Malmö högskola
Lärarutbildningen
Natur, miljö, samhälle

Examensarbete
10 poäng

Teaching Number Sense to Kindergarteners

-Att arbeta med taluppfattning i förskoleklass

Malin Rasmusson

Lärar/förskolelärarexamen 140 poäng
Matematik och lärande
Höstterminen 2006

Handledare: Tine Wedege

Examinator: Per Jönsson

Sammanfattning

Då jag tidigare besökt förskoleklasser i USA har jag förvånats över hur mycket tid som ägnats åt laborativ matematik. När nationella läroplanen i matematik i USA, *Principles and Standards for School Mathematics*, omarbetades blev fokus inom matematik att arbeta för att stärka elevers taluppfattning. Lockad av tidigare erfarenheter från det amerikanska skolsystemet beslutade jag mig därför för göra en deltagande observation med löpande protokoll för att se hur man arbetar med taluppfattning i en förskoleklass i Texas. Under observationen fokuserade jag på att se samband mellan undervisningen, läroplaner och teorier inom matematikundervisning. Resultatet av min undersökning visar att nittio minuter varje dag ägnades åt laborativa matematikaktiviteter anpassade för att hjälpa eleverna att uppnå läroplanens mål. Därtill fanns en tydlig anknytning till teorier inom matematikundervisning.

Arbetet är skrivet på engelska. Detta för att termer, dialoger etc. inte ska översättas inkorrekt och för att skolan som observationen skedde på ska kunna ta del av resultatet.

Nyckelord: **deltagande observation, laborativ matematik, läroplaner, matematik i förskoleklass, taluppfattning**

Abstract

As I earlier visited Kindergarten classes in the United States, I was surprised to see how much time that was set aside for mathematical activities in a hands-on fashion. In the reform of the United States *Principle and Standards for School Mathematics*, number sense was an essential outcome. Hence, the purpose of my study was to investigate, using participant observation with running records as a method, how number sense is taught in a Kindergarten class in Texas. During my observation, I especially looked at the educations connection to the guidelines and mathematics education theories. The result of my investigation shows that ninety minutes every day was set aside for mathematical activities in hands-on fashion, adapted to meet the guideline requirements and goals. In addition, the teaching observed in the class was closely associated with the mathematics educational theories.

Key words: **guidelines, hands-on activities, Kindergarten mathematics, number sense, participant observation**

Acknowledgements

This observation could not have been done without the help from some, for this investigation, important people. First of all, I would like to thank the principal, who despite visitor restrictions in the school, allowed me to come to the campus to observe. Secondly, I express gratitude to the teachers who were very kind and took the time to inform me about their education. A special thank to the teacher who let me observe in her classroom. At last, I would like to thank the people here in Sweden, especially my supervisor Tine Wedege, Carl Henrik Gunnehill, Josephin Ripa and Gabriella Johnn, who have supported me throughout my work and given me fruitful thoughts and constructive criticism along the way.

Table of contents

1 Introduction 1

2 Aim and Questions 3

3 Method 4

3.1 Assortment 4

3.2 Data collection methods 5

3.3 Procedure 6

3.4 Validity and Dependability 7

4 Theoretical background 8

4.1 The mathematical main stream in the U S 8

4.2 Number sense 9

4.2.1 Definition of Number Sense 9

4.2.2 Number sense and the school curriculum 9

4.2.3 Children developing counting skills 10

4.2.4 Children understanding and using symbols for numbers 11

4.2.5 Young children's understandings within the field of number sense 12

4.2.6 Teaching Number Sense 12

5 Teaching frames for Kindergarten mathematics 15

5.1 Guidelines 15

5.1.1 Federal Guidelines 15

5.1.2 State Guidelines 17

5.1.3 District guidelines 18

6 Observation and analysis 20

6.1 The teacher, class and classroom 20

6.2 A regular number-class 22

6.3 Examples of Number Sense activities 27

7 Discussion 36

7.1 Summary and conclusions of the result 36

7.2 Validity and dependability of the result 37

7.3 Suggestions of further research 38

8 References 40

Appendix 1- Principles and Standards for school Mathematics

Appendix 2- Texas Essential Knowledge and Skills for Kindergarten Mathematics

Appendix 3- District lesson plans

1 Introduction

During my years attending the teachers' programme in Sweden, I have spent numerous of weeks in Pre-Kindergarten and Kindergarten classes. According to the Swedish mathematics syllabus for Compulsory school (2001), the school in its teaching of mathematics should *aim to ensure that pupils develop an interest in mathematics, as well as confidence in their own thinking and ability to learn and use mathematics in different situations*. (Syllabus for mathematics, National Agency for Education, 2001 p.23). Unfortunately, throughout my time in Kindergarten classes I have experienced that mathematical activities are remarkably scarce. The mathematical activities occurred randomly for about half an hour once or twice a week and the mathematics education constituted merely a minor part of the children's education.

In contrast to the education described above, I came in contact with a structured, elaborative and laboratory mathematics education when I visited Kindergarten classes in the United States six years ago. At the time, I had not embarked on my education. As a result of attending the teachers' programme, and the consequential insight I have gained from the experience, I have from a fresh perspective decided to investigate if mathematics education in Kindergarten is still as well-planned and experimental as I remembered it to be. In the United States *Principles and Standards for School Mathematics*, number sense is an essential part. Hence, this investigation will focus on how number sense is taught and worked with in a Kindergarten class in Texas, where all guidelines to follow clearly states that number sense should be in focus of the education and taught in hands-on fashion. Additionally, I will in this investigation look for connections to mathematics education theories and to the guidelines that should be the building blocks which the education should be constructed upon.

I strongly feel that the six-year-old children in Kindergarten classes in Sweden are curious and interested in digging into new mathematical endeavours. Therefore, I intend to work consciously with the Kindergarteners and use the children's surroundings and manipulative material to explore the wonderful world of numbers, patterns and shapes. Could the Texas way of teaching Kindergarten mathematics inspire me and other Swedish Kindergarten

teachers to teach mathematics to kindergarteners using more organised and hands-on activities?

2 Aim and Questions

The purpose with my study is to examine how numbers are taught and worked with in a Kindergarten class in Texas to help the students develop a strong number sense. In my investigation I will look closer at the teaching of numbers to observe how the education is connected to the guidelines and the mathematics education theories. The reasoning behind this is due to the theoretical backgrounds and legal frames within the number sense area, which form the skeleton that the education should be constructed upon.

In this report I intend to answer the following questions:

- How is number sense taught, considering the mathematical content and teaching methods, in a Kindergarten class in Texas?
- How is this content and activity connected to the guidelines and mathematics education theories?

3 Method

3.1 Assortment

My investigation is based on the observations made in one Kindergarten class. I decided to focus on how number sense is taught in this particular Kindergarten class since the topic is an essential outcome of the *Curriculum and Evaluation Standards for school mathematics* (NCTM, 2005) reform. The first thought to cross my mind was to observe a Kindergarten class in California where I, a few years earlier, was involved in a lot of exciting and organised hands-on activities. However, I was curious to see if this particular way of teaching occurred in other parts of the US as well. Hence, I took a closer look at different states' guidelines and found that the Texas guidelines, *Texas Essential Knowledge and Skills* (2006), clearly state the mathematics the students should comprehend at the end of their Kindergarten year. Further on, amongst others, it encourages an education that is built on communicating mathematical ideas, evaluating the solutions, drawing parallels to the student's every day life as well as using real tools and manipulative material to solve problems.

Consequently, I contacted relatives in Texas who supplied me with contact information to the district principals whom in turn forwarded me e-mail addresses to the different school principals. I described my purpose to the principals and one principal suggested a specific Kindergarten teacher who had recently won the price for being the "district elementary teacher of the year". I reasoned that a teacher who had won the above price must be able to teach according to the guidelines and that she would most likely be a respectable teacher to observe and learn from. I contacted her and asked if I could visit her class over a time period of two weeks. She told me that I was more than welcome. She was informed that I came from a teachers programme in Sweden and that I wished to watch how they worked with numbers. The teacher told me that during my time in the class, they would work with numbers, but the same amount of time would be set aside for work with shapes and patterns.

In this investigation I have, due to research ethics, given the teacher and the children fictive names. The teacher will in this observation be referred to as Mrs. Berry. The reason for

using her last name is that this is how the students address her. Further, the school district will also be kept anonymous.

3.2 Data collection methods

I decided to use observation as the data collection method to record how number sense is taught in a Kindergarten class in Texas. One of the advantages with using direct observations as a method is, according to Esiasson et.al. (2004), that I as the researcher will personally be present to monitor the activities and interactions. However, this could have an impact of the objectivity. Further, when undertaking studies of people and social phenomenon in its natural surrounding, Mertens (2005) referred to Adler and Adler (1994) who differentiated between regular observation and participant observation. In a qualitative observation, the researcher usually wishes to interact with the participants while collecting data which makes it a participant observation. I intend to use participant observation as soon as I have acquired a general impression of the structures and activities that occur in the classroom. In my opinion, the interaction with the students will present the most accurate picture of the activities that take place in a classroom.

During my observation, I will make running records on what I notice in the classroom. According to Johansson and Svedner (2001), this is the simplest and often the most appropriate method for collecting data during an observation. In the running records, the researcher describes with his or her own words, the course of events in the classroom. The running records express the actual happenings and make it possible to see connections between different events as opposed to schedules where the course of events is categorised into isolated behaviour.

When making observations, it is of importance that the language is as close to the observed as possible and the most sufficient way of doing this is to use examples from the actual speech when presenting the result (Johanson och Svedner, 2001). Consequently, I intend to give examples from the actual dialogue taking place in the mathematics classes. Because of the dialogues and other terms that I wish to portray in its original representation, this investigation will be written in English. In addition, I wish for the teacher observed to be able to read the result from my investigation. However, since the language in a Kindergarten classroom is not very advanced, I will as well try to keep the language in this

investigation on a level that Swedish Kindergarten teachers and others from Sweden who may have an interest in this observation, can understand. Still, specific terms considering teaching materials etc. will be used in this written investigation.

3.3 Procedure

Before my arrival, I had contact with the teacher whom I, due to discretion, have decided to call Mrs. Berry. She gave me some information about the class, the school and the district. On my first day in the classroom, I introduced myself to the children and explained that I was there to see the exciting things they were working with. I also described that I came from another country and showed them Sweden on their globe. During my first day, I did not participate as much in the activities, but spent the majority of the time in a corner, taking notes to describe the classroom, the children, the teacher and the interactions between them. The students were all used to visitors in the classroom and did not pay me much attention.

