HÖGSKOLAN
Dalarna

Master Thesis in Science Communication

Md Khademul Islam

Supervisor: Lars Broman

Local supervisor: Ernst van Groningen

Pupils' Interaction with a Science Center: Communication Perspective Analysis

HDa-SC-11

Contents

Abstract 5
1. Introduction 6
1.1 Place of Field Work 6
1.2 Background: Why and How the Project Was Chosen 6
1.3 Aim of the Study 7
1.3.1 Objectives 7
1.3.2 Hypothesis 8
1.4 Previous Knowledge, Previous Studies 8
1.5 Theoretical Background 11
1.6 Acknowledgments 15
2. Method 17
2.1 The Title of the Research 17
2.2 Field Study 17
2.3 Study Population and Sampling 17
2.3.1 Sampling Method 18
2.4 Data Collection 18
2.5 Data Collection Method 18
2.5.1 Pre and Posttest 18
2.5.2 Interviews 22
2.6 Data Analysis 22
2.6.1 Statistical Analysis of Pre and Posttest Data 22
2.6.2 Analysis of Student's and Teacher's Interviews Data 23
3. Pre and Posttest and Interview 24
3.1 Pretest 24
3.2 Posttest 25
3.3 Interviews of Students 25
3.3.1 Typical Answers of Students to Different Questions of Interview 26
3.4 Interviews of Teachers 28
3.4.1 Prime Answers of Teachers to Different Questions of Interview 28
4. Results 32
4.1 Results of Pre and Posttest 32
4.1.1 Mean Score of Students in Pre and Posttest 32
4.1.2 Difference of Mean Score between Post and Pretest among Different Classes 33
4.1.3 t-Test of Mean Score among Classes 33
4.1.4 Comparison of Mean Score between Girls and Boys in Pretest 34
4.1.5 Comparison of Mean Score between Girls and Boys in Posttest 35
4.1.6 Comparison of overall Mean Score between Girls and Boys in Pre and Posttest 36
4.1.7 Increased of Mean Score between Post and Pretest by Girls and Boys 36
4.1.8 t-Test of Increased Mean Score by Girls and Boys 37
4.1.9 t-Test of Mean Score between Girls and Boys 38
4.1.10 Mean Score in Pre and Posttest by Different Age Group Students 40
4.1.11 Age Effect on Pre and Posttest Score 40
4.2 Results of Student's Interviews 41
4.2.1 Source of Information about Science and Technology 42
4.2.2 Learning Science First Time and Source of Learning 42

4.2.3 Student's Visit at Science Centers 43
4.2.4 Leisure Time Activities of Students 45
4.2.5 Grades Given by the Students to the Exhibits 45
4.2.6 Reasons for Enjoying Exhibits 47
4.2.7 Attracting and Holding Power of Exhibits 48
4.2.8 Learning in Science Center 49
4.2.9 Evaluation of Exhibits Labels (On the Basis of Information Supplying Function) 50
4.2.10 Learning in Planetarium 50
4.2.11 Student's Evaluation about Their Visit at the Science Center at Dalarna University 52
4.3 Results of Teacher's Interviews 53
4.3.1 Source of Information about Science and Technology 53
4.3.2 Learning Science First Time and Source of Learning 53
4.3.3 Teacher's Visit at Science Centers 54
4.3.4 Leisure Time Activities of Teachers 54
4.3.5 Grades Given by the Teachers to the Exhibits 55
4.3.6 Reasons for Enjoying Exhibits 56
4.3.7 Attracting and Holding Power of Exhibits 56
4.3.8 Learning in Science Center 57
4.3.9 Evaluation of Exhibits and Planetarium Programs 57
4.3.10 Learning by Watching Planetarium Programs 58
4.3.11 Teacher's Evaluation about Their Visit in the Science Center at Dalarna University 58
4.3.12 Comparison between the Exhibits of Dalarna University and Framtidsmuseet 59
4.3.13 Teacher's Future Plan Their Visit in the Science Center at Dalarna University 59
4.3.14 Best Environment for Student's Learning 59
4.4 Validity and Reliability 60
4.4.1 Validity 60
4.4.2 Reliability 61
5. Discussion 62
5.1 Students' Existing Knowledge on Science 62
5.2 Learning in a Science Center 63
5.3 Role of Science Center as Science Communicator 66
5.4 Pupils' Interaction with a Science Center 68
References 70
Appendices 74
Appendix A 74
A.1 Data of Questionnaires of Pretest 74
A.2 Data of Questionnaires of Posttest 78
A.3 Data of Student's Interview Questions and Answers. 81
A.4 Data of Teacher's Interview Questions and Answers. 86
Appendix B 88
B.1 Questionnaires of Student's Interview 88
B.2 Questionnaires of Teacher's Interview 91

