Sudan University of Science and Technology

College of Graduate Studies

College of Computer Science and Information Technology

Learning Computer Science basics by 1st grade Pupils Using the Unplugged Technique

تعليم تلاميذ الصف الأول أساس مبادئ علوم الحاسوب بدون إستخدام الحاسوب

A Thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Information Technology

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بسم الله الرحمن الرحيم

((رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحاً تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ))

صدق الله العظيم

سورة النمل : 19

Dedication

To my best friends ... my father and my mother.

To my lovely sisters and my only brother.

To my wife, Ayman and Rahaf.

To the soul of Abd Alwahid ,who left so early.

To all my teachers, specially Ustaz Hamad Hasab Alrasoul, whose precious guidance still affects my life.

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I'm also thankful to all my colleagues during all my life, especially the Msc colleagues, who were kind, lovely and funny.

Abstract

Computer Science Unplugged is a set of activities used to show the children the kind of thinking that is expected by computer scientists in a funny and engaging way to help introduce computer science basics as early as possible. The counting in binary numbers and the picture representation activities were introduced to two elementary school 1st grade pupils in Khartoum North Locality (Boys only /Girls only).The assessment results showed that 99% passed the counting in binary assessment and 97% passed the picture representation assessment which were promising and showed that the 1st grade pupils easily understood the computer science concepts those were transferred through the activities. It was observed that the children found the activities funny specially the binary numbers. A teaching tool was developed to reduce time while introducing the picture Representation activity. It is strongly recommend considering including these activities as part of 1^{st} grade computer science curriculum in Sudan when one is prepared.

المستخلص

"تعليم علوم الحاسوب بدون إستخدام الحاسوب" عبارة عن مجموعة أنشطة تستخدم لإيضاح طريقة التفكير المتوقعة من علماء الحاسوب بصورة ممتعة, مما يساعد على تعليم الأطفال مبادئ علوم الحاسوب في سن مبكرة . تم تطبيق نشاطي العد الثنائي و تمثيل الصور بالحاسوب بواسطة تلاميذ الصف الأول أساس بمدرستي أساس بمحلية الخرطوم بحري (أولاد/بنات).

أظهرت نتائج التقييم أن 99% من التلاميذ نجحوا في تقييم نشاط العد الثنائي و 97% من التلاميذ نجحوا في تقييم نشاط تمثيل الصور مما يعني أن أطفال الصف الأول أساس تمكنوا من إستيعاب مبادئ علوم الحاسوب المقدمة من خلال النشاطين مما يشجع على دمج هذه الأنشطه كجزء من مقرر علوم الحاسوب لأطفال الصف الأول أساس حينما يتم إعداده, وقد لوحظ سعادة الأطفال خلال الأنشطة و بالأخص نشاط العد الثنائي, كما تم تطوير وسيلة تعليمية لإختصار الوقت عند تطبيق تمرين تمثيل الصور بالحاسوب.

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CHAPTER ONE

Introduction

1.1 Introduction

No doubt computer applications are becoming more popular and widely used around the world. Checking the email, browsing news websites and following friends on different social media platforms has become a part of every one's early day activities. Our cars are 'learning' to drive themselves safely alone and we can control most of our home appliances using mobile applications when we are miles away from home.
Is not this enough to prove that computer science is really important to our lives!!

'Literacy' in the 21st century needs to be redefined, argued computer scientists while talking about 'Procedural Literacy', "the need to know about the science that lies behind the smart devices we use, and get ahead in our lives, means that we have to be literate" (Peraya,2011).

There is a need to add Computational thinking to the list of the basic knowledge transferred to our children; starting with, for example, making counting in binary like learning the alphabet and counting in decimal. Making computer science principles part of the elementary school's curriculum will definitely add value to our children. Learning algorithms and problem solving techniques for example will be a great adding to the way they think even if they are not interested in majoring in computer science in the future (Bell et al,2009).

The computer science unplugged project is established at Canterbury University, it consists of a set of activities, games, magic tricks and competitions to show children the kind of thinking that is expected of a computer scientist. It focuses on demonstrating Computer Science concepts rather than programming as programming can be an obstacle that guards some pupils from ever finding out what the deeper concepts are. The activities are kinaethetic, generally on a large scale, involving team work and funny. The materials used during activities are low cost (Bell et al,2009).

This study benefits of the ease of the binary numbers activity and the representation of pictures as pixels activity (Bell et al,2015) and capitalizes on the unplugged nature because most primary schools do not have computer laboratories.

The basic concepts in binary numbers and picture representation were introduced to a total of 83 1st grade pupils of two elementary schools(Boys only/Girls only), which are suitable for their age, and their ability to understand these concepts was measured.

1.2 Problem Statement

In Sudan the computer science is introduced to pupils at high school, but there's a need to Introduce Computer Science as early as possible to the pupils. While conducting this study, it was difficult to explain the picture representation activity as most of Sudanese primary schools use traditional blackboards, so a teaching tool was needed to help introducing the activity.

1.3 Aim of the study

This study aims to find out if it is possible that 1st grade pupils can understand computer science basics.

1.4 Research Hypothesis

1st grade pupils can understand computer science basics using the unplugged technique.

1st grade pupils will find it funny learning computer science basics using the unplugged technique.

The development of a teaching tool will reduce time needed to introduce the picture representation activity.

1.5 Research Objectives

To test the ability of 1st grade pupils to understand Computer science basics when introduced using the unplugged technique.

To introduce Computer Science basics to 1st grade pupils in a funny way.

1.6 Significance of the study

This study is the first study in Sudan to test the ability of 1st grade pupils to understand computer science basics.

1.7 Scope and Limitation of the study

This study focuses on testing 1st grade pupils' ability to understand computer science basics, introducing counting in binary and picture representation as the topics.

1.8 Research Methodology

The quantitative method was used. Binary numbers and picture representation basic concepts were transferred to pupils. An assessment was made to test their understanding and the results were analyzed.

1.9 Research Organization

Beside this chapter, this thesis consists of four chapters as follows chapter 2 provides literature review and related work, chapter 3 is about methodology and approach, chapter 4 contains results and discussion and finally chapter 5 shows conclusions and recommendations.

CHAPTER TWO

Literature Review

2.1 Introduction

Today's World is becoming more and more digital with many companies relying on the web based systems and using cloud computing. Computer scientists are talking now a days about the "intelligent world" as the 'Smart' devices are 'talking' to each other leading to the Internet of Things. The need of more computer scientists is growing, so we need to do more effort to convince more pupils to study computer science. On the other hand, many computer scientists think that computational thinking is essential to all pupils, not only those who will major in computer science. "Computational thinking is not used to solve problems with computers only, but to use ideas from computer science to solve real-world problems"(Bell et al,2009).

If you ask anyone what is computer science, most of them will answer is programming or something beyond programming, so many will think that computer science is a hard track; because of this there is a need to let more pupils explore the computer science concepts as early as possible.

The computer itself could distract young children's attention, so there is a need to teach the children computer science without using computers.

2.2 The Computer Science Unplugged project:

Computer Science Unplugged is known as teaching computer science without using computers. In Poland, Syslo used the Computer Science Unplugged approach in 1970's while introducing the concept of a stable marriage or pairing to university students by 'playing' the algorithm with groups of students (Syslo and Kwiatkowskal,2015).

In 1995 Tim Bell and his colleagues at Canterbury university developed a set of activities to show children computer science concepts without using computers. These activities in general contain some kind of challenge that pupils try to solve. The activities could be practiced by children of an early age as five years (Binary numbers activity for example).

Each activity aims to transfer a computer science idea, let pupils to figure out ideas and raise the spirit of team work.

The main principles of the Computer Science Unplugged project are :

- A focus on highlighting Computer Science concepts.
- Making the activities kinesthetic, generally on a large scale, involving team work.
- The activities are fun and engaging.
- The materials are low cost.
- The material is released using a creative commons license, so that others can pass them on freely and make their own contributions.

• The activities aim to be gender neutral (or at least, attractive to girls), and tend to focus on cooperative approaches rather than individualistic ones.

• The activities often are story-like to capture interest and motivate children.

(Bell et al,2009).

The teacher's book(Bell et al,2015) which consists of about 21 activities has been translated into twelve languages some of which is Arabic, Japanese, Swedish and Chinese. The activities are used in different contexts and are localized to be much easier to children to understand.

Appendix(A) lists all the activities and the targeted ages.

2.3 Related Work

Many countries around the world are getting more and more interested in including Computer science in primary school's curriculum, because it will be beneficial to all pupils, we will explore five countries' experiences in the following part.

2.3.1 Japan

A study was conducted during "Fujitsu Kids Event 2012" (Ishizuka et al,2013). The end goal was to show that it is available to do scientific understanding of informatics class for primary school pupils and it is effective to learn scientific understanding of informatics for primary school children.

A total of 90 children (30 children x 3 times) practiced binary numbers activity. The children were pupils of 4th, 5th and 6th grade. They were divided into six groups of around five by grade and gender in advance. Each session lasts for 40 minutes, as in Japan a typical school class lasts for 45 minutes.

Two kinds of work sheets were used during each session. The first worksheet was completed by the pupil with the help of a lecturer or a staff member and the second one was completed by each pupil alone.

The results showed that children greater than or equal to 4th grade can understand the contents of “binary number” of Computer Science Unplugged activity in 40 minutes class because the accuracy rate for all children is 77.8% .

2.3.2 Korea

A three parts study was carried to investigate how the Computer Science unplugged materials and other offline activities, are best adapted for the more formal requirements of day-to-day teaching in a school (Choi et al,2008).

A total of 87 4th grade pupils practiced the binary numbers activity. At the end of the sessions the pupils were tested, and the average score was 4.3 out of 6.

The second part of the study was done with 14 experienced teachers who were divided into four groups, each group was asked to teach other groups a topic from the Computer Science unplugged book. Teachers said that they could understand the activity very easy, but there was a gap between the activity and how it relates to computer science.

As the activities were designed, primarily, to show children what computer science is, it is clear that some explanation is needed to relate the activities with computer science and how it is used in practice. The authors advised teachers to visit the Computer Science unplugged project website where several videos are available online which explain the activities.

Another issue that faced the teachers was that they spent a lot of time to find a way to evaluate the participants in an unplugged activity, this led to the third part of the study where the 14 teachers were asked to review the Korean translation of the Computer Science unplugged book with a view to finding out how the materials might be used in a classroom, and if more information is needed for teacher to be able to use the activities effectively.

A summary of the findings is as follows:

- Activities are useful as group activity rather than for individual work.
- It is important to understand the application of the topic of the activity.
- Most of the teachers (9 out of 14) felt that the activities were best used as an introduction to a topic.

The activities were most suited to be used in the classroom.

The teachers saw the most suitable evaluation approaches being through self- or pair-evaluation, a written worksheet, and from the teacher observing the class. Pupil discussions, a paper test, and interviews with pupils also had some support.

Elementary school teachers favored teaching that made use of equipment and activities (6 out of 8), whereas the junior and high school teachers said that the text book is more important (4 out of 6).

2.3.3 England

A comparative study was carried in three small primary schools to explore three different techniques (unplugged computing, tangible computing, and Scratch programming) for teaching computer science to key stage one pupils (Wohl et al,2014). During the unplugged sessions, the children were introduced to the concepts of ‘inputs’ and ’outputs ‘ through the game of ‘Simon Says’.

Pupils were then split into pairs as one person acting as an input (Told to respond to a hand signal from the facilitator) and the other acting as an output (Eyes covered with a piece of cloth) and they sent a signal by holding hands. The pupils were then introduced to the boolean concepts of `or', `and', `xor' and `not' and with the facilitator created more complex systems which incorporated these concepts. The pupils worked in groups of 4 to 5 (2 inputs, 1 or 2 logic gates, and one output).To simulate a range of inputs, the facilitator used a range of verbal and visual cues to signal to the `input' children when to run across to the logic gate. Pupils who were `outputs' were given a small torch that they turned on or off depending on the signal they received from the logic gate. The results showed that unplugged generated the highest level of understanding of the concepts and Cubelets was the most engaging one.