The days to follow, I became more of a participant observer who interacted with the students. However, as Mrs. Berry introduced something new within mathematics in the meeting area, I merely observed and took notes. As the children worked at their tables with different activities, I walked around and participated in the activities, for example played games with the children. All the time I had my notebook, pen and a camera with me so that I could record specific phrases or activities. All the student's parents, but two, had given permission to take photos for the school website. Hence, these two children were excluded from all the pictures due to research ethics.

I spent entire days in the classroom, from eight in the morning until at least four in the afternoon. The children ended their day at a quarter past three and the rest of the time I spent asking questions to Mrs. Berry or taking a closer look at the different teaching materials. However, it was only during the mathematics activities that I took notes. Otherwise, I helped Mrs. Berry and the children with their work. I also held some short classes in other subjects than mathematics as Mrs. Berry had to leave the classroom for a while. Due to this interaction in the classroom, I would state that I really got to know the students and I enjoyed the time spent with them immensely.

3.4 Validity and Dependability

When doing research, the validity and dependability of the results need to be taken into consideration. According to Johansson and Svedner (2001), validity refers to whether the result covers what that was intended to investigate. Esiasson et.al.(2004) discuss two types of validity. *Conception validity* takes into account the connections between theories and the actual operation, as well as systematic mistakes or errors made in the investigation. *Result validity* deals with the question whether what is stated to be examined really is examined. According to Gunnarsson (2002), the term *dependability* refers to whether the methods used to obtain the result are dependable. Esiasson et.al. (2004), mention the incidence of unsystematic and random errors. As an example, it could be mistakes in the running records due to incorrect hearing, stress etc. According to Esiasson et.al.(2004), strong conception validity and dependability give rise to a strong result validity.

In section 3.2 above, I argued for why I should use direct observation, taking running records, as a method. Hence, when I decided to use this method, it was based on theories that suggest this method for my type of investigation. Still, I need to discuss the validity dependability of my result after my investigation since errors, especially unsystematic, can occur throughout the data collection.

4 Theoretical background

4.1 The mathematical main stream in the U S

When about to face a new millennium in the 1990's, the United States headlines were filled with reports of illiteracy, innumeracy and educational decay. Changes were made in the school mathematics, but still the education was criticised for not being adapted to the future. The *Mathematical Sciences Education Board* decided that one of the priorities for students that were to work with mathematical problems in the future was imaginative thinking. Hence, they gave six authors, who were scientists and mathematicians, the mission to express to the nation a new view of mathematics education where the old curriculum could evolve and meet the challenges of this millennium. The six authors' papers are all dealing with a certain area within mathematics and are included in the book *On the Shoulders of Giants: New Approaches to numeracy* (1990).

The six areas investigated in the book are *Pattern, Dimension, Quantity, Uncertainty, Shape* and *Change*. Within the chapter *Quantity* the fundamental concepts for counting, measuring, comparing and using numbers are outlined. Further more, the term number sense is introduced:

> *While there is a considerable debate concerning the risks and benefits of shifting attention in school mathematics from traditional skills to concepts and problem solving, there is no disagreement about the importance of developing student achievement in a variety of informal aspects of quantitative reasoning, to develop what might be called number sense. Even if machines take over a bunch of computation, it remains important for users of those machines to plan correct operations and to interpret results intelligently* (Fey, 1990, p. 79).

Considering the text above, it seems clear that number sense is a topic that does not become less important as the society evolves. Rather, a well developed number sense could be seen as the underlying tool to be able to work with and reason around mathematical problems in the present time as well as in the future.

4.2 Number sense

4.2.1 Definition of Number Sense

According to Anghileri (2000), some children in elementary school struggle to solve simple arithmetic problems. It seems as if they do not see the relationships between numbers in problems like [x- 4 = 9] or [100/ 25= x]. Instead of looking for facts already familiar to them, they seek for an appropriate procedure which could help them solve the problem. Students who on the contrary notice the connection between the numbers will most likely be able to solve this type of problems without difficulty. Students who have an awareness of relationships that allow them to interpret new problems in terms of previous results they remember and who can work flexibly to solve problems that contain numbers are said to have a "*number sense*" or "*feel for numbers*".

Another definition of number sense was given by Mcintosh et. al.:

> *Number sense refers to a person's general understanding of number and operations along with the ability and inclination to use this understanding in flexible ways to make mathematical judgements and to develop useful strategies for handling numbers and operations.* (Mcintosh et.al.1992, p.3)

Both Mcintosh et.al. and Anghileri stressed that someone with a good number sense possesses the skills to work flexibly with numbers and has the ability to see relationships between these. Hence, these parts will be the definition that I refer to when I mention number sense in my investigation.

4.2.2 Number sense and the school curriculum

In the curriculum reform in the United States, *the Curriculum and Evaluation Standards for School Mathematics*, number sense is an essential issue. In this context, number sense refers to the development of comprehension as well as the nurturing of confidence and positive attitude towards mathematics, something which has been lacking in more dated curricula. The *Standards* clearly express the need for students to develop an understanding for how to work with numbers and being confident in their own mathematical reasoning. According to Anghileri (2000), the former emphasis on arithmetic methods involving addition, subtraction, multiplication and division is no longer seen as the focal point in the

guidelines. The “drill and practise” exercises are no longer in focus since they are not considered to prepare the children for a life in a technological society. Instead, the teaching focuses on understanding the logical structures behind numbers and number operations.

4.2.3 Children developing counting skills

P. Munn (1997) argued that there are similarities between the early language learning and learning to count, in the way that it develops through occasions when the child itself takes the initiative to explore it. It is thus important that the adults take the child’s counting seriously, try to stimulate them to further counting activity and make the purpose of counting clear to the child. According to Richardson (1999), counting should be seen as a tool for finding the answer to “How many?”

For a child to be able to appreciate the connection between number words and a collection of objects requires that the child has tactile, visual and verbal experiences that all provide cognitive cues about the process of counting (Nunes and Bryant, 1996). Anghileri (2000) is referring to Thompson’s research from 1997, where he has chosen to divide the process of learning to comprise three stages that the child’s learning to count goes through:

Recitation - being able to recite the number words in their correct sequence;
Enumeration - assigning the correctly ordered number words in the one-to-one correspondence with the objects being counted;
Cardinality - realizing that the number assigned to the final object counted tells how many there are in the whole collection (Anghileri, 2000, p.27).

When the children start school, they should begin with recognising and reciting the number words since it “*reinforces the universal nature of counting*” (Anghileri,1997,p. 47). A suitable way to do this is to begin with counting in sequences and using rhymes such as “*One, two, three. Mother caught a flee*” (Anghileri,1997,p. 47) to play and explore with the relationship between counting and the counting words.

The unitary counting sequence, which means counting in ones, could be seen as a sequence of numbers that can be recited in a certain order. As the child is confident with beginning at one, it should be encouraged to start at another number and continue counting from there.

Counting up from another number than one is more demanding to the child, but yet a vital detail to be able to do when learning addition since the counting-on strategy is one of the more efficient strategies when learning addition in the primary years (Anghileri, 2000).

4.2.4 Children understanding and using symbols for numbers

According to Richardson (1999), when the children have acquired a strong base of counting skills, especially when they know the counting sequence and can count to ten using one-to-one correspondence, they are prepared to learn the symbols and associate the symbols with the corresponding quantities.

Consistent with Anghileri (2000), just like the children who explores the world of writing tries to copy letters, the children learning symbols for numbers will try to copy the number symbols as they see it. Still, these copied number symbols does not reflect the student's understandings and it does not help them to develop their ability to connect between the actual object and the number symbol used. Therefore, it is important that as the child writes number symbols it is also supported orally by adults in its surrounding to support their mathematical thinking and reasoning, and make connections to the actual objects.

When learning the symbols that represent numbers, there are often associations made with situations where numbers are used. However, according to Gray and Tall (1994), the children also need to develop a deeper and more abstract understanding of the numbers than just the relationship between the number symbol, number word and the number of objects. As an example, the children should not only learn the word six, the symbol "6" and to count to six. In addition, the child needs to be able to set the number six in relation to other numbers and make connections such as that six is the number after five and the double of three. Hence, to get a visual and a more abstract picture of how six could be composed in different ways is important to be able to relate the symbols to not only a word, but to the actual relationship to other numbers. Skemp (1979), referred to the above described understanding as "relational understanding". As opposed to "instrumental understanding", a student who has a "relational understanding" does not only know what to do, but also why it works. The student is able to discover the relationships and apply the previous knowledge to solve new problems.

4.2.5 Young children's understandings within the field of number sense

The understandings of five- and six-year-olds in the United States are described by Griffin (2005) in her article *Fostering the Development of Whole-Number Sense* published by the National Research Council in How Students Learn Mathematics in the Classroom. Griffin argued that an important step for the five-year-olds is to be able to solve problems involving small numbers (single digit), without using the actual objects to count. They are then said to have a "mental counting line" to keep track of the amount of objects already counted. However, the children's understandings still vary. Given a problem that they have four chocolates and receive three more, the most advanced child will say that he/she simply knows that there is seven since three and four makes seven. Still, most children at this age use their fingers to help them solve the problem. The most sophisticated counting strategy would be by the children holding up four fingers and starting on four, simply adding three while counting. A less sophisticated way of solving the problem would be to use the counting up from one strategy, using their fingers starting on one. The students who are unsure of this way of counting will put up fingers and add them to their nose etc. while counting. Still, all the children using any of the approaches described above demonstrate an awareness of that counting of numbers refers to real world quantities even though the objects are not present. Around this age, the children will also develop an understanding for two-digit numbers that makes them able to determine which number of some given examples that is the greatest, simply by looking at the numbers displayed.

According to Griffin (2005), the understandings of six-year-olds are often similar to the ones of five-year-olds described above. However, the six-year-old children will slowly be able to use subtraction and count backwards to figure out a problem. In addition, many of the six-year-olds have understood the advantage of starting with the largest number when adding.

4.2.6 Teaching Number Sense

According to Ljungblad (2001), one of the focal points when teaching mathematics in the early years is to help the children understand quantity and to encourage the development of a strong sense for numbers. Otherwise the entire mathematical experience will be complicated as the children may be unable to reason correctly while solving problems.