Abstract

The purpose of this study was to investigate pupils' knowledge about science and what role science center is playing as a medium of communication to increase knowledge among students. This study also tried to find out pupils' interaction: how they use science center as a source of scientific information, what they learn from their visit to a science center, their pattern of communication with it. This project also measured attraction, holding and learning power of exhibits of the science center at Dalarna University in Borlänge and learning power of planetarium program and slide show of Stella Nova Planetarium at Dalarna University.

The subjects of this study consisted of students of class seven and eight and teachers of an urban school in Borlänge, Sweden. To find out students' learning in a science center a pre and post visit test were conducted through questionnaires. Interview method by questionnaires was also used to explore pupils' interaction with science center.

The results of this study show that students learn by their visit to a science center but learning was not statistically significant (0.05).Girls learnt better than boys. School classes that have better pre-knowledge about science before a visit to a science center learnt worse than other classes having less pre-knowledge. Girls and boys interact with a science center in different ways. Science center is playing important role as a science communicator.

Keywords: science center, science communication, visitor studies, interaction, interviews, pre and posttest, planetarium, exhibits, questionnaires, informal learning.

1. Introduction

1.1 Place of Field Work

The science center at Dalarna University in Borlänge, Sweden. The science center consisted of two main parts: (1). Exhibits (2). A planetarium (Stella Nova). Most of the exhibits of this science center were built by the Masters' students of science communication of Dalarna University as partial fulfilment for their courses named Introductory Museology and Applied Museology.

The exhibits of this science center can be divided into 3 groups. They are:

(1) Exhibits on Mirrors : This exhibition includes different exhibits like Flat Mirror, Chess Mirror, Corner Reflector Mirror, Curve Mirror, Up-down Mirror, Periscope, Kaleidoscope, Parallel Mirrors (Look into Infinity), Images Mixer (Zebra Mirror), Light Reflector Squares.

(2) Mathematical Exhibits : This exhibition includes such as Make a cubic, Make a pyramid 1, Make a pyramid 2, Pythagoras and the squares, Geometrical figures, 6. Tic Tac Toe (Luffarschack), T Puzzle, Tangram Puzzle, Martas mattor, Maze (Labyrinten), 25-Squares (kvadraten), Something we do by ourselves 1(Solitar), Something we do by ourselves 2 (Solitar), Something we do by ourselves 3 (Solitar), Something we do by ourselves 4 (Solitar), Naum Gabo, Magic Squares 1, Magic Squares 2, Magic Squares 3, Mathematics in the World exhibits.

(3) Miscellaneous Exhibits: This exhibition includes the exhibits like The Ring on the Stick, The Ames Room, Nail Chair, Boom Crash, Strength of My Hand, Reaction Time, Pyramid, Confusing Colours, Disorientation Maze, How I Really Look Like, The Structure of My Ear, Flipper, What Makes the Lines Look Curve, Lamp and Song, Green House Effect.

1.2 Background: Why and How the Project Was Chosen

Generally there are four functions of communication: to inform, to educate, to entertain and to persuade (Berlo, 1960). Science center is a medium for conveying information to the general public about science and technology. It has some advantages to inform people about science. They are: (1) the visitors come to science center with a fairly clear expectation. Here the visitors expect to see science and to do something with science. (2) The science center has the abilities to convey science on a human scale. The very best science center presents science in an understandable and interesting way that makes the environment of science center funny, joy and playful. So science center can educate people by supplying entertainment (Nursall, A. 2003).

