who emphasized that the involvement of learners in assessment adds reflection to rote memory lessons. The interviewed learners explained that feedback on assessment enables them to identify their areas of weaknesses and strengths in mathematics hence they prefer to get more frequent feedback both positive and negative. This is backed up by Boaler (2015) who put forward that learners should receive regular diagnostic feedback on their work and not just mere grades or scores.

## 6 Discussion

This part gives an insight into a summary of our methods and results of our research, conclusions and recommendations for those intending to do further research on the same topic.

### 6.1 Method Discussion

The methods used for data collection worked well since the participants were willing and offered relevant information. We also noted similarities between the information offered during interviews and the observations made in classes. It was thus possible to obtain answers to our research questions.

The main problem experienced during our study was with language. The Swedish education system uses Swedish as the language of instruction, which the two researchers could not understand perfectly. It was a challenge for both the interviews and observations, for instance in the interviews this challenge in some way limited the respondents in terms of fully expressing their opinions and responding to answers. It also limited us to do the interviews with mostly grade nine pupils who could express themselves well in English. In the observations it was difficult to tell for instance if a teacher started the lesson by reviewing the previous lesson. It was also not possible to follow the conversations between the teacher and the learners and also among the learners.

### 6.2 Results Discussion

The school's way of teaching mathematics upheld the recommendations of the Swedish National Agency for Education which requires that mathematics education should give pupils an insight into its historical development, its relevance and its function in the society. This is because mathematics is an important part of the Swedish culture. Through the time travels, the learners were able to see how mathematics concepts were applied in the past through the use of various instruments like the weighing scale. The learners were also able to use these instruments and even realised that they are still used in the modern society but in an improved state. This is in contrast with the mode used in teaching and learning of mathematics in Kenya. As much as Mathematics has a rich history and has been utilitarian in the societal life since time immemorial, this has been neglected. Time travels and an outlook into the historic development on Mathematics in Kenyan schools is unheard of.

Our curiosity was also confirmed since the technological advancement has led to availability of numerous resources which make the learning of mathematics more interesting than in the developing countries. However, some learners still have a negative attitude towards the subject. This is also common in Kenya since despite the lack of advanced technology, only a number and not all learners have a negative attitude towards Mathematics.

### 6.3 Conclusion and Suggestions for Further Research

In our research, we sought to find out how the teaching and learning of mathematics is conducted in the Swedish schools. Our project presents findings as obtained from a single school. We would hence recommend that the data be collected from various schools in different part of the country to enhance a general view of the teaching and learning of mathematics in Sweden.

It was also noted that despite the fact that the schools are equipped with modern resources for use in the teaching and learning of mathematics, some teachers still do not make use of them. We hence suggest that the teachers be educated on how to use them, when it is appropriate to use them and the need/importance of using resources in the teaching and learning of mathematics.

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# Appendices

## Appendix A Interview Guide for Teachers

1. For how long have you taught mathematics and which grade have you been teaching?
2. Which methods do you use in class in the teaching and learning of mathematics?
3. What is your opinion on the various teaching and learning methods and how do you find them effective?
4. How do you link the mathematics knowledge taught in class to real life situations?
5. Do you use any resources in the teaching and learning of mathematics? If yes which ones?
6. What are the impacts/effects both positive and negative of using these resources in the teaching and learning of mathematics?
7. In your opinion, do you think the use of varied/different resources in the teaching and learning of mathematics enhances the learners` understanding and achievement?
8. How frequent do you assess the learners in mathematics? (Formative and summative assessment).
9. Do you offer learners feedback on their achievement/performance? If yes, how do you do it?

## Appendix B Interview Guide for Pupils

1. In which grade are you?
2. Which teaching methods of learning mathematics do you find effective and why?
3. Do you find the knowledge obtained during the classroom learning of mathematics relevant/applicable to day to day activities/outside classroom?
4. Is the use of several resources in learning mathematics of help to you? If yes, how?
5. In your opinion, do you think it is important for you to be assessed?
6. Is it necessary for the teacher to offer you feedback on your performance, why?



# Appendix C Observation Basis

The following will be the basis for our observation:

## 1. Teaching methods.

- The type of methods used in teaching and learning mathematics.
- Teacher-pupil interaction.
- The frequency of how the teacher offers students practise questions during the lesson.
- Whether the teacher gives the pupils the chance to ask questions, contribute or seek clarification during mathematics lesson.

## 2. Resources used.

- The amount and nature of learning resources available in mathematics classes.
- The way in which these resources are used.
- Teachers knowledge and familiarity with the use of teaching learning resources available.

## 3. Assessment

- The number and type of questions given in mathematics classes.
- Assignments given at the end of the lesson.

Appendix D Sample of Letter of Consent for Teachers

LETTER OF CONSENT

Hey!

We are two exchange students, (Anne Waswa and Michelle Wambua), from Kenya. We will write an independent work in one of our courses. The aim of the work is to explore how mathematics is taught and learnt in Sweden.

For our research, we would like to collect data through observations in the classroom environment and an interview with teachers and pupils to keep their active view on this.

The study is based on the principles of research ethics and all the facts will be discussed based on the four basic principles of information requirement, the requirement of consent, confidentiality obligations and utilization requirement.

To facilitate the analysis we will record the interview. This is because it provides an opportunity to go back and check the answers. After the work has been approved by the examiner, the recordings will be erased.

Do you have any questions concerning our study? Please contact us or our supervisor for further information.

Students: Anne Waswa  
[annenyarotso@gmail.com](mailto:annenyarotso@gmail.com)  
Michelle Wambua  
wambuamitchelle@gmail.com

Director: Berit Roos Johansson  
berit.roos-johansson@lnu.se

I have read the above information and know that I at any time have the right to cancel the interview.

I sign and agree therefore that I set up the interview.

Name:

~~~~~

Printed name:

Date and place

## Appendix E Sample of Letter of Consent for Pupils

### LETTER OF CONSENT

Hello,

We are two exchange students Anne Waswa and Mitchelle Wambua from Kenya in Linnaeus University. We are writing and independent project work in one of our course, whose aim is to explore the teaching and learning of mathematics in Sweden.

To gather information for our research, we would like to collect data by conducting interviews with pupils from your school and also through observations of the lessons in class. The interviews will be voluntary and the pupils have the right to withdraw from the interviews if they feel so. The names of the pupils will not be printed in our final written work.

In our study, we have put into consideration the ethical principles of research, and all the facts will be discussed based on the four basic principles of information on requirement, the requirement of consent, confidentiality obligations and utilization requirement.

To facilitate the analysis, we will record the interviews, so that we can go back and check the answers. After approval of the work by the examiner, the recordings will be erased.

If you have any questions regarding our study please feel free to contact us or our supervisor for more information.

Students: Anne Waswa

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I have read the above information and i know that I at any time have the right to cancel the interview.

I as the school headmaster sign and agree therefore that my pupils are set up for the interview.

Name and sign

Date and place