This theory is supported by Ahlberg (1995). She claims that the children must have an adequate comprehension of numbers, especially within the range 1-10, to be able to succeed in mathematics later on when dealing with higher numbers and values.

When teaching numbers to young children, it is firstly important to get to know the student's current understandings. The understandings of five- and six-year-olds have been described within section 4.3.5 above. According to Donovan and Bransford (2005), the education must begin with focus on the student's knowledge, ideas, attitudes and skills since these lay the foundation to new learning.

Secondly, when aware of the student's understandings and what you wish to teach, the problem will be how to maximize the opportunities for all the children to achieve the knowledge goal. The National Research Council has developed a *Number Worlds* program containing over 200 activities based on research on how students learn. They present six principles that are relevant to keep in mind when planning the classroom activities:

-Activities should expose children to major ways number is represented and talked about in developed societies.
-Activities should provide opportunities to link the "world of quantity" with the "world of counting numbers" and the "world of formal symbols".
-Activities should provide visual and spatial analogues of number representations that children can actively explore in hands-on fashion.
-Activities should be affectively engaging and capture the children's imagination so that knowledge constructed is embedded not only in their minds, but also in their hopes, fears and passions.
-Activities should provide opportunities for children to acquire computational fluency as well as conceptual understanding.
-Activities should encourage or require the use of meta cognitive processes (eg. problem solving, communication, reasoning) that will facilitate knowledge construction. (Griffin, 2005, p.283)

For young children, it is especially important to use hands-on materials and activities. Young children learn mathematics best from the physical exploration of objects. Concrete objects need to be moved and organised in order to create new mathematical ideas. This

activity cannot be replaced by a teacher demonstrating the activities to the child (Dacey and Eston, 1999). For the children to be able to explore materials further individually, materials that have been introduced during large group activities could be placed in Activity Centers where the students can go to develop a deeper understanding (Abrohoms, 1992).

Another issue, which has been widely discussed in teaching, is the importance of context. According to Anghileri (2000), a good way to get the children interested in learning more about numbers is to make sure to relate the context to the children's personal lives. When the children are given real life problems that they can connect to, work with through practical activities and play games, they will begin to recognise the symbols and understand the order and relationship that is important.

There are others who agree with Anghileri about the role of context. In her article *The Role of Context in the Mathematics Classroom* (1993), Boaler argued that the degree to which the context in the education affects the children's performance is truly underestimated. Boaler suggested that the context includes the children's real world, the local community and individual examples that the children may interpret and analyse. This makes it possible for the children to associate with mathematics without necessarily having to transfer information from a textbook to a real world problem. However, Boaler emphasised that while the mathematical context is supposed to be related to the children's real world it is often extracted from the adult's world instead. This insinuates that the students cannot relate to the context, but still they engage in the tasks that tell them to pay house hold bills etc.

According to Dacey and Eston (1999), the mathematical context and activities in the classroom should build on children's natural curiosity which should be woven into the curriculum. By enabling the children to ask questions and receive attention, the children gain respect in their role as responsible for their own learning process. When the children explore questions and make connections to their own world, by using the calendar or counting down to their birthdays, they can also make sense of their own world. This sense-making assists the children to gain self-confidence which in turn trigger the children to take greater risk in their explorations and become more curious. This in turn gives rise to new question and the procedure starts all over again (Dacey and Eston, 1999).

5 Teaching frames for Kindergarten mathematics

5.1 Guidelines

When teaching a Kindergarten class in Texas, there are federal, state and district guidelines to follow. The federal guidelines are behind the state guidelines and the district guidelines are based on the guidelines set by the state. When I, in this investigation, use the term guidelines, I refer to all guidelines presented. When referring to a more specific guideline, the name of the guideline is mention in the text. Under this topic, the number sense parts of the different guidelines are discussed.

5.1.1 Federal Guidelines

In January 2002, George Bush signed the first version of the "No Child Left Behind Act". This Act clearly states the schools' responsibility for not letting any of their students from Kindergarten to high school be left behind in any school subject. It could be considered as a tool to help increase individual achievement and to make sure that no child slips through the cracks. Every year there is an evaluation of each school to make sure that the students have reached the required goals. If not, the school will be helped to improve their work by further educating the school board and teachers[1]. The Act is built on four "common sense pillars":

Accountability for results - includes identifying where improvement is needed and providing schools with the improvement needed to help getting back on track. This part of the Act also states that the teachers should all be highly qualified for the subject that they teach.

Doing what works due to scientific research - the education practised should be proven effective by scientific research.

[1] The United States government has set aside $ 24.3 billions to help reinforce this act.

Expand parental options – by ensuring that parents are provided with information on their child's progress in school.
Expand local control and responsibility - expresses that the states have more freedom to decide in which areas to spend the funding. (U.S. department for teachers, 2004)

Apart from the *No Child Left Behind Act*, the teacher who teaches Kindergarten Mathematics have federal curriculum to follow, *Principles and Standards for school Mathematics,* which the National Council of Teachers of Mathematics, NCTM, is responsible for. These Standards are divided into three different areas within the *Number and Operation Standard*, with specific goals to be reached at the end of 2:nd, 5:th, 8:th and 12:th grade. The areas are the following:

- Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
- Understand meanings of operations and how they relate to one another.
- Compute fluently and make reasonable estimates.(NCTM, 2000)

Within the above areas, there are specific goals described that focuses on counting to find an answer to "How many", develop a sense for whole numbers and be able to connect number words and numerals to the actual quantity it represents. Further, the children are supposed to generate strategies for whole number computations, and use different methods and tools to carry out these computations. For the specific and more outlined goals within the number area for Pre-K to grade 2, see appendix 1.

Central to the *Number and Operation Standard* is the development of number sense. Students with number sense "*naturally decompose numbers, use particular numbers as referents, solve problems using the relationship among operations…and have a disposition to make sense of numbers, problems and results*". (NCTM, 2000, Standards for school mathematics, overview)

Further on, the NCTM (2006) has recently released *Curriculum Focal Points* which contains the most important mathematical topics for lasting learning at each grade level. Within the area of number and number sense, the following can be found as a Focal Point in Kindergarten:

Number and Operations: Representing, comparing, and ordering whole numbers as well as joining and separating sets (NCTM, Curriculum Focal Points, 2006).

5.1.2 State Guidelines

In Texas, a board of teachers and mathematicians has interpreted the *NCTM Principles and Standards for school mathematics* and the *No Child left behind Act* and constructed a more concrete and detailed guideline for how to teach mathematics. This guideline is called the TEKS, *Texas Essential Knowledge and Skills,* and the latest version was amended to be effective on the first of August 2006. The TEKS contains a specific chapter with goals to be reached at the end of each year within the various school subjects. Looking closer at the TEKS goals considering numbers and understandings in Kindergarten, it is clear that the focus in Kindergarten mathematics should be to develop number concepts and understandings for these. The following and much more is found in § 111.12:

(*a) Introduction.*
(1) Within a well-balanced mathematics curriculum, the primary focal points at Kindergarten are developing whole-number concepts and using patterns and sorting to explore number, data, and shape.
(2) Throughout mathematics in Kindergarten-Grade 2, students build a foundation of basic understandings in number, operation, and quantitative reasoning… Students use objects to create and identify patterns and use those patterns to express relationships, make predictions, and solve problems as they build an understanding of number, operation, shape, and space… Students collect, organize, and display data and use information from graphs to answer questions, make summary statements, and make informal predictions based on their experiences.
(3) Throughout mathematics in Kindergarten-Grade 2, students develop numerical fluency with conceptual understanding and computational accuracy. Students in Kindergarten-Grade 2 use basic number sense to compose and decompose numbers in order to solve problems requiring precision, estimation, and reasonableness…
(4) Problem solving, language and communication, connections within and outside mathematics, and formal and informal reasoning underlie all content areas in

mathematics...Students use these processes together with technology and other mathematical tools such as manipulative materials to develop conceptual understanding…
b) Knowledge and skills.
(K1) Number, operation and quantitative reasoning. The student uses numbers to name quantities. The student is expected to:
(A) use one-to-one correspondence and language such as more than, same numbers as, or two less than to describe relative sizes of sets of concrete objects.
(B) use sets of concrete objects to represent quantities given on a verbal or written form (through 20); and
(C) use numbers to describe how many objects are in a set (through 20) using verbal and symbolic descriptions.
(http://www.tea.state.tx.us/rules/tac/chapter111/ch111a.html)

For the entire TEKS Kindergarten Mathematics curriculum, please refer to appendix 2.

As could be seen from the excerpt above, the teaching methods are interwoven with the goals in the guidelines. Hence, there is no specific chapter containing teaching methods which tells how the students should learn. However, as a general conclusion from TEKS it could be implied that the children should use formal and informal reasoning, communication, technology and mathematical tools such as manipulative material when learning about numbers.

5.1.3 District guidelines

Looking at the school district webpage for more specific district guidelines, it refers back to the TEKS. However, as I visited Mrs. Berry, she explained that the district has an online curriculum solely available to the teachers, which is set up by the district board. The district board consists of teachers and other representatives from each school subject. Hence, there is a certain district board that looks at the TEKS to see what the children are supposed to comprehend at the end of their school year within every school subject. In addition, they develop a very detailed curriculum with lesson plans for Kindergarten that all the Kindergarten teachers in the district have to follow. This curriculum is divided into nine week periods, with ninety minutes of math every day in the Kindergarten class. Online, the teacher first checks the planning notes for the nine weeks. Here, the board has written

important facts about the nine weeks to come. The planning notes are followed by a couple of planned lessons, where some are required and some optional to teach. The lesson plans are very detailed, clearly stating what part of TEKS the lesson is connected to.

Additionally, the lesson plans are divided into different parts with specific questions to ask and activities to do with the class. The planned lessons are followed by a section that tells what vocabulary the children should learn, gives tubbing ideas for the math tubes and some examples of further resources. The final section of the nine week plans contains a page with literature and Internet resources.

6 Observation and analysis

I have decided to present the results of my observation in three sections. Each of these sections is a summary of what I have noticed within the topic and fills the purpose of giving an overall idea of the field. At the end of each section, I reflect on comments made by Mrs. Berry as well as connections to the guidelines and the theoretical framework presented in section four. I will begin with a description of *the teacher, class and classroom* since this context affects the learning and the activities that are carried out. This is followed by an example of a *regular number-class* which will represent the structure of the general class, although it also displays the activities and dialogues taking place in the classroom. However, I noticed a lot more activities within number-sense and I have decided to let some *number sense activities* be represented in a section by itself.