People visit science center to fulfil their needs. The needs are to satisfy a personal sense of identity, to create a sense of value within the world, and to fulfil personal intellectual and emotional needs (Brown et al, 1989). Different people interact with/visit science center for

different reasons. For example, adults visit science center to satisfy their intellectual curiosity and stimulation. They want to fulfil their needs for getting relaxation and enjoyment (Ballantyne and Packer, 2005). They take their children to the science center because they think this kind of visit will supply their children education and entertainment (Rounds, 2004). Interest and motivation of people are the main reasons to visit science center (Hoffstadt, 2002).Social interaction are also a reason for visiting the science center (Perry, 1993). Dierking and Falk (1994) have stated that visitors come to the science center mainly to have fun or to learn.

Science center can educate people because it is the right environment for learning for two reasons (Salmi, 2003). Firstly, it is a place where visitors can learn science by interacting with the exhibits. Secondly, it is an environment where knowledge can be gained in an open study environment, without following strict curriculum. In a science center, visitors spend time by reading labels, playing, experimenting with the exhibits, interacting socially, and observing phenomena and other visitors' actions (Quin, 1990; Dierking and Falk, 1994; Diamond, 1999).

Science center has the abilities to inform and educate people about science. It can also supply entertainment through education. By informing, educating and supplying entertainment science center can persuade people in favour of science especially it can influence students to take science as their future career. But what role science center is playing in informing and educating people especially school students about science? We don't know the exact answer of this question due to lack of research in this field. It is necessary to conduct research in this field. So after consultations with Lars Broman and Ernst van Groningen Science Communication, Dalarna University, I have chosen this project.

1.3 Aim of the Study

The purpose of this study is to find out students' science center interaction pattern and learning from their visit to a science center.

The objectives of this study are to investigate the following questions:

1.3.1 Objectives

1. What do students learn from their visit in a science center?

2. Is there any significant difference among students' learning in a science center on the basis of different gender, age and school class?

3. What is the relation between prior knowledge of students about science and increased of knowledge by a science center visit?

4. What is the role of a science center as a science communicator?

5. Why and how the students interact with a science center?

These questions are practical and relevant to find out the pattern of interaction between students and a science center. The results from this study would be useful to find out the role of science center in learning and as a science communicator. The results will also help to increase the role of science center in learning process.

1.3.2 Hypothesis

The following hypotheses are derived from the above questions.

1. Learning is achieved through a visit to a science center.

2. Learning in a science center varies in different school classes, gender and age groups of students.

3. School classes that have better pre-knowledge about science before a visit to a science center learn better than other classes having less pre-knowledge.

4. Science center plays significant role as a science communicator.

5. Girls and boys interact with a science center in a different way.

1.4 Previous Knowledge, Previous Studies

Studies related to interaction, learning and science centers are very limited. The paucity of extensive research results related to science centers should not be surprising. Research on learning in museums and science centers is hard to do because of

> "*the episodic nature of the interaction, the divergent backgrounds of the visitors, the free-form nature of a museum visit itself and the non-verbal character of the experiences that museums particularly excel in providing. But it is also just those features of the museum experience that make the question of learning in museums so interesting and worthy of study*" (Semper, 1990, p.3).

According to Falk 1982; Falk and Dierking 1992, there was very little early research into learning, teaching and education in science centers, and few data are reliable and valid. Research into science centers increased during the late 1980s (Salmi, H. 1993).