2.3.4 Slovenia

Irena Demsar and Janez Demsar translated Computer Science Unplugged activities to Slovenian and tried it in different settings, from classroom and after school activity to summer school to professional development courses and said that they have found Computer Science unplugged an excellent inspiration for teaching computer science concepts, and that made them add more kinesthetic learning and gamification (Demsar and Demsar,2015) .

More over Computer Science unplugged was included in the elective subject 'Computer Science' in the 5th grade of primary school in year 2015/2016.

2.3.5 USA

Computer Science unplugged was adapted by National Center for Women and Technology. Together with the authors of Computer Science unplugged book they Developed " Computer Science-in-a-Box: Unplug Your Curriculum" that was released in may 2008 and contains seven activities from Computer Science unplugged book (NCWIT,2017).

CHAPTER THREE

Methodology and Approach

3.1 Introduction

This study focuses on children at primary 1st grade and aims to test their understanding of computer science principles when presented using the computer science unplugged approach. In Sudan children go to school at the age of 6, so in this study two activities were chosen to be presented to 1st grade pupils, as suggested by Computer Science unplugged teacher's book, list of all activities ,Appendix (A) :

- Binary numbers.
- Picture representation.

Two elementary public schools in Khartoum north locality were chosen to practice with the 1st grade pupils the activities and assess their understanding of the key concepts of each activity.

This study is gender neutral, so the two schools were chosen as one for boys only school and one for girls only school.

A total number of 83 pupils joined the binary numbers activity. The number of the boys was 34 pupils, and the number of the girls was 49 pupils.

In picture representation activity 92 pupils were involved. 43 boys and 49 girls had joined.

3.2 Activities

Binary numbers and picture representation activities were chosen to be conducted in this study, because they:

- Explain to children how data is represented in computer.
- Show children the way images are displayed on screen.
- The degree of complexity of these activities is suitable for this age.

3.3 Session execution

All sessions followed same structure, starting with binary number activity, followed by picture representation activity.

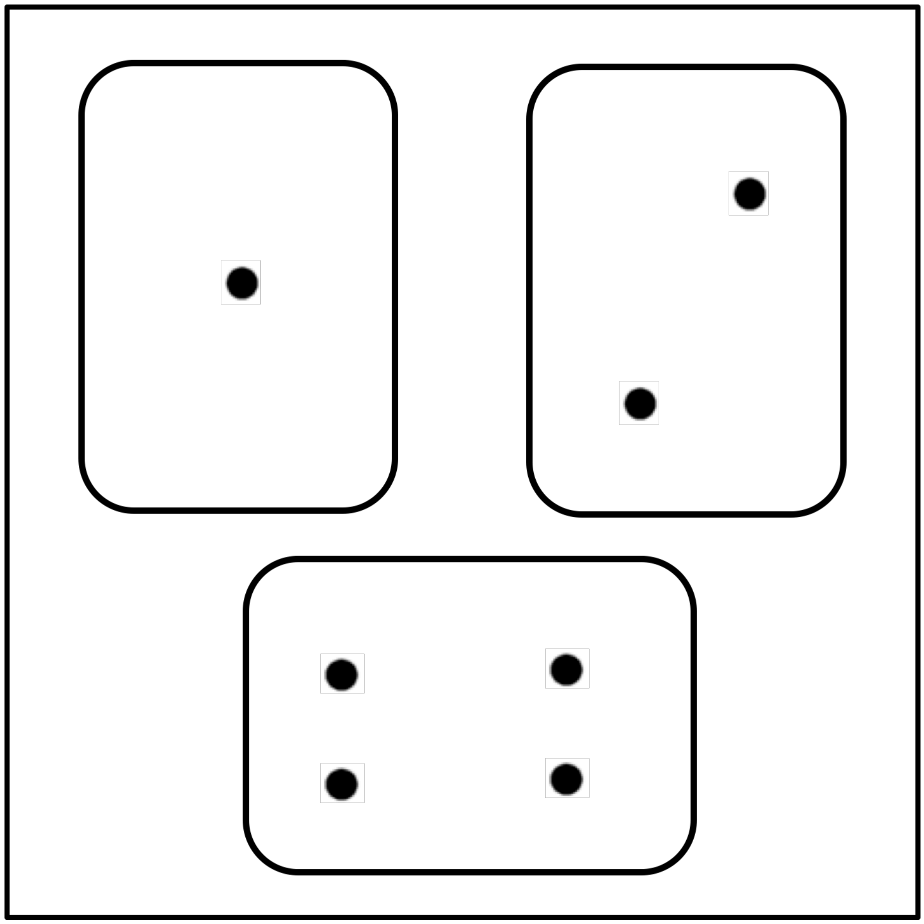
The binary numbers was presented and revised in two lessons and two more lessons were needed for assessment. The picture representation activity took three lessons for explanation and revision and two lessons for assessment.

In Sudan a lesson lasts for 40 minutes.

3.3.1 Binary numbers activity

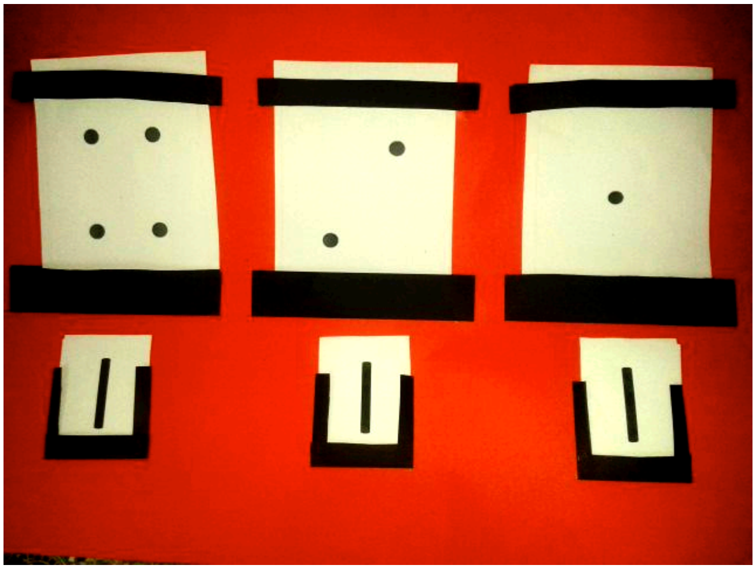
For binary numbers activity the following concepts were addressed:

- Composing a binary number, by flipping the right cards.
- Counting in binary till decimal seven.
- The original activity material was used with the pupils, shown in figure(3.1).



Figure(3.1) Binary numbers activity pupil's material

A teaching tool was developed to help in simplifying the work shown on figure(3.2).



Figure(3.2) Teaching tool for binary Numbers activity.

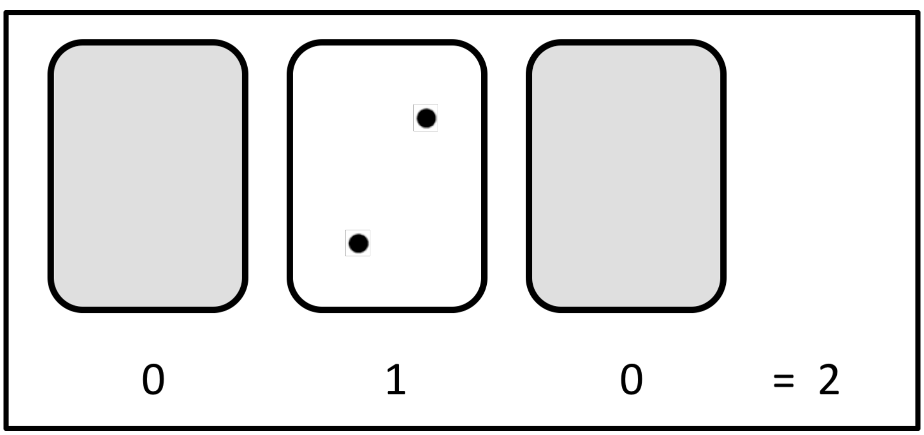
The tool consists of two rows and three columns, the top row represents the cards and the bottom row represents the binary digits equivalent to each card state.

The activity begins with describing that computers work on electrical power, which has two states, either the power is on or the power is off. These states are simulated using the cards, when power is on then the card is flipped face-wise and the corresponding digit is equal to one, on the other hand when the power is off then the card is flipped back-wise and the corresponding digit equals zero.

Then the order of the cards was explained, starting with the card containing one dot as the right most card, followed by the one with two dots and finally, during this activity, with the card containing four dots. The class counted from zero to seven composing the binary number on the bottom row each time.

The idea of the lowest possible value, zero, and the highest possible value, during this activity, seven, was highlighted.

The children then used their own cards, cut card by card, shown on figure(3.1) to exercise the activity. Representing decimal number two by flipping cards is shown on figure(3.3).



Figure(3.3) Representing decimal number two by flipping cards

The second part of the activity was done by groups of three pupils, to let pupils enjoy the nature of working in a team.

Each group of pupils stands holding the three cards flipped back-wise representing zero and then flipped the cards on and off to count till decimal seven, with the rest of the class reading the corresponding binary number. Appendix(B) shows photos of pupils counting in binary.

An assessment was then conducted, it consists of two questions:

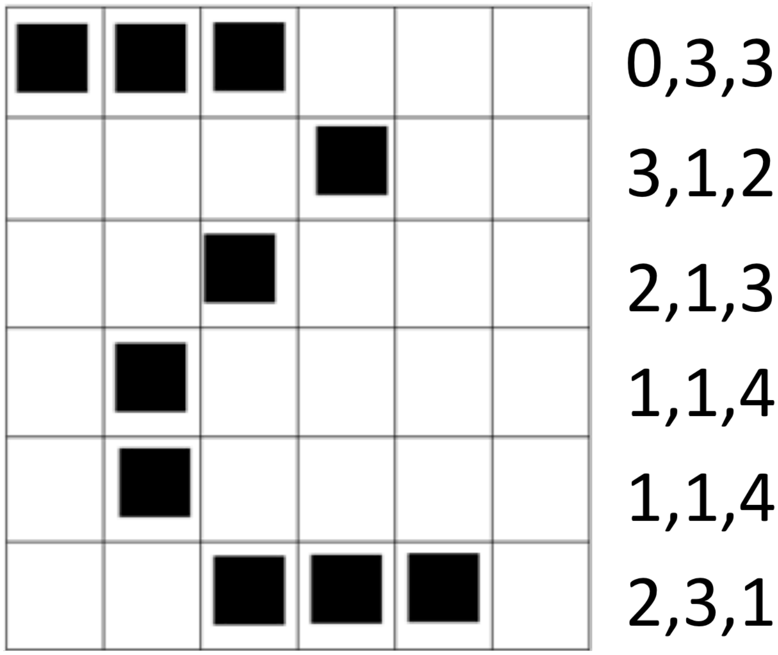
- Composing a binary number by flipping the appropriate cards.
- Reading a composed number in binary.

3.3.2 Picture Representation activity

In picture representation activity the focus was on the following concepts:

- How pictures are stored in a computer.
- Screen is divided up into small dots called Pixels.

Arabic alphabet letters were used as pictures to be represented during the exercises a sample shown on figure(3.4).



Figure(3.4) Arabic Alphabet (ح),used in picture representation activity

The activity starts with remembering that computers can only store numbers, followed by explaining the idea of dividing computer screens into small dots called pixels then explaining that in a black and white picture, each pixel is either black or white, so when a computer stores a picture, all that it needs to store is which dots are black and which are white.