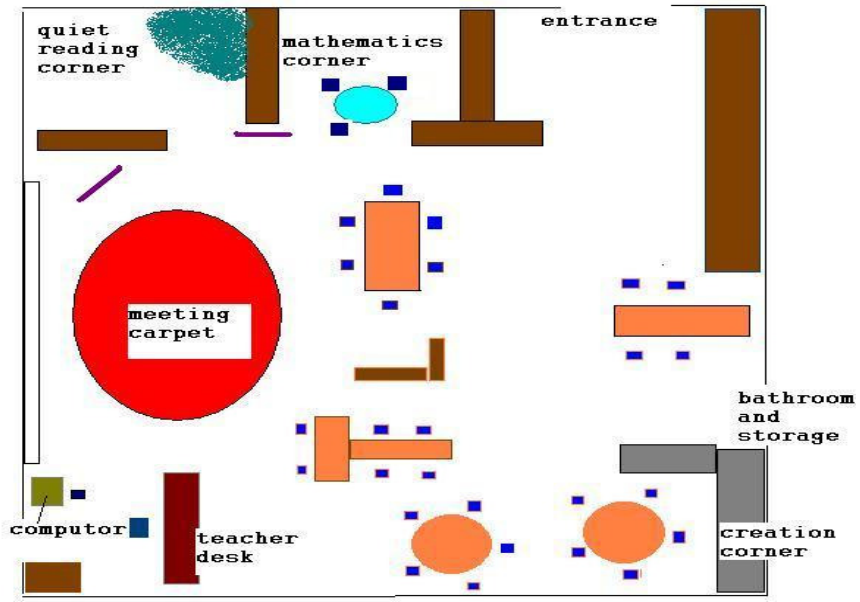
6.1 The teacher, class and classroom

Mrs. Berry is a 43 years old woman who six years ago received her Bachelor's degree for grade preK-6. She decided to become a teacher since she loves children and wants to make a difference. Since she got her degree, she has been teaching in Kindergarten classes at two different schools. The current school has around 500 students from pre K- grade 5 and in Mrs. Berry's kindergarten class there are 19 five-year-old children. Mrs. Berry is included in a team with three other Kindergarten teachers, who are all responsible for their own class. The children in the class come from different social backgrounds and around half of the children are ethno Mexicans and speak Spanish at home.

As a visitor in Mrs. Berry's classroom, I noticed how she had structured the room into certain areas for different activities (see figure 1). The classroom has five small and short tables, labelled 1-5, surrounded by 5-6 small chairs. The classroom also has a white board with a calendar, a quiet reading corner, a creating corner, literacy stations, a meeting area on a big carpet decorated with numbers and a mathematics corner.

In this mathematics corner, hundreds of counters, connecting cubes, unifix cubes, number charts, dice, building blocks, tangrams and stencils for mathematical activities are situated. Book shelves separate the classroom into the different areas by going halfway to the ceiling. Wherever I turn my head in the classroom, numbers, words, shapes and patterns decorate the walls.

Figure 1: Sketch over Mrs. Berry's classroom



classroom with meeting area

Mrs. Berry's comments

As I talked to Mrs. Berry about her class and how she had organised the classroom, she explained to me that the children need to be able to work in small groups with hands-on activities. Simultaneously, they require areas where they can have private time to engage in

a book etc. Mrs. Berry also considers the need for the children to be able to move around in the classroom without disturbing each other. She emphasised that the children in Kindergarten still have trouble sitting still and focus on the same activities for a long time. Since half of the class has English as their second language, Mrs. Berry wanted small tables with only four children around (and an extra chair for herself) so that there can be a lot of talking and hands-on activities around the tables, even in the math classes. Further on, Mrs. Berry also sees an advantage in being able to gather the entire class in a circle where all the children can look at each other. At the same time Mrs. Berry can observe the children as she introduces new activities. Therefore, she has placed a big red carpet on the floor by the white board.

6.2 A regular number-class

A regular mathematics class in Mrs. Berry's classroom usually begins in the meeting area on the carpet. The children finish their previous activities to the clean-up music and return to their spot on the carpet ready for new endeavours. On the carpet, Mrs. Berry reviews what has been learned the previous day by asking questions to the children. The following dialogue gives a good view of how the communications in the classroom usually are between students and teacher.

Mrs. Berry: *Do I have any children in this class who can tell me what this number is called?*
Sarah: *That is eight .*
Mrs. Berry: *That's right. Is here anyone who can tell me something about the number eight?*
Lincey: *It is one bigger than seven!*
Thomas: *It is one smaller than nine!*
Bryan: *I have eight fingers up!*
Patrick: *It looks almost like two zero's on top of each other!*
Mrs. Berry: *You guys are so smart. You are almost doing first grade work now! Now, I am going to give out these connecting cubes to you. I want you to take out eight and place these on top of your fingers. And when you have placed them on your fingers, I want you to touch them to your nose and count them. Do you think you can do that?*
Students: *Yes!*

Mrs. Berry hands out ten connecting cubes and the children start to add eight of these to their fingers.

Mrs Berry: *Now, let us all look at Kate's fingers. Can you please show us how you decided to place your eight cubes?*
Kate: (holds up her hands) *I have four on this hand and I have four on this. Because four and four is eight.*
Mrs. Berry: *That is one out of many correct ways of showing eight! Is there any child here who has placed their connecting cubes differently? Yeah, Ashley?*
Ashley: *I have five on this one and three on this one (holds up her hands).*
Mrs. Berry: *Students, do you see! Ashley's hand does not look the same as Kate's. Does Ashley still have eight? Tom?*
Tom: *Yes, she has eight. Five and three is eight!*
Andrea: *I also have eight, but I have three on this hand and five on the other hand!*
Mrs. Berry: (takes a pen and writes the different combinations on the white board) *Now, I want you all to look here on the board and see how many different ways you have made eight. Could you think of combinations that you cannot make by dividing the cubes on your two hands?*
Ashley: *Six and two. I don't have six fingers on my hand.*
Kate: *Yeah, and seven and one.*
Mrs. Berry: Very good (writes the combinations on the board). *How about using zero?*
Garreth: *Yeah, Zero the Hero!* (Refers to a song)
Sarah: *Zero and eight. That's eight. Zero is nothing.*
Mrs. Berry: *Good thinking. Now, can you please….*
Ashley mumbles something to Sarah
Mrs. Berry: *Ashley, Do you want to say something?*
Ashley: *I was just telling Sarah that nine, take away one is also eight.*
Mrs. Berry: (Looks surprised) *Yeah,…… that's right. You know what Ashley,…. when you are thinking like that, you are definitely doing first grade work!... Now, could you all please double check that you have eight by touching the connecting cubes to your nose once again?*

The children start touching them to their nose. Suddenly Jessica bursts out:

- I only have seven! I have five and two, but that is seven!

Mrs. Berry: *Yes that is right Jessica. I am very glad that you noticed! Now, we are going to play this game at our tables so I want you all to go to your table and wait on your chair for more instructions, ok?*

All students: *Yes!* (Return to their seats around their tables)

At the table, the children are given more examples by Mrs. Berry together as a whole class, but each child places connecting cubes on his/her fingers. Mrs. Berry continues to ask them how they know that they have the given number and all the students explain, using their own words. After four examples of numbers up to eight, Mrs. Berry encourages the students to work in pairs around the table and try to do different numbers in various ways, using the connecting cubes as a tool. When I look around the classroom, all the students are engrossed in their work. In some pairs there are obvious differences in the understandings between the two children, however, they all seem engaged in the activity. Mrs. Berry walks around in the classroom and observes the students. As she notices children with difficulties, she sits down by the pair and helps them. On the contrary, as she notices pairs that are doing very well, she challenges them and tells them to also use number cards to show the numbers they work with. After about twenty minutes of group activities, Mrs. Berry asks the children to tell their classmates what numbers they show on their hands and how they present it. All children tell about their numbers and how they made it to the rest of the class. Mrs. Berry compliments them for being smart and hard workers before encouraging them to put away the connecting cubes and line up for recess.

The class described above represents the structure of almost all the classes that I observed. They always began with a review, thence a new activity or number was introduced (see

below for how a new number is introduced). Initially, the new activity was carried out in a large group on the carpet, and then the children continued with similar activities by their tables. Mrs. Berry walked around, observed the children's work and helped or further stimulated the children who needed it. The classes always ended with a summary in the entire class.

Mrs. Berry's comments:
Considering the specific class above, I asked Mrs. Berry to reflect on the lesson at the end of the day. She told me that she was amazed that so many children came up with such good suggestions and that Ashley who had talked about eight as nine, take away one, has had some troubles with the understandings in the beginning of the autumn. Hence, she had really enjoyed hearing Ashley's comments. Further, Mrs. Berry stresses that she and the children really enjoy activities like the one with the connecting cubes described above. All the children can engage on their own level and it presents her as a teacher with a great opportunity to see how the students are doing. Mrs. Berry explained to me:

> *Today, I looked closer at two things. First I wanted to estimate their ability to come up with various combinations for the same number. Next, I noticed if they needed to remove all the connecting cubes and start over, or if they had realised that they will need the same eight cubes, but place them differently. Then, as I gave them a new number, I watched to see if they started counting from the number they had and added cubes, or if they had to start all over on one again. Children use different strategies when counting but the children who have started to understand the numbers, they do no longer need to start on one when they count.*

Connections to theories and guidelines:
Considering Mrs. Berry's comments above, it seems to me that she is aware of the existence of different counting strategies, as presented for instance by Griffin (2005). All the children in her class use one of the three counting strategies which according to Griffin demonstrate an awareness of that counting of numbers refers to real-world quantities. Still, some children need the actual objects as they count and cannot be considered to have developed what Griffin called "the mental counting line". In Mrs. Berry's class, Ashley showed that her understanding of numbers is past the level of a five-year-old considering the counting strategies, and on the level of a six-year-old as she used subtraction and

counted backwards to describe the number eight. According to Gray and Tall (1994), it is vital that the children do not only learn the number word, the number symbol and the number of objects when learning about numbers. The students also need to set the number eight in relation to other numbers and see how it could be decomposed or composed by sets of other numbers. In Mrs. Berry's class, the children were, amongst others, working with the number eight. They used their fingers and connecting cubes to compose the number in different ways. Together, the class discussed how the number eight could be represented differently. The students who were able to put the number eight in relation to other numbers had gained what Skemp (1979) called "relational understanding". These students do not only know that eight is a number that represents a certain quantity, but also know that eight is *one bigger then seven* or *one smaller than nine*. Further, the students were able to represent eight in sets of other numbers with the help of connecting cubes which visualise the quantity a number represents for the children and make it easier for them to gain "relational understanding".