Eva Insulander discussed some important studies related to learning in science centers and museums in her research titled 'Museums and Learning-- a research overview' (http://www.smvk.se/content/1/c4/54/70/Museer%20och%20l%C3%A4rande%20%C3%B6vers%C3%A4ttning%20(3).pdf). She wrote:

> *Literature reviews of museums and learning have been published in England, USA and Australia in the past few years. Research Centre for Museums and Galleries (RCMG), Leicester, published a bibliographic overview in 2002, covering research between 1990-1999. The overview shows how the area of research has evolved. During the 70s and 80s museum-pedagogical research primarily treated North American, positivist and quantitative studies. These were often supported by learning models from the behaviourist psychology and by sociological models from theories of mass communication. The assumption was that if media of communication was optimally developed, learning would occur……. The journal Science Education published an issue on research on museums and learning in the summer of 2004. The editors are Lynn Dierking,*

> *Kirsten Ellenbogen and John Falk, active at the Institute of Learning Innovation in Annapolis, USA. This theme issue was a part of a mission by the National Science foundation with the purpose of reflection over previous research commitments and draw the guidelines for the development of praxis, evaluation and future research. The different articles in the journal consist of selected contributions to a closed conference around the common theme; "What do we know about learning at museums after a decade of research?"* (Insulander, 2005, p.11 and 12).

The articles of the journal Science Education were related to the areas of research such as families' learning and learning in the interface between school and museum. Research on school-visits to museums mostly paid attention to the students' perception of the museum and in school. From these studies it was found that children's interaction with museums varies due to their pattern of visit whether the visit is alone or with their families. This type of research has also proven that informal learning at science centers has been able to strengthen the students' understanding of scientific concepts, and has also increased their interest for natural science. (Insulander, 2005).

Rennie and McClafferty (1995) synthesize educational research about learning in interactive science and technology centers from numerous sources and conclude that:

> *'Visits to interactive science and technology centers, museums, aquariums, and zoos provide valuable motivational opportunities for students to learn science and they affect students' learning. Overall, the research suggests that students usually find visits enjoyable but both the amount and nature of their cognitive and affective learning vary. The factors examined in the research literature indicate that learning is influenced by the extent to which students are familiar with the setting, their prior knowledge, the match between the cognitive level of students and the thought processes required by the exhibits, the degree of structure of the visit, the provision and nature of the cues for learning and the social aspects of the visit.'*

From recent studies we have found that students understanding of science can be changed by visiting science center (Anderson, 1999). Learning that occurs in a science center depends on various factors of learner such as previous knowledge, interests, mediation by different interpersonal communication medium such as relatives, friends, teachers, parents, influenced by other sources of information like books, mass media, schools, family members, friends, Internet (ibid).

Judy Diamond studied the behaviour of family groups and found that they spent different times to different exhibits. They spent less than one minute to most of the exhibits and at a few exhibits they spent longer time from 5 to 30 minutes (Diamond, 1986).

There are very few studies of the effect that science centers have on students' career choice. Woolnough (1994) showed that extracurricular science activities encouraged students to study science at school and to pursue science careers.

Coventry (1997) surveyed university students. She found that 80% of students studying for science based careers had visited the science center in Perth, Australia at least once whereas 64% of students who were not studying for science-based careers had visited Scitech.

Similar findings were made by Salmi (1993) in Finland. There is evidence that youth programs in science centers have encouraged participants to pursue careers in science teaching (Siegel 1998).

Falk and Dierking (2000), summarize the key points about documenting learning from museums as follows:

> • *'Over the years providing compelling evidence for learning from museums has proved challenging. This is not because the evidence did not exist, but rather because museum learning researchers, museum professionals, and the public alike historically asked the wrong questions and searched for evidence of learning using flawed methodologies.*
>
> • *Recent research using an appropriate search image and set of assessment tools strongly supports the premise that museum learning experiences facilitate some degree of learning in virtually all participants.*
>
> • *Visitors learn in all kinds of museums about all facets of human knowledge, including history, science, and art. Visitors learn broad generalizations and show generalized increases in understanding and interest; however, the specifics of what they learn are normally highly personal and unique.'*

Anderson (1999) writes:

> *'There are several areas in the fields of learning and museum studies which are under-researched, in particular, the processes of learning resulting from museum-based experiences; the role of prior knowledge in learning resulting from museum experiences; the criteria for design of post-visit activity experiences; and effects of post visit experiences on subsequent learning.'*

There is a need for new methods in science centers interaction and learning research. Some researchers strongly believe that informal education should not be studied using classical quantitative methods alone (Diamond 1982). This is supported by the latest trends in educational science (Erickson, 1986). All research into informal learning must be conducted very carefully: the imprecise data and reports based on anecdotal evidence are already more than sufficient (Falk and Dierking 1992). Quantitative as well as qualitative methods have been used in the earlier studies, often combined. An increasing number of researchers however emphasize the importance of qualitative methods, where interviews are the most common method of documentation.