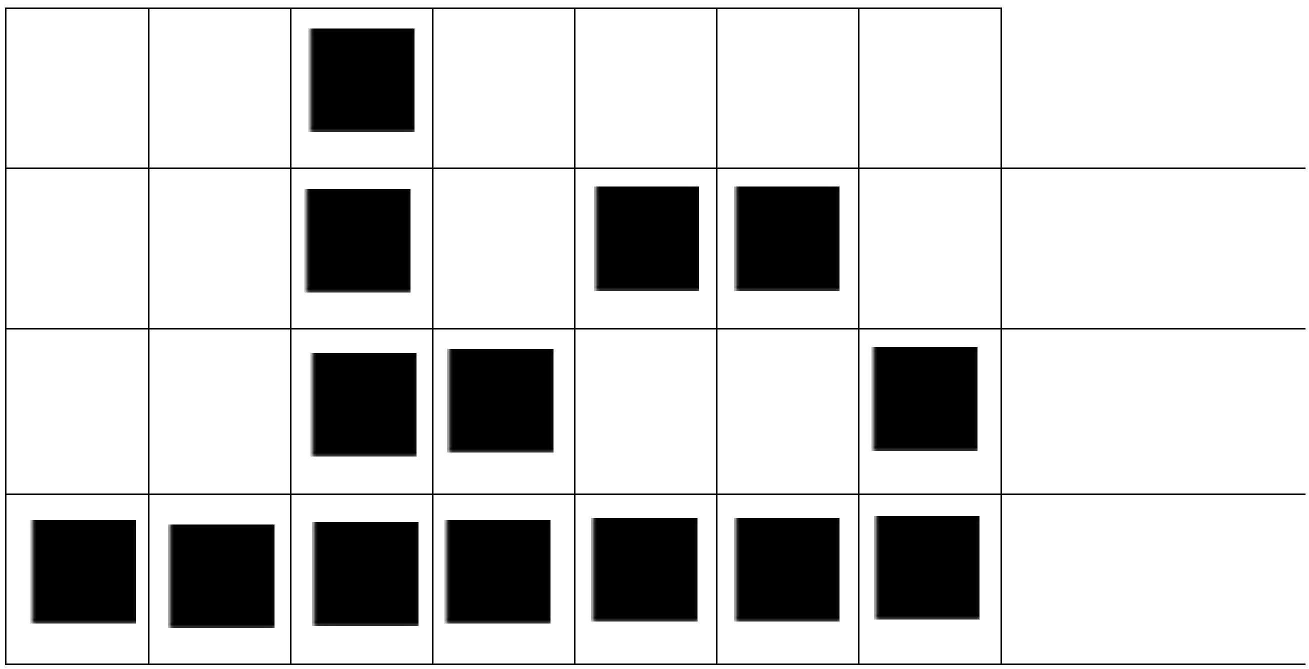
When representing a picture, the first number always relates to the number of white pixels. If the first pixel is black the line begins with a zero.

In figure(3.4) the first line begins with three black dots followed by three white dots. Thus the line was represented by 0,3,3.

Pupils practiced coding the lines for two pictures shown on figure(3.5).

Finally an assessment was done by asking each pupil to:

- Code a line that starts with a white pixel.
- Code a line that starts with a black pixel.
- Color a line that does not begin with a zero.
- Color a line that begins with zero.



Figure(3.5) Sample Picture to be coded by pupils

Then the pupils colored two pictures as shown on figure(3.6).

							4,1,2
							7
							3,3,1
							6,1
							3,3,1
							7

							0,3,4
							3,1,3
							2,1,4
							1,1,5
							1,1,5

Figure(3.6) Pictures to be colored by pupils

3.3.3 Picture Representation Teaching Tool

This activity was difficult to practice because in Sudan most schools use traditional blackboards, so a teaching tool was developed.

The tool consists of three screens:

-Main screen: is used to explain how computer screens are divided Into small dots called pixels and shows the pupils that each line of the screen is plotted by sending the series of white/black dots numbers as figure(3.7) shows.

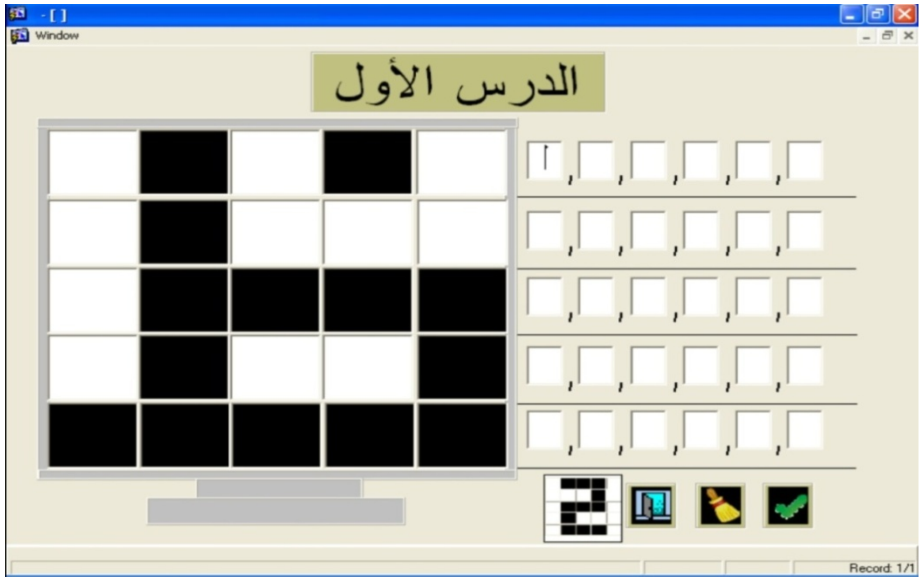
Figure(3.7) Teaching tool, main screen

This screen is used by the instructor to draw any picture and code the corresponding line and then check if the coding is correct by pressing the  button.

A happy face will be displayed beyond the correct line, while a sad face will be displayed next to a wrong line as Figure(3.8) shows.

Figure(3.8) Teaching tool, main screen (correction)

-First lesson screen: is used to show how to code a picture, as Figure(3.9) shows.



Figure(3.9):Teaching tool, first lesson screen

A happy face will be displayed on the upper right corner if the coding is correct as Figure(3.10) shows.

Figure(3.10) Teaching tool, first lesson screen(correction)

-second lesson screen: is used to show pupils how to color a coded picture as Figure(3.11) shows.

The code written to develop the teaching tool is enclosed in Appendix(C).

Figure(3.11) Teaching tool, second lesson screen

CHAPTER FOUR

Results and Discussion

4.1 Introduction

The instruction of this study was carried during the first period of 2016/2017 academic year. In Sudan a lesson lasts for 40 minutes.

As previously mentioned at chapter(3), the binary numbers was presented and revised in two lessons and two more lessons were needed for assessment. The picture representation activity took three lessons for explanation and revision and two lessons for assessment, that was mainly because the number of pupils is around 45 pupils in the boys' class and 50 in the girls class.

4.2 The assessment criteria

The assessment criteria was based on asking each pupil in person and because they are all around six years old, it took some time chatting before asking questions to let them calm down.

4.3 The binary numbers activity assessment results

Each pupil was asked two questions:

- To compose a binary number by flipping the appropriate cards.
- To read a composed number in binary.

The full mark of each question is five marks. If the pupil fails to answer correctly on the first trial, a mark will be deducted by each wrong answer.

For binary numbers activity the assessment yield the results shown on table(4.1).

Table(4.1) Binary numbers assessment results

Mark	No. of Pupils	%
10	49	59
9	14	17
8	14	17
7	2	2
6	3	4
4	1	1
Total	83	

A total of 83 pupils participated in this activity. The assessment consists of two questions weighted five marks each.

The assessment showed that 99% of the pupils gained the pass .59% of the pupils had scored 10 out of 10, thus the achieved results are excellent. The simplicity of the activity and the funny way in which it was presented to pupils helped them understand the topic.

93% of them scoring 8out of 10 and above as figure (4.1) shows.

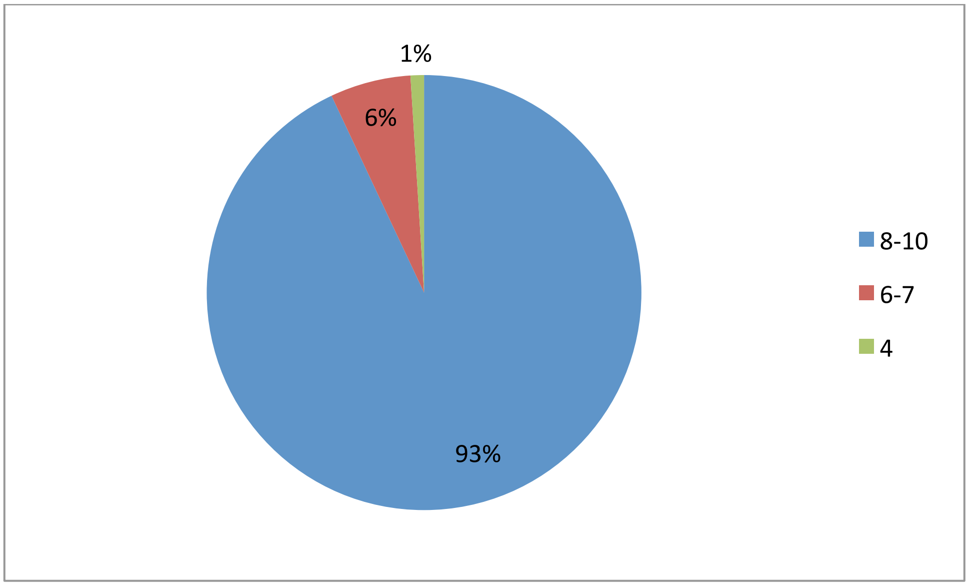


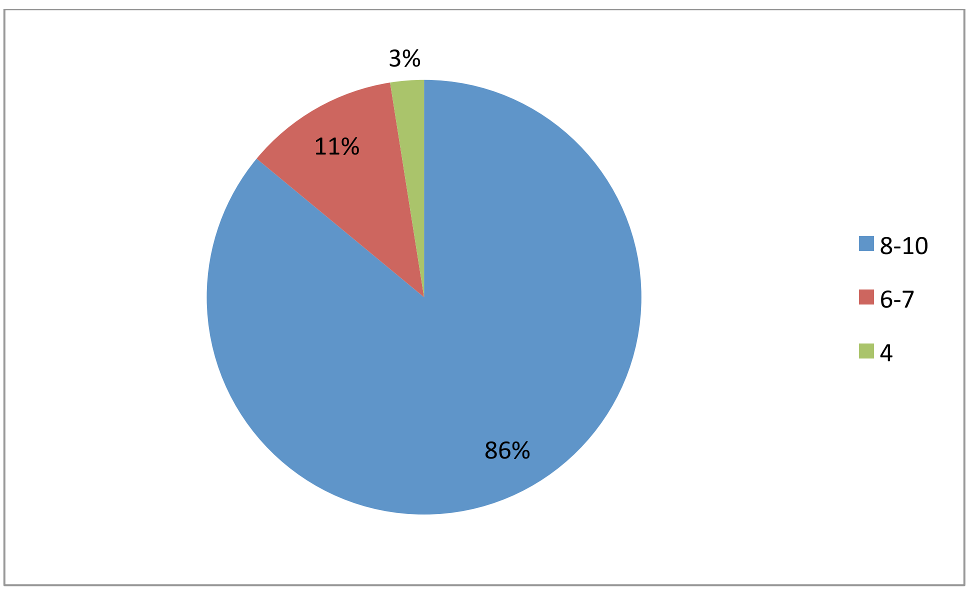
Figure (4.1) Marks Scored in Binary numbers assessment

Marks scored by the boys are shown on table(4.2).