In addition, the activity presented above could be considered as a sufficient method to strengthen the student's number sense. The connecting cubes on finger activity gives the children visual, tactile and verbal experience which supply cognitive cues about the process of counting (Nunes and Bryant, 1996). The children in Mrs. Berry's class who had understood the relationship between the numeral word and the number it represented and were doing well on the activity, were given numeral cards to work with as well. Richardson (1999) agreed with Mrs. Berry's action of distributing these numeral cards to the children who comprehended the counting sequence. He argued that these children are ready to learn the symbols that represent the numbers.

These examples of connections to theories about number sense, illustrates that Mrs. Berry is following at least one of the four common sense pillars in the No Child Left Behind Act, (2005); *Doing what works due to scientific research*. Further on, I see the *Kindergarten Focal Points* (NCTM, 2006) in the *Number and Operation* section; *Representing, comparing…joining and separating sets*, in the class described above. Also, there are clear connections to TEKS 2006 §111.12, in the sense that the *students use sets of concrete objects to represent quantities given on a verbal or written form*, *use numbers to describe how many objects that are in a set,… using verbal and symbolic descriptions* and *use basic number sense to compose and decompose numbers in order to solve problems*. I also state

that Mrs. Berry teaches according to TEKS, since the children use *language and communication…formal and informal reasoning…* and *manipulative materials to develop a conceptual understanding*. Considering the district guidelines, the above described goals are all included in the lesson plans made by the district board for the current nine week period, and should be taught and worked with during this time. Still, the lesson is not suggested or required by the district board. When observing Mrs. Berry's personal lesson plans, this activity is included in the schedule for the day.

6.3 Examples of Number Sense activities

In addition to the class presented in the previous section, numerous other number-activities took place during the two weeks I spent in the class. The activities were almost all hands-on and the children in the Kindergarten class had no specific books that they worked in during mathematics.

Introducing a new number

As the children were to learn a new number, Mrs. Berry always had them gathered on the meeting carpet. When she introduced the new number, it was always done by comparing the new number to a number already known by the children. Hence, the first introduction included both zero and one at the same time so that they could compare the two. Mrs. Berry asked questions like: - *Would you rather like your daddy to give you zero or one candy?* When dealing with larger numbers, such as eleven, Mrs. Berry placed ten markers in the shape of ducks on the white board and asked the children how many there would be if she added another one. She explained to them that since this number is greater than ten, it could no longer be represented by only one numeral. One child raised her hand and asked:-*Is it the same as with the calendar? That when there are already ten in the same place we take them and make one ten instead of ten ones by itself?* Mrs. Berry answers:- *Yes, that is right. But there are still ten because that stick in the ten pocket on the calendar is the same as the ten ones. Why do you think that we change these ten ones in the one-pocket into one ten in the ten-pocket*? *… What if we had the number forty three just like on the calendar yesterday? How would it be to count them if they were all in the ones-pocket* ? Another girl who so far had been very quiet during the weeks I had been in the classroom raised her hand said: - *It would take a lot of time. When we do like that,* (referring to collecting the

sticks in piles of tens and ones) *we can count the tens in the calendar first and then just take the ones*. Mrs. Berry looks surprised but compliments her: *Very good thinking Marissa, I'm very glad that you decided to share that with us. This is first class work, so if you find this hard to understand, I can promise you that you will understand this later. Now, let us go back to the ducks on the board. Let's count and make sure that we have eleven. Gary, would you please grab a pointer and come up and help me*? The class count together as Gary points to the ducks, before they begin with more hands on activities dealing with the number eleven.

Calendar

Every day, the children gathered on the carpet to "do the calendar" together. On the white board in the classroom was a homemade calendar with the months of the years, the weekdays, the dates, a weather graph and a section that displayed the number of days the children had been in school so far. Mrs. Berry began by asking a child to come up to the calendar and tell the weekday, date and month to the rest of the class. The child picked a date card and added it to the rest in a row, making a colour pattern. The majority of the children managed this part without difficulty. After a weather song, the children determined the weather outside by looking out the window. One child filled in the weather graph, and the class counted together how many days it had rained, been sunny and so on since the school started. Then Mrs. Berry asked the class how many days they had been in school so far and told them to look on the board to see how many days it had been the day before. They added one day by placing a new number card next to the others, continuing on the long day-snake. They also added one more stick into the schoolday-pockets. There was one pocket for the ones and one for the tens. Every time the one-pocket got ten sticks, it was transferred to one stick in the ten-pocket. The calendar procedure was finished by questions asked by Mrs. Berry about the weekday, the number of days that it had rained, number of months left this year etc. As the children answered, Mrs. Berry always asked them to share their thinking and reasoning with their classmates.

Calendar

Math tubs

Every Monday morning, Mrs. Berry introduced five new math tubs to the children by showing them in the meeting area. The math tubs were five large plastic boxes, each containing materials for one specific activity. Mostly, the activities were individual, although sometimes they required working together within the group. During the week, the children alternated between the stations, spending one day's math tub time (35 minutes) on one specific math tub. During my two weeks in the classroom, I saw one set of math tubs dealing with shapes and one set of math tubs where the children would be working with numbers. The number math tubes were:

Counting boards -the child picked a counting board with a picture that they liked. They were then given an index card to show what number they should work with. Using the same amount of the connecting cubes, unifix cubes, or counters the child would play with the material. For example, one child chose to work with the playground counting board. She picked counters in the shape of bears and pretended that seven little bears were playing on the playground. Continuing, the children used more counting boards, index cards and numeral cards to label their work. This activity was further extended by some children who copied the numerals instead of using the pre-made numeral cards

Creation station -on this station, the child chose a creation card of e.g. a giraffe. They then used the exact amount of connecting cubes to construct the picture, thinking that it should

be standing up. As the child had built its creation, he/she recorded the number of cubes used by labelling a paper and placing it next to their creation.

Cover the dots - the children used Tell-Me-Fast dot cards and various counters. They covered up the dots, counted out loud and then labelled their work with numeral cards.

Role-a-Tower Race -the children had a game board with one row for each number 1-6, a dot cube or die, and connecting cubes. The child rolled the die or cube and placed the same amount of connecting cubes on top of each other as the number shown on the die. The tower was then placed in the column for that specific number. The number-column first filled was the winner. This game was extended by some children who used number dices or numbers greater than six.

Make-a-Train Race -this activity was carried out working in pairs. The children used connecting cubes and die to take turns in rolling the die and adding the same amount of connecting cubes to their train. Whoever has the longest train at the end wins. This game was varied by some children using a number die or by pulling away instead of adding cubes from an already built train.

Math tubs- Counting boards

Other activities

Music -both during music lessons and in the classroom, the children sang songs with rhymes that included counting up to twenty, clapping three at a time etc. The children's personal favourite songs were Zero the Hero and One, two, three, four, five- once I caught a fish alive. The children also liked the number song where each child was given a number in their hand. As they heard their number in the song, they were supposed to stand up. The next time they heard it they were supposed to sit down. Much of the music material was

from Frog Street Press sing and read CD called *Number words,* which came with big books too.

Computer -almost every day, the children went to the computer lab and worked on different computer programmes. Computer games such as *Math Keys, Unlocking whole numbers*, *Kid Pix 3 Deluxe*, *Clifford Learning Activities* etc. were used to stamp numbers and objects to represent them, search for numbers in pictures, listen for numbers, write them and so on. The children also used online games such as those at www.coolmath4kids.com.

Fiction books -in the classroom, Mrs. Berry had numerous of colourful books in different sizes that all contained exciting stories about numbers, patterns and shapes. These books were often read out aloud, but just as often the children chose a lovely pointer from the pointer stand and read the book him/herself. The children also read flip-over books where they flipped half of the page over and the number seven turned into seven keys etc.

Other counting games and activities -during the classes, Mrs. Berry used a lot of activities from the books *Hands on math*, *Developing number concept*s and *Mathematical discoveries for young children.* They were all activities that required working with your hands, touching and moving objects or using other senses to explore. The examples presented below, were activities that took place more than once during the observed mathematics classes, although some were varied and used for the learning of shapes too. Examples of activities were:

- Making number crayons out of old melted crayons on a cookie sheet.
- Grabbing cubes from a bag and guessing the amount, working in pairs.
- Collecting a certain given amount of objects at home and having show and tell to the class.
- Number search in the school building. The class walks together and the children raise their hands as they notice a number. Mrs. Berry let the children tell their classmates about what they see.
- My big book of numbers. The children made a book with the numbers 1-9. It is a flip-open book with drawn objects on the back to represent each number.
- Slide and count game. The children had a pile of connecting cubes in front of them. They then used the connecting cubes and slid to the side while counting to a certain number. In the beginning they begun counting at one but then they moved on to

begin at another number such as three, five etc. Some children used numeral cards to represent their work.

- Reviewing numbers in the whole class on the white board. The children chose a pointer, a number and an amount of magnet counters to place next to it. The class then counted together as the pointer touched the magnets.

Pointers used when reading or counting

Grab and count counters from a bag

Mrs. Berry's comments

As I talked to Mrs. Berry and asked her to give a definition of number sense, I got the following answer:

> *I think number sense in Kindergarten means the ability for the students to recognise numerals when they see them, identify their values and know how to use the numerals for counting, measuring, problem solving and representation. I think that number sense develops gradually and varies from student to student.*

She argues that she wants to use activities like the calendar for mathematical activities since it is something that she feels is relevant for the children to learn and at the same time it is a good way to learn more about numbers. She stresses that she tries to vary the activities but still to use the same concepts and rules so that these will be familiar to the students as they are about to try a new activity. Almost all activities are hands-on activities which Mrs. Berry explains that she feels as the only relevant way to teach Kindergarten since the children need to explore with their hands and use their senses to develop a deeper

understanding. She emphasises the importance of the hands-on activities for the children in her class since a majority has another language than English at home. Further, Mrs. Berry stresses that when the students work with hands-on materials they get the experience, but the activities should also include communication and reasoning to help develop their English and the ability to express themselves in mathematical terms.