Early studies of learning at museums originated to a great extent from an experimental investigation design, which for example measured the knowledge of visitors before and after a visit. The studies were however limited in several ways; it was difficult to confirm the results through control groups and since the methods were strongly controlled and one had to decide what variables to test beforehand, it meant that unexpected results were missed. Lately more qualitative research methods have been developed, adjusted to the museum environment. Such studies contain observations of the learning, interviews and analysis of artefacts (drawings, photos etc.) that the learners have produced in connection to the visit. (Rennie et al, 2003).

The majority of research studies were found to concentrate on the role of science centers in learning for a short period of time. There is a need for more long period time studies to measure the impact of science centers in learning. Some recent, long-term studies demonstrate that visits to science centers foster further interest in science and stimulate further enquiry far into an individual's life. New ways of questioning visitors are showing that almost all visitors gain some degree of learning from their experiences in science center. There is a need for more research into the influence of a science center in learning.

1.5 Theoretical Background

Science literacy at the citizenry level is very important for building science and technology capability and capacity in a nation. People can learn about science from various sources like talking with parents, friends, relatives, from teachers in the class room, by reading books/journals/newspapers, by watching mass media(television, radio, films), by using the internet, by visiting science centers and museums and from other sources like nature etc.

> "*Learning can take place in schools but also in out-of-school settings. The latter could happen while watching television, reading books, talking to other people, surfing on the internet and in museums"* (Crane et al., 1994).

Learning in out-of-school settings is often called informal learning (Dierking et al., 2003). People visit science center for different reasons such as to get entertainment and to learn something new. Science center visits always happen in a social context (Falk and Dierking, 1992). Most often people visit science center in a group: family, friends, colleagues etc. Those who do come alone will most likely interact in some way or another with science center staff or other visitors (Falk and Dierking, 2000). This interaction with other people influences each person's science center experience.

Science center tries to give education through entertainment. It provides one of the best opportunities for informal learning (Hofstein and Rosenfeld, 1996). Among the researchers of science education, it is well known that extracurricular activities are an important part in supporting the formal learning process (Tunnicliffe, 1999). Museums and science centers have a unique role in learning they bring real things to people who might not have the chance to see those objects, organisms and ecosystems in their natural setting.

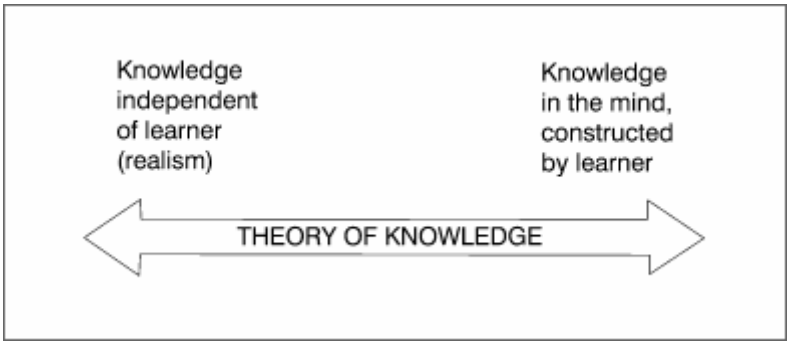
At science center visitors can learn about science and technology through play with interactive exhibits. But does this offered opportunity for learning also result in learning? This question has puzzled researchers for at least two decades (e.g., Falk, 1983; Falk et al., 1986; Falk and Dierking, 1992; Rennie and McClafferty, 1996; Borun and Driftas, 1997; Falk and Dierking, 2000; Duensing, 2002; Rennie et al., 2003) and much has been written about learning from interactive museums. The general conclusion is that the science center experience is highly individual and the exact knowledge a visitor gains at science center has proven very difficult to measure.