Table(4.2) Boys' marks in binary numbers assessment

Mark	No. of Pupils	%
10	18	53
9	3	9
8	8	24
7	1	2.5
6	3	9
4	1	2.5
Total	34	

97.5% of the boys passed.53% scored 10 out of 10 and 86% scoring 8 out of 10 and above as shown on figure(4.2).



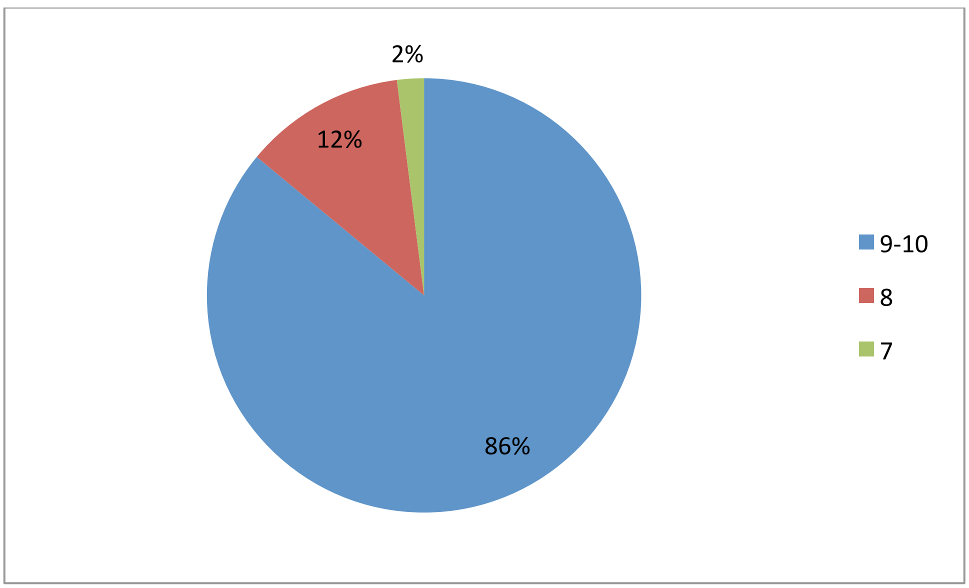
Figure(4.2) Boys' marks in binary numbers assessment

Marks scored by the girls are shown on table(4.3).

Table(4.3) Girls' marks in binary numbers assessment

Mark	Girls	%
10	31	63
9	11	23
8	6	12
7	1	2
Total	49	

All the girls scored 7 out of 10 and above.86% scored 9 out of 10 and above. 63% scored 10 out of 10 as shown on figure(4.3).



Figure(4.3) Girls' marks in binary numbers assessment

4.3.1 First question results

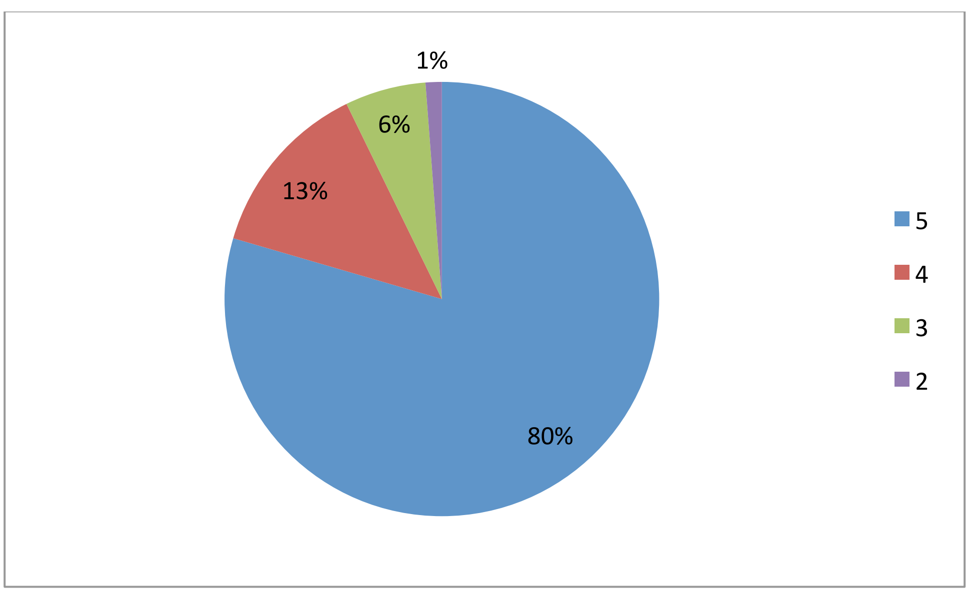
Each pupil was asked to compose a binary number by flipping the appropriate cards.

The assessment of this question yield the results shown on table (4.4)

Table(4.4) Binary numbers question one assessment results

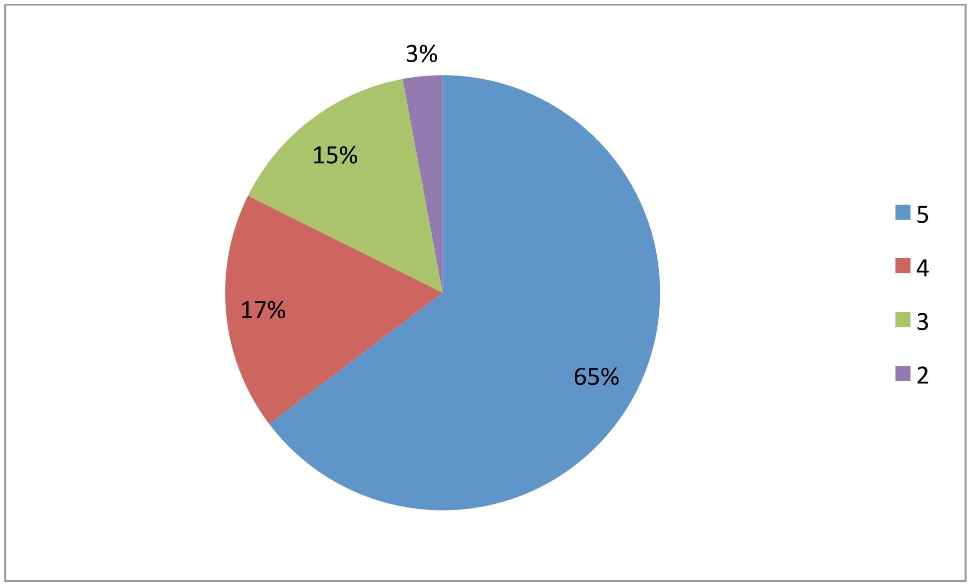
Mark	Boys	Girls	Total	%
5	22	44	66	80
4	6	5	11	13
3	5	0	5	6
2	1	0	1	1
Total	34	49	83	

99% of the pupils gained pass in this question, with 93% of them scoring 4 out 5 marks, as shown on figure (4.4)



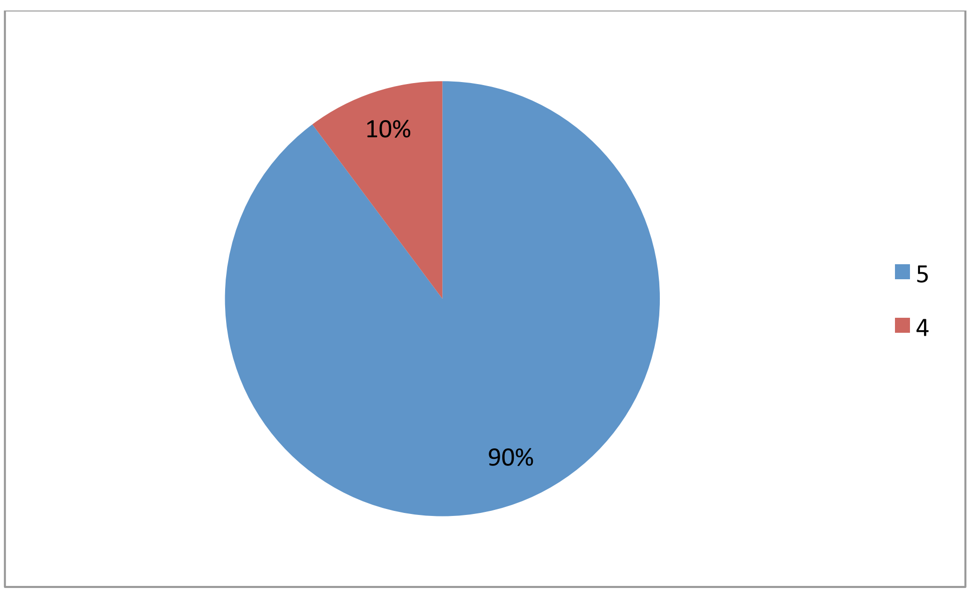
Figure(4.4) Marks scored in Binary numbers assessment first question

97% of the boys passed question one. 82% scored 4 out of 5 and above.65% scored 5 out of 5. The results are shown on figure (4.5).



Figure(4.5) Binary numbers first question boys results.

All the girls gained 4 out of 5 and above with 90% of them scoring 4 out of 5 as shown on figure (4.6).



Figure(4.6) Binary numbers first question girls results.

4.3.2 Second question results

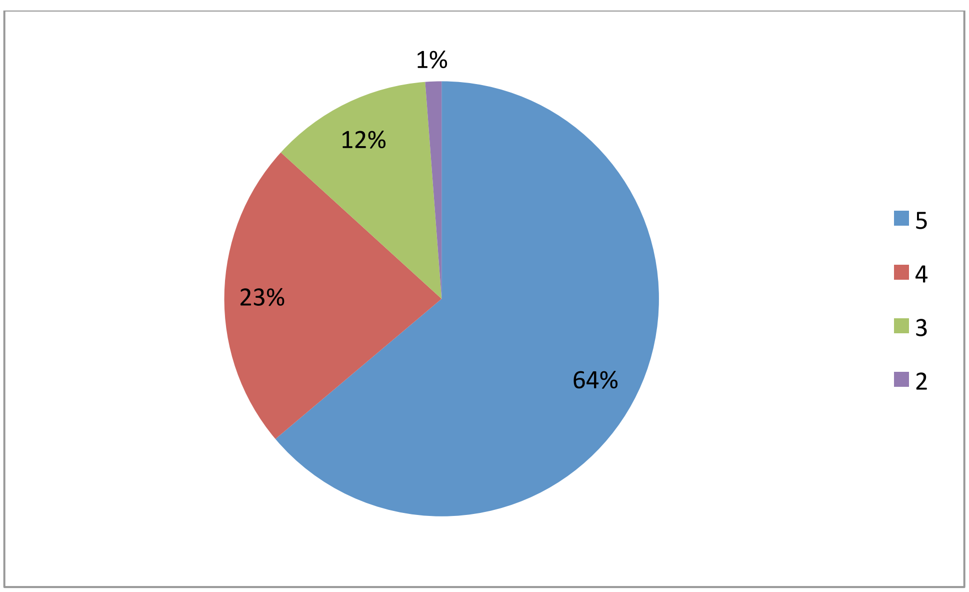
Each pupil was asked to read a composed number in binary.