Connections to theories and guidelines

In addition to the earlier presented connections to guidelines and theories in section 6.3, the activities and Mrs. Berry's reasoning given in this section also have clear connections to teaching frames and research within the field of number sense. First of all, Mrs. Berry's own definition of number sense contains many resemblances with the ones presented by Anghileri (2000) and Mcintosh (1992). Both Anghileri and Mcintosh referred to number sense as having an awareness and understanding that enables the person to work flexibly with numbers to solve problems. Similarly, Mrs. Berry referred to number sense in Kindergarten as the ability to understand and use numbers to solve mathematical problems. In my opinion, Mrs. Berry has understood the concept of number sense, taken it one step further and adapted the definition to the Kindergarten class she teaches. Ljungblad (2001), indicated that the focal point when teaching mathematics in the early years should be to support the children in developing an understanding for quantity and a strong number sense. Anghileri (2000) debated that number sense is an essential outcome of the *Principles and Standards for School Mathematics*, but that this number sense does not only refer to develop a comprehension of numbers. Rather, it emphasises the importance of nurturing confidence to work with numbers among the students. This, I could clearly see in Mrs. Berry's classroom. All the students were involved in the activities and Mrs. Berry complimented the students when they managed to solve a problem. In addition, many of the activities were constructed in a way that the students themselves noticed if they were on the right track or not, and gained confidence as they progressed with their task.

Considering the number sense tasks, most of them were hands-on activities. According to Dacey and Eston (1999), young children learn mathematics best from the physical exploration of objects. As the students move and organise the objects, they are able to create new mathematical ideas. Mrs. Berry stressed the same thing as Dacey and Eston (1999) and talked about teaching numbers using manipulative tools and hands-on material

as the only means to teach Kindergarten mathematics. The *slide and count* activity was one of the activities where manipulative material, in terms of connecting cubes, was used. This activity is supported by Anghileri (2000), where she entailed that children who are confident with beginning at one when counting should be encouraged to begin at another number.

Bearing in mind number activities, a lot of time was spent on the math-tubs. Mrs. Berry introduced the activities to the class on the carpet. Later, the children worked individually with these activities to explore them further. According to Abrohoms (1992), materials that have been introduced during large group activities should be placed in Activity Centers so that the students can develop a deeper understanding as they explore it further on their own.

Apart from the math-tubs, the calendar was a daily event. In accordance with Dacey and Eston (1999), the calendar represented, in Mrs. Berry's eyes, a way to connect to the children's reality and explore the world of numbers at the same time. The calendar activity is also connected to TEKS in other parts than the ones earlier discussed in section 6.3, in the sense of the weather graph. The TEKS (2006) states that the students should *collect, organize, and display data and use information from graphs to answer questions, make summary statements, and make informal predictions based on their experiences*. Another daily activity was the singing and rhyming activities. Anghileri (1997) implied that this counting in sequences and using rhymes can help young children to *reinforce the universal nature of counting.*

The other activities presented were also activities that engaged the children in the work. To melt down crayons and make new ones in the shape of numbers, use the computers to investigate numbers and the relationships between them, playing counting games together, making their own books and going on a number-hunt in the school building, was seen as exciting and fun by the children. The context was always numbers in different ways, and not numbers greater than that the students knew them and could relate to them. Boaler (1993) argued that the context also should include the real world and the local community. Mrs. Berry explained that she always tries to connect to the children's every day lives. Even though Mrs. Berry is aware of that it is preferable to connect to the world outside of school,

I merely witnessed three activities with connections to every day lives during the visit in the classroom.

To sum up, from the activities that in general took place in Mrs. Berry's classroom and the connections made to the six principles developed by the National Research Council which are represented in Griffin (2005), I would claim that the six principals could more or less be seen in all activities. Numbers were represented and talked about in various ways and there were connections between the numeral, the number and the amount it represented. The activities were mostly hands-on and the children were engaged in the activities, and communicated and reasoned as they learned. Moreover, plenty of opportunities were given for the children to acquire computational fluency and develop a conceptual understanding.

There are clear connections to the Kindergarten Focal Point (NCTM, 2006) about *number and operations* as well as to the goals that are to be reached at the end of second grade, which are presented in the *Principles and Standards for School Mathematics* (NCTM, 2006). The connections to the TEKS are also very visible as the children communicated, reasoned and explored the relationships of numbers using hands-on materials. The district guidelines for the nine week period were always supported by Mrs. Berry's lesson notes. The content in the lesson plans were also followed, although some activities took more time and were extended to the class the following day.

However, I did not notice sufficient activities that were connected to the student's real world outside of school, in order to be able to claim that this part of TEKS was fulfilled. This part could be considered especially important since a majority of the children had another background than the "typical American". I do see a risk that the children, even though they seemed to enjoy the mathematics classes, do not see a connection between school mathematics and their every day life.

7 Discussion

7.1 Summary and conclusions of the result

The purpose of my study was to investigate how number sense is taught in a Kindergarten class in Texas and if the content and way of teaching has connections to theories and guidelines within the area. In this section, I intend to attempt to answer the two questions posed in section two using knowledge from my experience and what has been discussed in the *Observation and analysis* section presented above.

- *How is number sense taught, considering the mathematical content and teaching methods, in a Kindergarten class in Texas?*

In Mrs. Berry's class, number sense is taught and worked with together as a class, in smaller groups and individually. This provides Mrs. Berry with the opportunity to observe the children and account for their knowledge in different situations. The mathematical contents that I observed for this investigation was mostly taught through activities that were in hands-on fashion. The children used their different senses (sight, touch and hearing) to explore the world of numbers. For instance when crayons were melted and shaped into numerals or when they were to listen for a number, slide and count connecting cubes. During the math classes, the children used informal and formal mathematical language to explain their thinking. Mrs. Berry encouraged all the children to express their thoughts and voice their reasoning at whole class activities to help their classmates understand. All the hands-on activities and the communication and reasoning gave the children the visual, verbal and tactile experiences needed to develop a strong number sense.

- *How is this content and activity connected to the guidelines and mathematics education theories?*

As earlier stated, Mrs. Berry's teaching is closely connected to one of the common sense pillars in the *No Child Left Behind Act*: *-Doing what works due to scientific research*. Mrs. Berry's education is consistent with the mathematics education theories presented above.

She teaches in a way that inspires the children, evoking their curiosity as well as stimulating and encouraging them to express themselves, according to research in the field of mathematics education. The other three common sense pillars in the act are not possible for me to observe since they deal with more organisational issues that would be the same for the entire school district. Looking closer at the *Principles and Standards for School Mathematics* (NCTM, 2005), and the goals that should be reached by the second grade considering numbers and operations, Mrs. Berry teaches by a method that in accordance with the mathematics education theories will help the students to attain these goals. The *Kindergarten Focal Point*; *developing whole-number concepts and using patterns and sorting to explore number data and shape* permeates all the activities taking place in Mrs. Berry's classroom. Every activity has connections to the guidelines. This could be due to the fact that they are recommended by district board which has interpreted TEKS and made lesson plans for the teachers to follow. However, I see one part of TEKS that is not truly present in the lessons and activities observed. Only three or four times during the two weeks, Mrs. Berry connects to the children's real world outside of the classroom. This should be done frequently according to the theories and guidelines presented earlier and could perhaps be seen as especially important when a majority of the class has its roots in another culture.

7.2 Validity and dependability of the result

My investigation is based on observations in one Kindergarten class. This method was used in accordance with theories earlier presented and gave me a result which could answer my questions. Hence, the conception validity of my investigation could be considered good. Taking into consideration the result validity, I claim that I examined what I intended to. The part that could be questioned is the dependability of my investigation. The observation is only made in one kindergarten class. Hence, no general conclusions for all the classes in the school district, the state of Texas or United States could be obtained from the result. To acquire a result that reflects the education in a greater area, the observation would need to be completed in a representative amount of classes by a significant number of observers and span a greater period of time. Still, the intentions were never to undertake such an extensive research but to focus on the teaching of number sense within one class.

As I observed in the classroom, I used a notebook, pen and camera to record my results. The notes, accompanied by photographs, have given me a good view of the activities that took place in the classroom. Still, I cannot disregard that there would have been more interesting dialogues documented if I also had a tape recorder. However, I did not wish the children to feel observed and afraid of making comments due to the presence of a tape recorder. In addition, most of the activities took place in smaller groups which could make it hard to record the dialogues on a tape.

During my observation, I bared in mind that I had once been impressed by the hands-on activities in other schools. Since I did not wish my own values to be reflected in the observation, I decided to try and consider the negative parts of this manner of teaching. However, no matter how hard I tried, the only thing I found to criticise was the connection to the student's real world.

In conclusion, I believe the teaching methods and activities I observed in the kindergarten classroom in Texas to be authentic and they had not been manipulated in order to satisfy the aim of my observation. The children in the class were obviously familiar with the structure of the classes, the communicating, reasoning and working with hands-on materials, which further supports this claim.

7.3 Suggestions of further research

In my opinion, the result of my investigation shows that there are plenty of mathematical activities that support the children's number sense, which occurred in the kindergarten class visited. Further, my observation suggests that the activities often were of hands-on fashion and that the children used different senses to discover the relationships between numbers.

I cannot help to wonder about the obvious differences between the education I have noticed among the six-year-olds in the Swedish kindergarten classes and the five-year-olds in the class in Texas. The amount of time spent on mathematics, the activities and the children's ability to express themselves mathematically were significantly more and better in the class visited in Texas. However, if I were to assume that the teaching observed in the class in

Texas represents the teaching in the entire United States, comparative studies between countries, such as TIMSS (2003), do not reflect that students in the later school years in United States score superior on mathematics tests to Swedish students. Rather, the students in the two countries have received similar points on the tests. Hence, I do speculate where the student's mathematical development is halted. One thought of mine, which would be interesting to investigate further, is that the problem occurs when there are no longer as many hands-on activities during the mathematics classes.

In addition, I would like a greater comparative study between the school system and views on teaching in Texas (or another district or state where similar activities take place) and Sweden. Supplementary, personally, I would very much enjoy trying to teach Kindergarten mathematics in a Swedish class more like the way it is taught in the observed class in Texas to explore possible differences in the children's understandings in later school years.