The classic pretest-posttest research design, which assumes that all subjects experience the same treatment, is unsuitable since the experience is so individual and furthermore meaningful control groups are difficult to find (Falk and Dierking, 1992; Crane et al., 1994; Rennie et al., 2003). But difficult to measure though researchers do agree that learning is achieved from a science center visit (Semper, 1990; Wellington, 1990; Falk and Dierking, 1992; Davis and Gardner, 1993;; Rennie and McClafferty, 1996; Falk and Dierking, 2000). For any consideration of learning in museums and science centers, we can ask an epistemological question, what is the theory of knowledge applied to the content of the exhibitions? We also need to ask a question about learning theory, How do we believe that people learn?

An educational theory consists of two major components: a theory of knowledge and a theory of learning (Hein, 1998). In order to consider how a museum and science center is organised to facilitate learning, we need to address both what is to be learned and how it is to be learned. Hein (1995) mentioned

> *"Our beliefs about the nature of knowledge, our epistemology, profoundly influence our approach to education. It makes a difference whether we believe that knowledge exists independently of the learner, as an absolute, or whether we subscribe to the view that knowledge consists only of ideas constructed in the mind. Plato believed in the existence of ideal forms, independent of the learner. Thus, for him, learning consisted of arriving at knowledge through an intellectual process. Conversely, Berkeley believed that knowledge existed only in the mind of the knower".*

We can represent this epistemological dichotomy as a continuum, with the extreme positions at each end, as illustrated below:



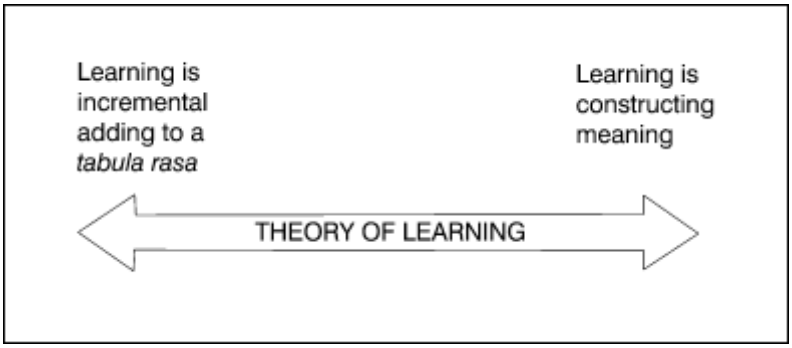
This diagram was taken from the article "The Constructivist Museum" by Hein G E (1995).

The second component of an educational theory encompasses our beliefs about how people learn our psychology of learning. According to Hein (1995)

> "*One assumes that learning consists of the incremental assimilation of information, facts and experiences, until knowledge results. This view leads to a behaviourist position; to the conclusion that learning consists of the addition of a myriad number of simple associations (responses to stimuli) and that the resultant 'knowing' is simply the aggregate of these small steps. Usually associated with this view is the belief that the original condition of the mind is a tabula rasa, and that all that is known has been acquired through experience. Locke is the best known proponent of this view*".

A diametrically opposed view of learning postulates that the mind constructs schemas and that learning consists of selecting and organising from the wealth of sensations that surround us. This synthetic view of learning is exemplified by Piaget's work. Proponents of this view also usually take the position that certain structures, such as learning language, are part of the anatomy with which we are born (Vigotsky. L S, 1962).

This second dimension of educational theory can also be represented by a continuum along the dimension of the process of learning thus:



This diagram was taken from the article "The Constructivist Museum" by Hein G E (1995).

There are at least four rich themes in education theory that especially relate to the learning activities found in museums and science centers. These comprise curiosity or intrinsically motivated learning in education, multiple modes of learning, play and exploration in the learning processes, and the existence of self-developed world views and models among people who learn science (Semper, R.J. 1990).