The assessment of this question yield the results shown on table (4.5)

Table(4.5) Binary numbers question two results

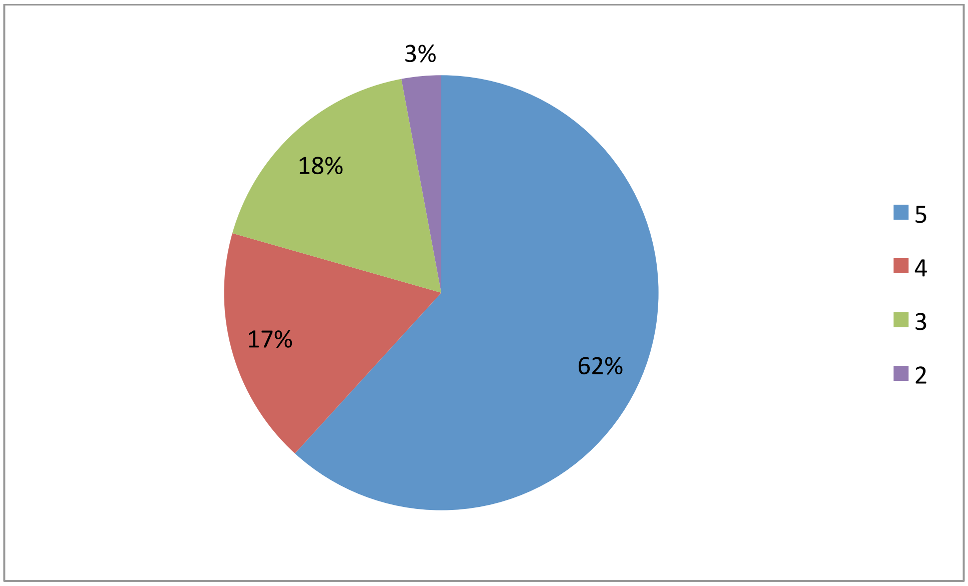
Mark	Boys	Girls	Total	%
5	21	32	53	64
4	6	13	19	23
3	6	4	10	12
2	1	0	1	1
Total	34	49	83	

99% of the pupils passed this question, with 87% of them scoring 4 out 5 marks, as shown on figure (4.7)



Figure(4.7) Marks scored in Binary numbers second question

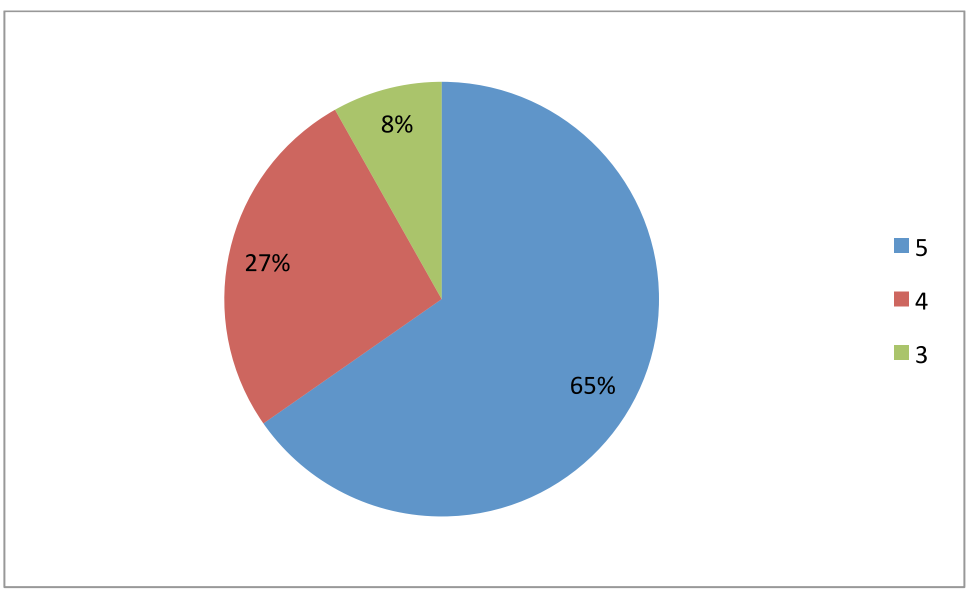
97% of the boys passed question two of the binary numbers assessment.79% of the boys scored 4 out 5 and 62% of the boys scored 5 out of 5. As shown on figure (4.8).



Figure(4.8) Boys' marks scored in Binary numbers second question.

All of the girls scored passed question two.92% scored 4 out 5 and above .

65% scored 5 out 5 as shown on figure (4.9).



Figure(4.9) Girls' marks in Binary numbers second question

4.4 Picture representation assessment results

Each pupil was asked to do four tasks:

- Code a line that starts with a white pixel.
- Code a line that starts with a black pixel.
- Color a line that does not begin with a zero.
- Color a line that begins with zero.

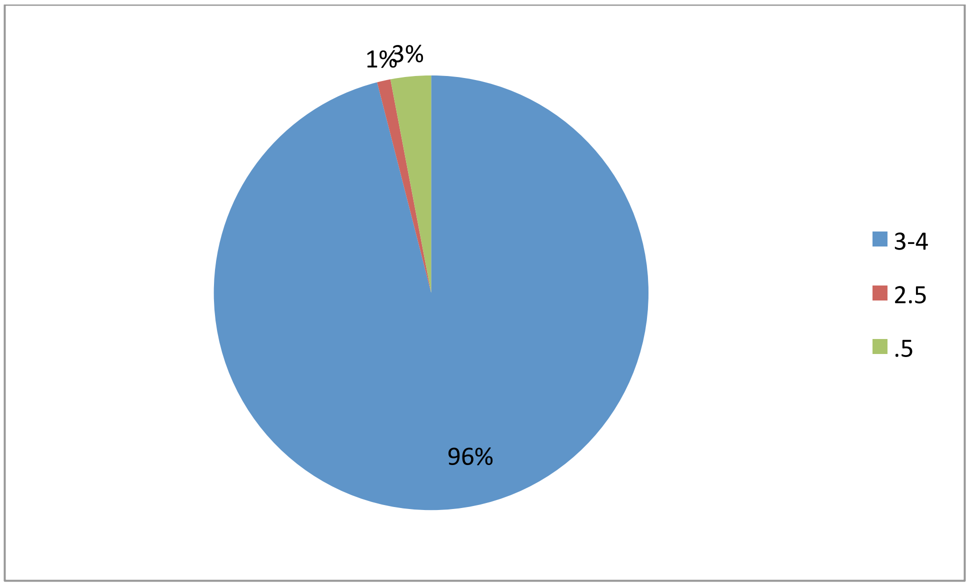
Each question weighted one mark; a one and only one wrong answer was given half a mark, else a zero mark.

The Picture Representation assessment results are shown on table(4.6).

Table(4.6) Picture Representation Assessment Result

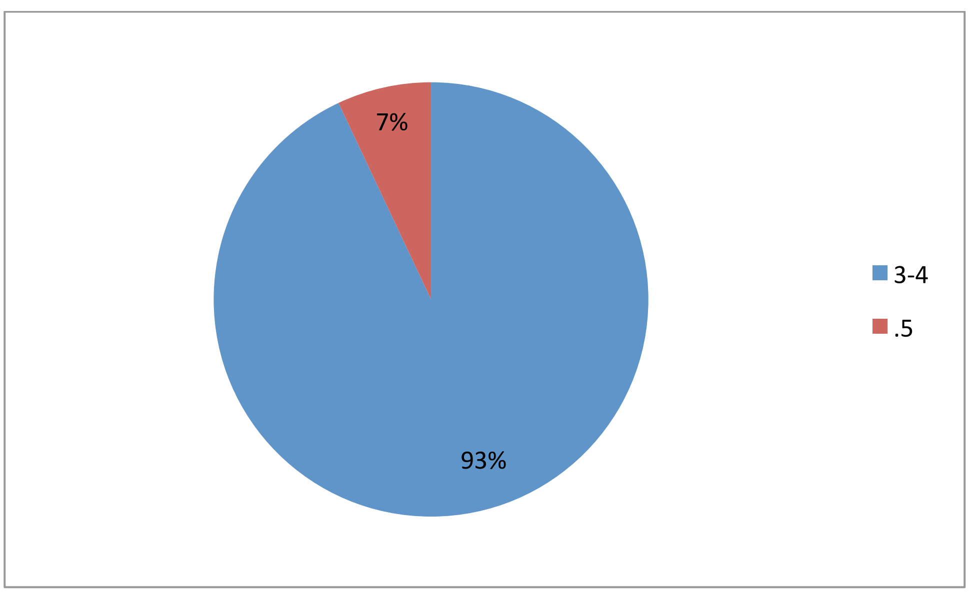
Mark	Boys	Girls	Total	%
4	30	39	69	75
3.5	7	5	12	13
3	3	4	7	8
2.5	0	1	1	1
0.5	3	0	3	3
Total	43	49	92	

As the result shows 97% of the pupils passed. 96% scored 3 out of 4 marks and above.75% gained 4 out of 4. As shown on figure(4.10) . It's clear that the use of arabic alphabet during this activity and the ease of the activity made the pupils gain excellent results.



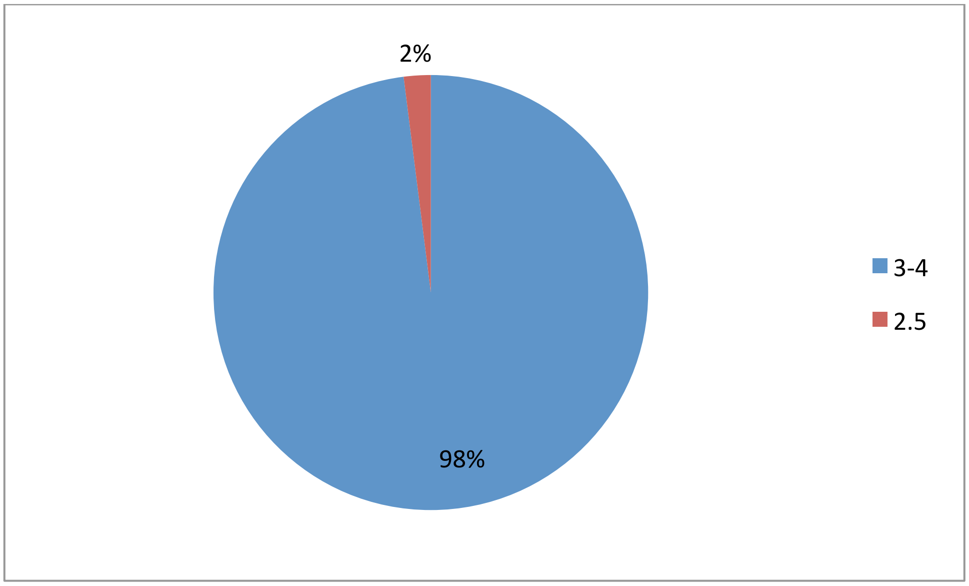
Figure(4.10) Marks Scored in Picture Representation Assessment

93% of the boys scored 3 out of 4 and above. 70% scored 4 out of 4. as shown on Figure(4.11) .



Figure(4.11) Boys marks in picture representation Assessment

98% of the girls scored 3 out of 4 and above. 80% scored 4 out of 4. as shown on Figure(4.12).



Figure(4.12) Girls marks in picture representation Assessment

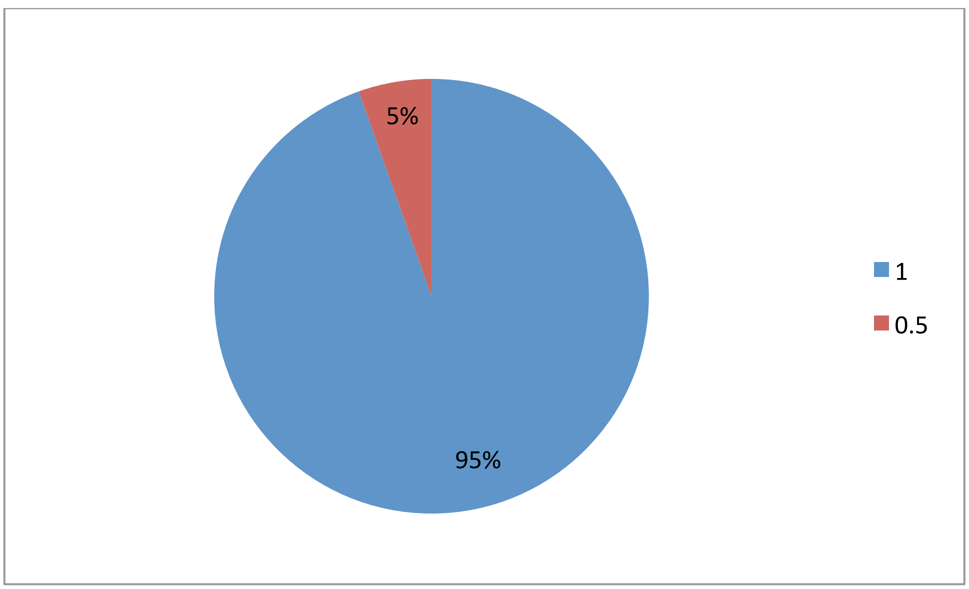
4.4.1 Picture representation first question's results

The pupil was asked to code a line that starts with a white pixel. The results are shown on table (4.7).