8 References

Abrohoms, A. (1992). *Mathematical discoveries for young children- using manipulatives*. China: Learning Resources Inc.

Ahlberg, A. (1995). *Barn och matematik*. Lund: Studentlitteratur

Anghileri, J. (1997). Uses of counting in multiplication and division. In I. Thompson (ed.), *Teaching and learning early number*. Buckingham: Open University Press

Anghileri, J. (2000). *Teaching number sense*. London: Continumm

Boaler, J. (1993). The role of context in mathematics classrooms. *For the learning of mathematics,* 13(2), 12-17

Dacey, L. and Eston, R. (1999). *Growing mathematical ideas in Kindergarten*. Susalito: Math Solutions Publications

Donovan, S. and Bransford, J. (2005). Introduction. In National Research Council (ed.), *How students learn mathematics in the classroom* (pp.1-24). Washington D.C.: The National Academies Press

Esiasson, P. et. al. (2004). *Metodpraktikan*. Stockholm: Norstedts Juridik AB

Fey, J. (1990). Quantity. In L-A. Steen (ed.), *On the shoulders of giants- New approaches to numeracy* (pp.61-94). Washington D.C.: The National Academies Press

Gray, E. and Tall, D. (1994). Duality, ambiguity and flexibility: a proceptual view of simple arithmetic. *Journal for Research in Mathematics Education*, 25, 116-140

Griffin, S. (2005). Fostering the Development of Whole-Number Sense: Teaching Mathematics in the Primary Grades, In National Research Council (ed.), *How students learn mathematics in the classroom* (pp.257-308). Washington D.C.: The National Academies Press

Gunnarsson, R. (2002) *Validitet och reabilitet*, Instutitionen för Medicin vid Göteborgs universitetet; Downloaded 2006-12-20 from www.infovocie.se/fou

Johansson, B. and Svedner, P-O. (2001). *Examensarbetet i lärarutbildningen*, Uppsala: Kunskapsföretaget

Ljungblad, A-L. (2001). *Matematisk medvetenhet*, Klippan: Argument Förlag

Mcintosh, A. et. al. (1992). A proposed framework for examining number sense. *For the learning of Mathematics*, 12(3), 3

Mertens, D. (2005). *Research and evaluation in education and psychology*, Thousand Oaks: SAGE Publications

National Council of Teachers of Mathematics (NCTM). (2000-2004). *Principals and standards for school mathematics*. Downloaded 2006-11-16 from http://standards.nctm.org/document/appendix/numb.htm

National Council of Teachers of Mathematics (NCTM). (2006). *Curriculum focal points for prekindergarten through grade 8 Mathematics; A quest for coherence*. Downloaded 2006-11-16 from http://www.nctm.org/focalpoints/bygrade_K.asp

Nunes, T. and Bryant, P. (1997). *Learning and teaching mathematics* : an international perspective. Hove, East Sussex: Psychology Press

Richardson, K. (1999). *Developing number concepts- Counting, comparing and pattern*. United States: Dale Seymour Publications

Skemp, R. (1976). Relational and Instrumental Understanding. Mathematics Teaching, *Bulletin of the Association of the Teachers of Mathematics*, 77, 20-26

Skolverket. (2000). *Syllabus for mathematics in compulsory school*. Downloaded 2006-12-11 from www.skolverket.se (kursplaner och betygkriterier, engelska översättningar).

Skolverket.(2003).*TIMSS 2003 - Trends in International Mathematics and Science Study*. Downloaded 2006-12-17 from www.skolverket.se/sb/d/252/a/365

Steen, L-A. (1990). Mathematical Science Education Board and National Research Council. *On the shoulders of giants- New approaches to numeracy*. Downloaded 2006-12-15 from www.nap.edu/openbook/0309042348/html/R1.html

Texas State Division of Policy Coordination. (2006).*Texas essential knowledge and skills* Downloaded 2006-11-16 from www.tea.state.tx.us/rules/tac/chapter111/ch111a.html

U.S. Department for teachers. (2004). *No child left behind act, A toolkit for teachers.* Downloaded 2006-11-16 from www.ed.gov/teachers/nclbguide/nclb-teachers-toolkit.pdf

Appendix 1 – Principles and Standards for School Mathematics, NCTM

Understand numbers, ways of representing numbers, relationships among numbers, and number systems

Pre-K–2 Expectations:

In prekindergarten through grade 2 all students should–

- count with understanding and recognize "how many" in sets of objects;
- use multiple models to develop initial understandings of place value and the base-ten number system;
- develop understanding of the relative position and magnitude of whole numbers and of ordinal and cardinal numbers and their connections;
- develop a sense of whole numbers and represent and use them in flexible ways, including relating, composing, and decomposing numbers;
- connect number words and numerals to the quantities they represent, using various physical models and representations;
- understand and represent commonly used fractions, such as 1/4, 1/3, and 1/2.

Understand meanings of operations and how they relate to one another

Pre-K–2 Expectations:

In prekindergarten through grade 2 all students should–

- understand various meanings of addition and subtraction of whole numbers and the relationship between the two operations;
- understand the effects of adding and subtracting whole numbers;
- understand situations that entail multiplication and division, such as equal groupings of objects and sharing equally

Compute fluently and make reasonable estimates

Pre-K–2 Expectations:

In prekindergarten through grade 2 all students should–

- develop and use strategies for whole-number computations, with a focus on addition and subtraction;
- develop fluency with basic number combinations for addition and subtraction;
- use a variety of methods and tools to compute, including objects, mental computation, estimation, paper and pencil, and calculators

Chapter 111. Texas Essential Knowledge and Skills for Mathematics
Subchapter A. Elementary

Statutory Authority: The provisions of this Subchapter A issued under the Texas Education Code, §28.002, unless otherwise noted.

---

§111.11. Implementation of Texas Essential Knowledge and Skills for Mathematics, Grades K-5.

The provisions of this subchapter shall be implemented by school districts beginning with the 2006-2007 school year.

Source: The provisions of this §111.11 adopted to be effective September 1, 1998, 22 TexReg 7623; amended to be effective August 1, 2006, 30 TexReg 7471.

---

§111.12. Mathematics, Kindergarten.

(a) Introduction.

(1) Within a well-balanced mathematics curriculum, the primary focal points at Kindergarten are developing whole-number concepts and using patterns and sorting to explore number, data, and shape.

(2) Throughout mathematics in Kindergarten-Grade 2, students build a foundation of basic understandings in number, operation, and quantitative reasoning; patterns, relationships, and algebraic thinking; geometry and spatial reasoning; measurement; and probability and statistics. Students use numbers in ordering, labeling, and expressing quantities and relationships to solve problems and translate informal language into mathematical language and symbols. Students use objects to create and identify patterns and use those patterns to express relationships, make predictions, and solve problems as they build an understanding of number, operation, shape, and space. Students progress from informal to formal language to describe two- and three-dimensional geometric figures and likenesses in the physical world. Students begin to develop measurement concepts as they identify and compare attributes of objects and situations. Students collect, organize, and display data and use information from graphs to answer questions, make summary statements, and make informal predictions based on their experiences.

(3) Throughout mathematics in Kindergarten-Grade 2, students develop numerical fluency with conceptual understanding and computational accuracy. Students in Kindergarten-Grade 2 use basic number sense to compose and decompose numbers in order to solve problems requiring precision, estimation, and reasonableness. By the end of Grade 2, students know basic addition and subtraction facts and are using them to work flexibly, efficiently, and accurately with numbers during addition and subtraction computation.

(4) Problem solving, language and communication, connections within and outside mathematics, and formal and informal reasoning underlie all content areas in mathematics. Throughout mathematics in Kindergarten-Grade 2, students use these processes together with technology and other mathematical tools such as manipulative materials to develop conceptual understanding and solve meaningful problems as they do mathematics.

(b) Knowledge and skills.

(K.1) **Number, operation, and quantitative reasoning.** The student uses numbers to name quantities.

The student is expected to:

(A) use one-to-one correspondence and language such as more than, same number as, or two less than to describe relative sizes of sets of concrete objects;

(B) use sets of concrete objects to represent quantities given in verbal or written form (through 20); and

(C) use numbers to describe how many objects are in a set (through 20) using verbal and symbolic descriptions.

(K.2) **Number, operation, and quantitative reasoning.** The student describes order of events or objects.

The student is expected to:

(A) use language such as before or after to describe relative position in a sequence of events or objects; and

(B) name the ordinal positions in a sequence such as first, second, third, etc.

(K.3) **Number, operation, and quantitative reasoning.** The student recognizes that there are quantities less than a whole.

The student is expected to:

(A) share a whole by separating it into two equal parts; and

(B) explain why a given part is half of the whole.

(K.4) **Number, operation, and quantitative reasoning.** The student models addition (joining) and subtraction (separating).

The student is expected to model and create addition and subtraction problems in real situations with concrete objects.

(K.5) **Patterns, relationships, and algebraic thinking.** The student identifies, extends, and creates patterns.

The student is expected to identify, extend, and create patterns of sounds, physical movement, and concrete objects.

(K.6) **Patterns, relationships, and algebraic thinking.** The student uses patterns to make predictions.

The student is expected to:

(A) use patterns to predict what comes next, including cause-and-effect relationships; and

(B) count by ones to 100.

(K.7) **Geometry and spatial reasoning.** The student describes the relative positions of objects.

The student is expected to:

(A) describe one object in relation to another using informal language such as over, under, above, and below; and

(B) place an object in a specified position.

(K.8) **Geometry and spatial reasoning.** The student uses attributes to determine how objects are alike and different.

The student is expected to:

(A) describe and identify an object by its attributes using informal language;

(B) compare two objects based on their attributes; and

(C) sort a variety of objects including two- and three-dimensional geometric figures according to their attributes and describe how the objects are sorted.

(K.9) **Geometry and spatial reasoning.** The student recognizes attributes of two- and three-dimensional geometric figures.

The student is expected to:

(A) describe and compare the attributes of real-life objects such as balls, boxes, cans, and cones or models of three-dimensional geometric figures;

(B) recognize shapes in real-life three-dimensional geometric figures or models of three-dimensional geometric figures; and

(C) describe, identify, and compare circles, triangles, rectangles, and squares (a special type of rectangle).