Table (4.7) Picture Representation first question's Result

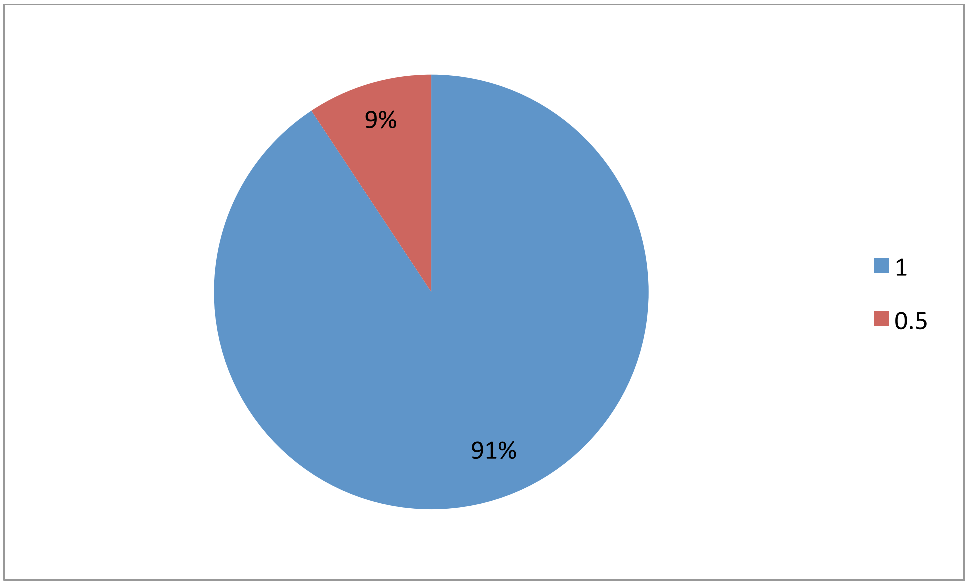
Mark	Boys	Girls	Total	%
1	39	48	87	95
0.5	4	1	5	5
Total	43	49	92	

All pupils passed this question, 95% gained the full mark as shown on figure(4.13).



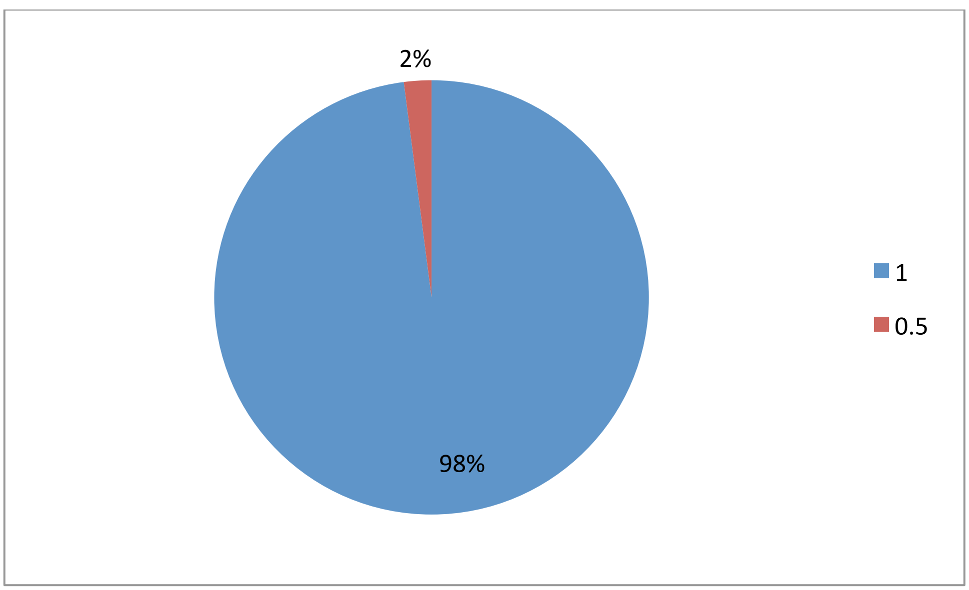
Figure(4.13) Marks scored in picture representation assessment 1st question

91% of the boys scored the full mark as shown on figure(4.14).



Figure(4.14) Boys' marks in picture representation assessment 1st question.

98% of the girls scored the full mark as shown on figure(4.15).



Figure(4.15) Girls' marks in picture representation assessment 1st question.

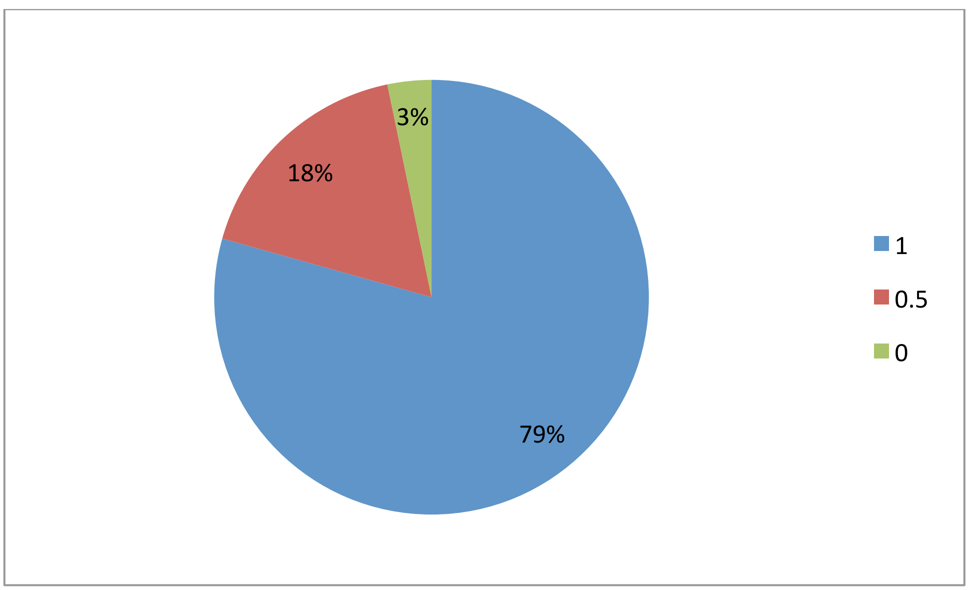
4.4.2 Picture representation second question's results

The pupil was asked to code a line that starts with a black pixel. The results are shown on table (4.8) .

Table(4.8) Picture representation second question's result

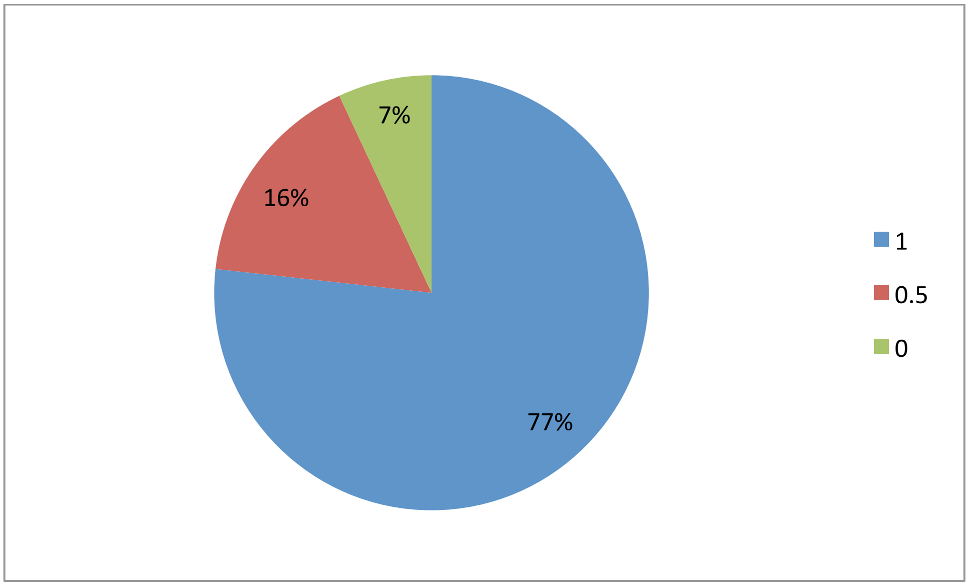
Mark	Boys	Girls	Total	%
1	33	40	73	80
0.5	7	9	16	17
0	3	0	3	3
Total	43	49	92	

97% of the pupils passed this question with 80% scoring the full mark as shown on figure (4.16).



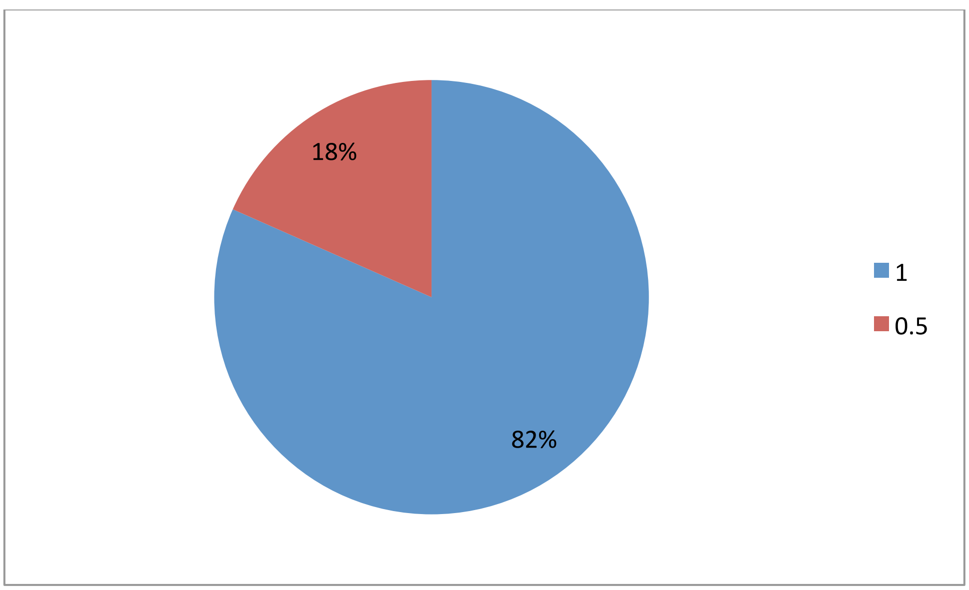
Figure(4.16) Marks scored in picture representation 2nd question

93% of the boys passed this question.77% scored the full mark as shown on figure(4.17).



Figure(4.17) Boys' marks in picture representation assessment 2nd question.

82% of the girls scored the full mark as shown on figure(4.18).



Figure(4.18) Girls' marks in picture representation assessment 2nd question.

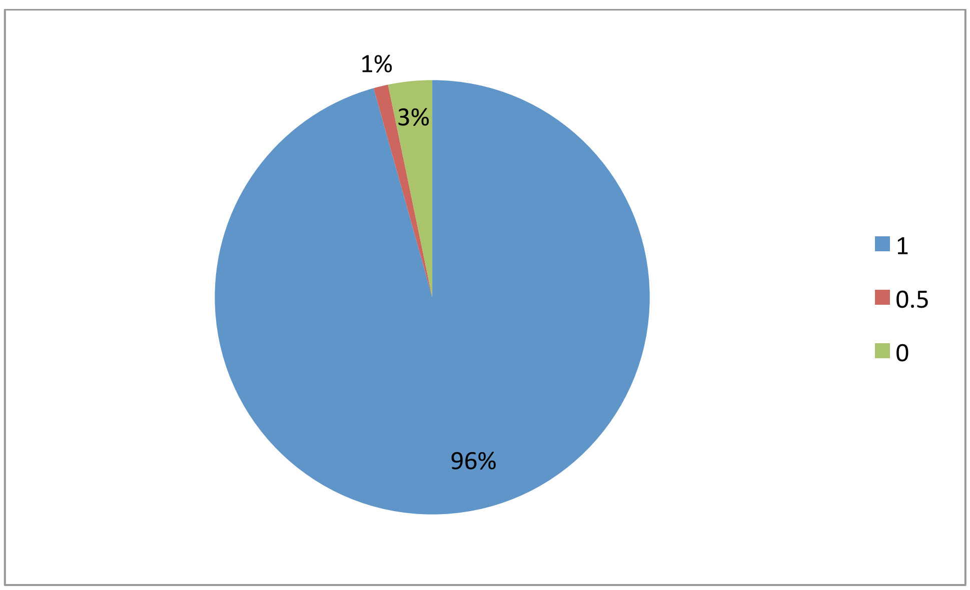
4.4.3 Picture representation third question's results

The pupil was asked to color a line that does not begin with a zero. The results are shown on table (4.9) .

Table(4.9) Picture representation third question's result

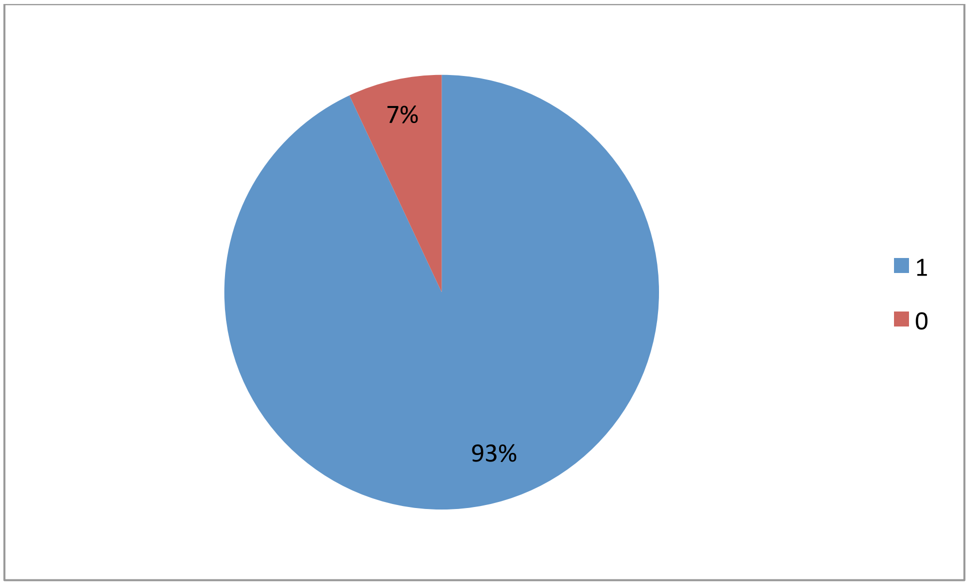
Mark	Boys	Girls	Total	%
1	40	48	88	96
0.5	0	1	1	1
0	3	0	3	3
Total	43	49	92	

97% of the pupils passed this question with 96% scoring the full mark as shown on figure (4.19).



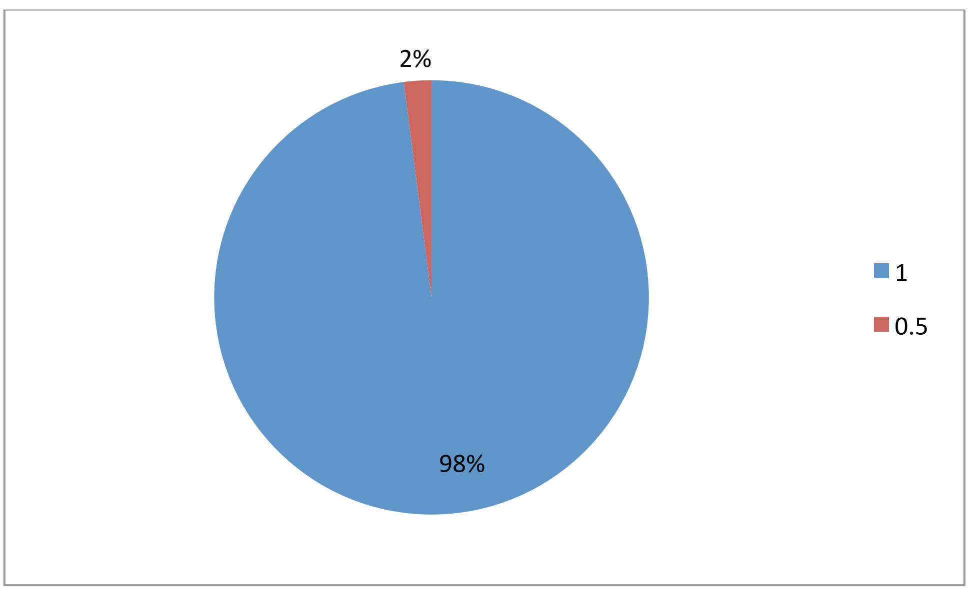
Figure(4.19) Marks scored in picture representation 3rd question

93% of the boys scored the full mark as shown on figure(4.20).



Figure(4.20) Boys' marks in picture representation assessment 3rd question.

98% of the girls scored the full mark as shown on figure(4.21).



Figure(4.21) Girls' marks in picture representation assessment 3rd question.

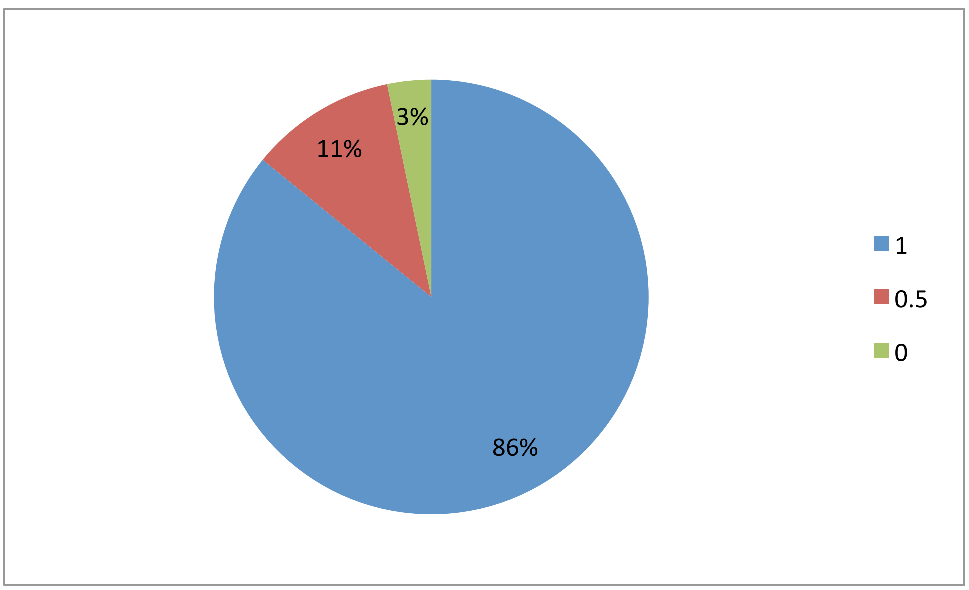
4.4.4 Picture representation fourth question's results

The pupil was asked to color a line that begins with a zero. The results are shown on table (4.10) .

Table(4.10) Picture representation fourth question's result

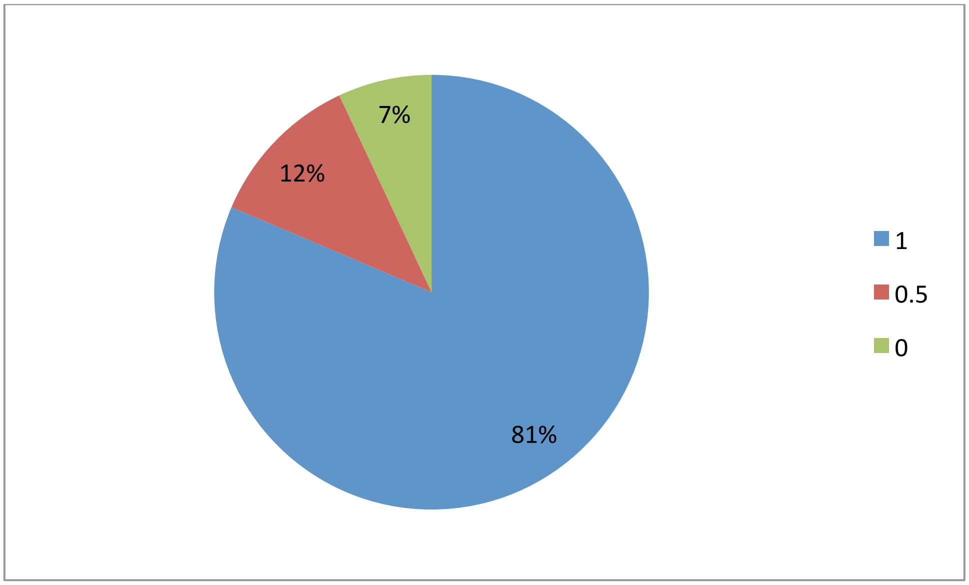
Mark	Boys	Girls	Total	%
1	35	44	79	86
0.5	5	5	10	11
0	3	0	3	3
Total	43	49	92	

97% of the pupils passed this question with 86% scoring the full mark as shown on figure (4.22).



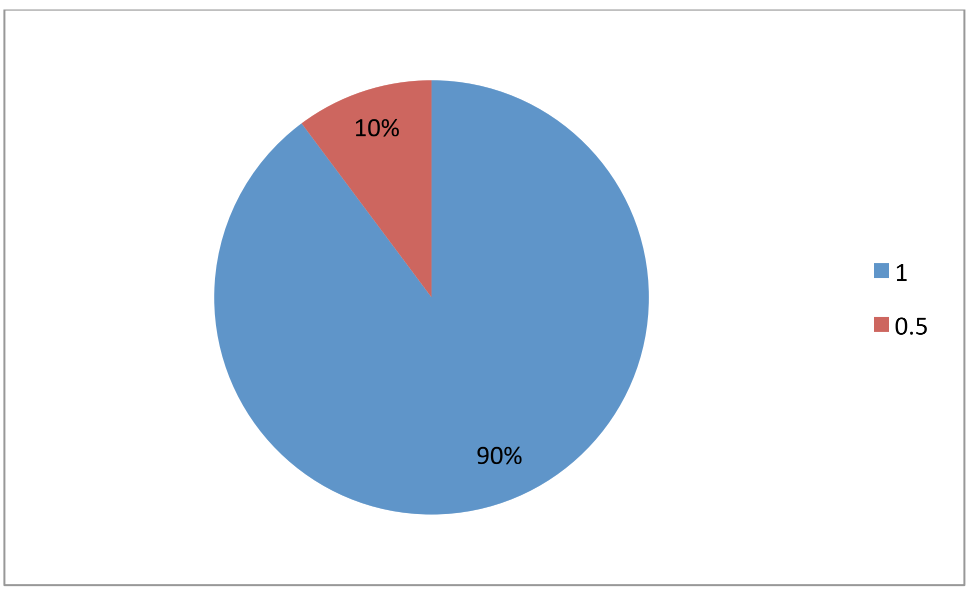
Figure(4.22) Marks scored in picture representation 4th question

81% of the boys scored the full mark as shown on figure(4.23).