(K.10) **Measurement.** The student directly compares the attributes of length, area, weight/mass, capacity, and/or relative temperature. The student uses comparative language to solve problems and answer questions.

The student is expected to:

(A) compare and order two or three concrete objects according to length (longer/shorter than, or the same);

(B) compare the areas of two flat surfaces of two-dimensional figures (covers more, covers less, or covers the same);

(C) compare two containers according to capacity (holds more, holds less, or holds the same);

(D) compare two objects according to weight/mass (heavier than, lighter than or equal to); and

(E) compare situations or objects according to relative temperature (hotter/colder than, or the same as).

(K.11) **Measurement.** The student uses time to describe, compare, and order events and situations.

The student is expected to:

(A) compare events according to duration such as more time than or less time than;

(B) sequence events (up to three); and

(C) read a calendar using days, weeks, and months.

(K.12) **Probability and statistics.** The student constructs and uses graphs of real objects or pictures to answer questions.

The student is expected to:

(A) construct graphs using real objects or pictures in order to answer questions; and

(B) use information from a graph of real objects or pictures in order to answer questions.

(K.13) **Underlying processes and mathematical tools.** The student applies Kindergarten mathematics to solve problems connected to everyday experiences and activities in and outside of school.

The student is expected to:

(A) identify mathematics in everyday situations;

(B) solve problems with guidance that incorporates the processes of understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness;

(C) select or develop an appropriate problem-solving strategy including drawing a picture, looking for a pattern, systematic guessing and checking, or acting it out in order to solve a problem; and

(D) use tools such as real objects, manipulatives, and technology to solve problems.

(K.14) **Underlying processes and mathematical tools.** The student communicates about Kindergarten mathematics using informal language.

The student is expected to:

(A) communicate mathematical ideas using objects, words, pictures, numbers, and technology; and

(B) relate everyday language to mathematical language and symbols.

(K.15) **Underlying processes and mathematical tools.** The student uses logical reasoning.

The student is expected to justify his or her thinking using objects, words, pictures, numbers, and technology.

Source: The provisions of this §111.12 adopted to be effective September 1, 1998, 22 TexReg 7623; amended to be effective August 1, 2006, 30 TexReg 7471.

Appendix 3- District lesson plans

Lesson 1

Author: Anonymous

Learning Standards:
TEKS K.1A, K.1B, K.1C **Use** Numbers to Name Quantities to 10

use one-to-one correspondence and language such as more than, same number as, or two less than to describe relative sizes of sets of concrete objects.[K.1.A]

use sets of concrete objects to represent quantities given in verbal or written form (through 20).[K.1.B]

use numbers to describe how many objects are in a set (through 20) using verbal and symbolic descriptions.[K.1.C]

use tools such as real objects,manipulatives, and technology to solve problems.[K.13.D]

communicate mathematical ideas using objects, words, pictures, numbers, and technology.[K.14.A]

relate everyday language to mathematical language and symbols.[K.14.B]

justify his or her thinking using objects, words, pictures, numbers, and technology.[K.15.A]

Part 1: Give students 6-10 blue counters and 6-10 red counters. Have them line the blue counters up. For every blue counter the see, have them match a red counter on top of it. Now give them a blank ten frame and ten red counters. Call a number from 1-10 and have them count by sliding the each counter on to the ten frame.

Ten frame activities.

Part 2: Make sets of subitizing cards with numbers 0-10 displayed (paper dessert plates and dot stickers are nice for making these cards). At first have students identify the number and model that number with counters on their own card (or paper plate). Have them use one to one correspondence to check that the sets have the same number of objects. **(This activity can be repeated using a ten frame. Emphasize visual benchmarks as students fill in the TEN frame, such as 5 and two more is 7 or seven is three away from 10)**
subitizing cards:

Part 3: Use subitizing cards to show a set of numbers. Have students identify the number. Ask students to show one less or one more on their card. Question students on how they know they have the correct amount. Have students record the model the teacher showed on one side of the paper and their model of one less or one more on the other side of the paper.
(This activity can be repeated using a ten frame) Now show student a "benchmark" of 10 counters and have them make a set of more than five counters and a set with less than 10 counters. Have them justify their solutions. Have them record their solutions by making a representation on paper. On one side of the paper they show their set of "Less than 10" and on the other side show their set of " More than 10".

Part 4: Show a row of three green counters and a row of five yellow counters. Count the counters and switch the order of the counters. Ask, "Are there still the same number of counters?" Count again. Have students record different arrangements of the green and yellow counters on their paper. Have them count to confirm there are still 8. Have them write 8 by each set.

Part 5: Use two-color counters and have student count out 6-10. Have them line up the counters with all the same color and record the model on their paper. Now ask them to flip one counter over. Ask students to verbalize what the see. Ask students to record the model on their paper and count to confirm there is still the same number of counters. Continue to flip counters and record. Periodically ask students to verbalize their pictures i.e. "This is two yellow and four red but there is still six counters".

Part 6: Show students a numeral card. Ask the students to use counters to show the quantity represented on the card.

Part 7: Count backwards from ten. Make a number line on the floor with masking tape and have students walk forward and backward on the line while saying the numbers.

Part 8: Give each student a set of counters and have them line the counters up left to right. Tell students to count four counters and push them under their left hand. Point and ask, "How many are there?" (four) so let's count like this: f-o-u-r (pointing to their hand), five, six, seven,....Repeat with different numbers under the hand.

Vocabulary: number, more than, **same** number as, set, one, two, three, four, five, **six, seven, eight, nine, ten**, zero, numeral, one-to-one correspondence

Internet Resources:

This site will take you the Math Thier Way Newsletter Chapter10 on Number concepts. Starting on page 15 and going to 21 are more ideas for developing number concepts. Pages 25 and 26 have description of number "stations"

This is the Math Their Way Newsletter site where you down load any black-line masters you need.

Materials:
Counters (spray painted beans, cubes, color chips, two color counters, etc.)
Subitizing cards

Lesson 2

Author: Anonymous

Learning Standards:
TEKS K.1A, K.1B, K.1C Use Numbers to Name Quantities to 10
use one-to-one correspondence and language such as more than, same number as, or two less than to describe relative sizes of sets of concrete objects.[K.1.A]
use sets of concrete objects to represent quantities given in verbal or written form (through 20).[K.1.B]
use numbers to describe how many objects are in a set (through 20) using verbal and symbolic descriptions.[K.1.C]
use tools such as real objects,manipulatives, and technology to solve problems.[K.13.D]
communicate mathematical ideas using objects, words, pictures, numbers, and technology.[K.14.A]
relate everyday language to mathematical language and symbols.[K.14.B]
justify his or her thinking using objects, words, pictures, numbers, and technology.[K.15.A]

Investigations: Collecting, Counting, and Measuring, Investigation 1: Counting Books p.3-5
Discuss counting, read a book, students observe how book is made in preparation of making their own counting books.
Part 1: Counting Book (focus time)

Part 2: Grab and Count p.12-13

Part 3: Counting Jar p.14

Vocabulary: number, more than, **same** number as, set, one, two, three, four, five, **six, seven, eight, nine, ten**, zero, numeral, one-to-one correspondence

Materials:
Anno's Counting Book or another counting book suggested in text
paper
stickers
crayons
pencils
Investigations Book: Collecting, Counting, and Measuring p. 3-5

Literature and Internet Resources

Author: Anonymous

Learning Standards:
TEKS K.1A, K.1B, K.1C Use Numbers to Name Quantities to 10

Literature Connections:
These are suggestions and purely optional based on availability. There are many counting books that go to ten. Look for books that count down from 10 as well.
Anno's Counting Book or another counting book suggested in text
One...Two...Three...Sassafras! By Stuart Murphy
Ten Little Indians (song-counting backwards)
Always Room for One More by Nonny Horigan
"Eight Balloons" from *A Light in the Attic* by Shel Silverstein,
Ten Black Dots

Internet Resources:
Interactive Ten Frame.

National Library of Virtual Manipulatives – Fraction Bars – this tool can be used to model unifix cube trains to compare and order trains of unifix cubes.

Vocabulary, Tubbing and Additional Resources

Author: Anonymous

Learning Standards:
TEKS K.1A, K.1B, K.1C Use Numbers to Name Quantities to 10

Key Vocabulary:
Six
Seven
Eight
Nine
Ten
Same

Additional Resources:
SFAW chapters 4, 5 and 6

Tubbing Ideas:
Slowly Change the tubs to include numbers to 10.
1. Given Numeral Card, Students Make Sets
Match numerals with sets. Given dot or numeral cards, students make sets using buttons, cubes, or pasta (0-10 only) to show the quantity represented. As a follow up, students continue practicing skill with a work page and markers, stickers, stamps.
Materials:
dot cards (0-10),
numeral cards (0-10)

2. Numeral Cards to Describe Set
Match numerals with sets. Given a set of objects, students select a numeral card to describe how many objects are in the set (1-10 only). Practice skill using work page in which students write the number to go with a given set.
Observe children making sets.
Materials:
sets of objects,
numeral cards

3. **TEXTEAMS "Cookie Frame"**
Students use 10 frame cookie sheet to place magnets and count. See detailed activity notes in Math Resource Notebook pgs. 1-K.1A-C. Instruct the students to place a specific number of magnets on the frame by selecting dot or numeral card. Ask the students how they knew how many magnets to place on the frame without counting them one at a time. Discuss their strategies. Students make records on blank paper ten-frames using stickers or drawing the magnets. Students write the numeral they made under the ten frame. Use student made ten frames in whole class number activities. (part 2 and 3 of the recommended lesson)
Materials:
dot cards (0-10),
numeral cards (0-10)
cookie sheet
stickers
Blank ten-frames

4. http://www.center.edu/pd/docs/chapter10.pdf
This site will take you the Math Thier Way Newsletter Chapter10 on Number concepts. Starting on page 15 and going to 21 are more ideas for developing number concepts. Pages 25 and 26 have description of number "stations"
http://www.center.edu/NEWSLETTER/newsletter.shtml
This is the Math Their Way Newsletter site where you down load any black-line masters you need.

5. Students make *circle maps* with ways to show 6-10. Students can look in magazines for pictures that represent the number as well as the visual representations. The "six" map may have pictures of six objects, subitizing representations, the word six, ten frame with six filled in, six tally marks…Combine ideas for each map to make a class map for each number.