Figure(4.23) Boys' marks in picture representation assessment 4th question

90% of the girls scored the full mark as shown on figure(4.24).



Figure(4.24) Girls' marks in picture representation assessment 4th question

CHAPTER FIVE

Conclusions and Recommendations

5.1 Introduction

The study was done during the first period of the academic year 2016/2017. Two 1st grade school pupils classes participated and the children were so happy during the activities. It was observed they enjoyed the activities and found them funny especially the binary numbers activity.

The binary numbers activity included team work as part of it, and the children were keen to help each other count in binary.

At the end of the picture representation activity session, the children were very happy to discover and understand how a picture is shown on computer screens.

It was found difficult to introduce the picture representation to the pupils because most Sudanese primary schools use blackboards, so a teaching tool was developed in order to help teachers introduce the activity.

5.2 Conclusions

This study aimed to test if the 1st grade pupils in Sudan can understand computer science principles without using computers.

The content of binary numbers and picture representation activities are simple and easy to be understood by the children as the assessment results showed 99% of them passed the binary numbers assessment and 97% passed the picture representation assessment.

The children clearly understood how data is represented as zeros and ones in computers and how pictures are shown on computer screens.

The results are promising and children can start learning computer science from an early age as 6 years in Sudan.

A teaching tool was developed to help instructors explain the picture representation activity.

5.3 Recommendations

Further work could be done in introducing more of the binary numbers to 1st grade pupils in Sudan.

More work could be carried out in exploring gender difference impact on learning computer science principles in 1st grade.

The unplugged technique can be considered to be part of teaching computer science basics to the1st grade pupils curriculum in Sudan , when one is prepared.

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Appendices

Appendix(A) A list of all Unplugged activities:

Chapter	Title	Sub tilte	Ages
1	Count the Dots	Binary Numbers	6 and up
2	Colour by Numbers	Image Representation	7 and up
3	You Can Say That Again!	Text Compression	9 and up
4	Card Flip Magic	Error Detection & Correction	7 and up
5	Twenty Guesses	Information Theory	10 and up
6	Battleships	Searching Algorithms	9 and up
7	Lightest and Heaviest	Sorting Algorithms	8 and up
8	Beat the Clock	Sorting Networks	7 and up
9	The Muddy City	Minimal Spanning Trees	9 and up
10	The Orange Game	Routing and Deadlock in Networks	9 and up
11	Tablets of Stone	Network Communication Protocols	9 and up
12	Treasure Hunt	Finite-State Automata	9 and up
13	Marching Orders	Programming Languages	7 and up
14	The poor cartographer	Graph coloring	7 and up
15	Tourist town	Dominating sets	7 and up
16	Ice roads	Steiner trees	7 and up
17	Sharing secrets	Information hiding protocols	7 and up
18	The Peruvian coin flip	Cryptographic protocols	9 and up
19	Kid Krypto	Public-key encryption	11 and up
20	The chocolate factory	Human interface design	7 and up
21	Conversations with computers	The Turing test	7 and up

Appendix(B) pupils counting in Binary.

Appendix(C) Teaching tool code.

Main screen check button code, first row check code:

```
PROCEDURE r1 IS
BEGIN
declare
al number;
xv number := 1;
mval number;
cnt number :=1;
begin
    for j in 1 .. 6 loop
        :row :=1;
     if j=1 then  -- first cell in the row
        if :v11 = 0 then
            if nvl(:a1,0) <> 0 then
              stmsg;
              exit;
             else
               mval := 0;
               cnt  := 1;
               xv   := 2;
             end if;
        else
           mval := 1;
           cnt  := 1;
```

```
        xv   := 1;
    end if;
elsif j=2 then
    if :v12 = mval then
       cnt := cnt+1;
    else
        mval := :v12;
        if xv = 1 then
               if nvl(:a1,0) <> cnt then
                  stmsg;
                  go_item('a1');
                  exit;
               end if;
        elsif xv=2 then
               if nvl(:a2,0) <> cnt then
                  stmsg;
                  go_item('a2');
                  exit;
               end if;
        elsif xv=3 then
               if nvl(:a3,0) <> cnt then
                  stmsg;
                  go_item('a3');
                  exit;
               end if;
```

```
      elsif xv=4 then
            if nvl(:a4,0) <> cnt then
               stmsg;
               go_item('a4');
               exit;
            end if;
      elsif xv=5 then
            if nvl(:a5,0)<> cnt then
               stmsg;
             go_item('a5');
               exit;
            end if;
      elsif xv=6 then
            if nvl(:a6,0) <> cnt then
               stmsg;
               go_item('a6');
               exit;
            end if;
      end if;
      cnt  := 1;
      xv   := xv +1;
   end if;
elsif j = 3 then
   if :v13 = mval then
      cnt := cnt+1;
```

```
else
   mval := :v13;
   if xv = 1 then
        if nvl(:a1,0) <> cnt then
           go_item('a1');
           stmsg;
           exit;
        end if;
   elsif xv=2 then
        if nvl(:a2,0) <> cnt then
           go_item('a2');
           stmsg;
           exit;
        end if;
   elsif xv=3 then
        if nvl(:a3,0) <> cnt then
           go_item('a3');
           stmsg;
           exit;
        end if;
   elsif xv=4 then
        if nvl(:a4,0) <> cnt then
           go_item('a4');
           stmsg;
           exit;
```

```
            end if;
        elsif xv=5 then
            if nvl(:a5,0)<> cnt then
              go_item('a5');
              stmsg;
              exit;
            end if;
        elsif xv=6 then
            if nvl(:a6,0) <> cnt then
              go_item('a6');
              stmsg;
              exit;
            end if;
        end if;
        cnt  := 1;
        xv   := xv +1;
    end if;
elsif j= 4 then
    if :v14 = mval then
      cnt := cnt+1;
    else
        mval := :v14;
        if xv = 1 then
            if nvl(:a1,0) <> cnt then
              go_item('a1');
```

```
    stmsg;
    exit;
  end if;
elsif xv=2 then
  if nvl(:a2,0) <> cnt then
    go_item('a2');
    stmsg;
    exit;
  end if;
elsif xv=3 then
  if nvl(:a3,0) <> cnt then
    go_item('a3');
    stmsg;
    exit;
  end if;
elsif xv=4 then
  if nvl(:a4,0) <> cnt then
    go_item('a4');
    stmsg;
    exit;
  end if;
elsif xv=5 then
  if nvl(:a5,0)<> cnt then
    go_item('a5');
    stmsg;
```

```
            exit;
          end if;
      elsif xv=6 then
          if nvl(:a6,0) <> cnt then
            go_item('a6');
            stmsg;
            exit;
          end if;
      end if;
      cnt  := 1;
      xv   := xv +1;
    end if;
  elsif j= 5 then
    if :v15 = mval then
      cnt := cnt+1;
    else
      mval := :v15;
      if xv = 1 then
          if nvl(:a1,0) <> cnt then
            go_item('a1');
            stmsg;
            exit;
          end if;
      elsif xv=2 then
          if nvl(:a2,0) <> cnt then
```

```
      go_item('a2');
      stmsg;
      exit;
    end if;
elsif xv=3 then
    if nvl(:a3,0) <> cnt then
      go_item('a3');
      stmsg;
      exit;
    end if;
elsif xv=4 then
    if nvl(:a4,0) <> cnt then
      go_item('a4');
      stmsg;
      exit;
    end if;
elsif xv=5 then
    if nvl(:a5,0)<> cnt then
      go_item('a5');
      stmsg;
      exit;
    end if;
elsif xv=6 then
    if nvl(:a6,0) <> cnt then
      go_item('a6');
```

```
            stmsg;
            exit;
          end if;
     end if;

    cnt  := 1;
     xv   := xv +1;

  end if;

elsif j=6 then
     if xv = 1 then
          if nvl(:a1,0) <> cnt then
            go_item('a1');
            stmsg;
            exit;
          end if;
     elsif xv=2 then
          if nvl(:a2,0) <> cnt then
            go_item('a2');
            stmsg;
            exit;
          end if;
     elsif xv=3 then
          if nvl(:a3,0) <> cnt then
```

```
          go_item('a3');
          stmsg;
          exit;
        end if;
elsif xv=4 then
        if nvl(:a4,0) <> cnt then
          go_item('a4');
          stmsg;
          exit;
        end if;
elsif xv=5 then
        if nvl(:a5,0)<> cnt then
          go_item('a5');
          stmsg;
          exit;
        end if;
elsif xv=6 then
        if nvl(:a6,0) <> cnt then
          go_item('a6');
          stmsg;
          exit;
        end if;
end if;
 while xv< 6 loop
     if xv=2 then
```

```
        if :a3 is not null or :a4 is not null or :a5 is not null or :a6 is not null then
          stmsg;
          raise form_trigger_failure;
        end if;
      elsif xv=3 then
        if :a4 is not null or :a5 is not null or :a6 is not null then
          stmsg;
          raise form_trigger_failure;
        end if;
      elsif xv=4 then
        if :a5 is not null or :a6 is not null then
          stmsg;
          raise form_trigger_failure;
        end if;
      elsif xv=5 then
        if :a6 is not null then
          stmsg;
          raise form_trigger_failure;
        end if;


      end if;
      xv:=xv+1;
    end loop;

READ_IMAGE_FILE('C:\master\semester2\csunplugged\prog\smile.bmp','BMP','IMG6
');
```

```
        set_item_property('img6',visible,property_true);
        -- al := show_alert('aok');
        :ind := 1;
      end if;
   end loop; -- columns
end;
END;
```

- code of check button of first lesson screen:

```
declare
al number;
begin
if :a1=1 and :a2=1 and :a3=1 and :a4=1 and :a5= 1 and :a6 is null
  and :b1=1  and :b2=1  and :b3=3  and :b4 is null  and :b5 is null and :b6 is null
  and :c1=1 and :c2=4 and :c3 is null and :c4 is null  and :c5 is null and :c6 is null
  and :d1=1 and :d2=1 and :d3=2 and :d4=1  and :d5 is null and :d6 is null
  and :e1=0 and :e2=5 and :e3 is null and :e4 is null  and :e5 is null and :e6 is null then
READ_IMAGE_FILE('C:\master\semester2\csunplugged\prog\smile.bmp','BMP','IMG4
');
   set_item_property('img4',visible,property_true);
   al := show_alert('aok');
else
READ_IMAGE_FILE('C:\master\semester2\csunplugged\prog\sad.bmp','BMP','IMG4');
   set_item_property('img4',visible,property_true);
   al := show_alert('ano');
end if;
end;
```

- code of check button of second lesson screen:

```
declare
al number;
begin
if :v11=1 and :v12=0 and :v13=0 and :v14=0 and :v15= 1
  and :v21=1 and :v22=0 and :v23=1 and :v24=0 and :v25= 1
  and :v31=1 and :v32=0 and :v33=0 and :v34=0 and :v35= 1
  and :v41=1 and :v42=1 and :v43=1 and :v44=0 and :v45= 1
  and :v51=0 and :v52=0 and :v53=0 and :v54=0 and :v55= 1 then

READ_IMAGE_FILE('C:\master\semester2\csunplugged\prog\smile.bmp','BMP','IMG4
');
   set_item_property('img4',visible,property_true);
   al := show_alert('aok');
else

READ_IMAGE_FILE('C:\master\semester2\csunplugged\prog\sad.bmp','BMP','IMG4');
   set_item_property('img4',visible,property_true);
      al := show_alert('ano');
end if;
end;
```