Intrinsic factors-such as curiosity, enjoyment in learning and mastery of challenge-also form potent motivational tools. Curiosity is a fundamental drive in humans and animals alike, and for obvious evolutionary reasons learning is an enjoyable activity (ibid). Mihaly Csikszentmihalyi (1988) has studied intrinsically motivated activities from rock climbing to chess playing. He makes the point that this kind of learning succeeds only when the challenge is close to but slightly greater than the skill level of the person and when feedback is immediate. If the challenge is too easy, there is nothing to question; too hard, and there is no chance to feel the sense of accomplishment that accompanies success. This notion argues both for creating a variety of exhibits that match the interests of many different visitors and for creating a variety of levels within each exhibit to maximize the chance that something will connect with the visitor in a meaningful way. Not every exhibit will be of interest to every person.

In science centers and museums, learning is multisensory, and the exhibits support many learning styles and abilities. Exhibits are visually exciting and most have a text to help explain what is going on. But they also produce sounds and encourage touching. Exhibits often use interesting kinetic experiences, play on words, spatial relationships and intriguing sounds as well as text and images. Because of this richness, museums and exhibits have the opportunity to connect with many different learning modes that people use (Semper, R.J. 1990).

Howard Gardner has pointed out in his book Frames of Mind (Basic Books, 1991) that we learn and develop intelligences in a multiplicity of ways. There are different ways one might categorize these intelligences, including linguistic, musical, logical-mathematical, spatial and bodily kinaesthetic. Traditionally we think of science education as being primarily logical-mathematical. There are certain concepts, however, that can be reinforced by other kinds of learning (Semper, R.J. 1990). An exhibit at the Ontario Science Center in Toronto gives visitors a kinaesthetic sense of the relationship between electric energy and work (ibid).

Play and exploration are important in the process of learning and marks the beginning of real learning (Papert, 1980). Play is rarely considered a significant part of learning (Hodgkin, 1985). In fact, play is considered an activity for kids, and often not a serious one at that. The playful atmosphere of science centers leads many people to think of them as places only for children. But play is a serious matter in science education. It leads to the development of skills in observation and experimentation and the testing of ideas, and it provides an opportunity to independently discover order in nature (Semper, R.J. 1990).

Early in life, most people develop a sophisticated world view to explain the everyday events that they see. One is struck, when talking to visitors in the informal atmosphere of a museum, by the variety of differing views about how the world works, many seemingly 'incorrect' from a scientific point of view. Science centers and museums are uniquely able to respond to the highly variable baseline scientific knowledge of the visitors. By creating exhibits that vary in both subject matter and style, a museum can provide a potential for meeting the comprehension level of many different people (Semper, R.J. 1990).

Learning in science center has been discussed by different researchers. George E. Hein (1993) mentioned nine Principles of learning. They are:

1. *Learning is an active process in which the learner uses sensory input and constructs meaning out of it.*
2. *People learn to learn as they learn: learning consists both of constructing meaning and constructing systems of meaning.*
3. *The crucial action of constructing meaning is mental: it happens in the mind. Physical actions, hands-on experience may be necessary for learning, especially for children, but it is not sufficient; we need to provide activities which engage the mind as well as the hands.*
4. *Learning involves language: the language we use influences learning.*
5. *Learning is a social activity: our learning is intimately associated with our connection with other human beings, our teachers, our peers, our family as well as casual acquaintances, including the people before us or next to us at the exhibit.*
6. *Learning is contextual: we do not learn isolated facts and theories in some abstract ethereal land of the mind separate from the rest of our lives: we learn in relationship to what else we know, what we believe, our prejudices and our fears*
7. *One needs knowledge to learn: it is not possible to assimilate new knowledge without having some structure developed from previous knowledge to build on. The more we know, the more we can learn. Therefore any effort to teach must be connected to the state of the learner must provide a path into the subject for the learner based on that learner's previous knowledge.*
8. *It takes time to learn: learning is not instantaneous. For significant learning we need to revisit ideas, ponder them try them out, play with them and use them. This cannot happen in the 5-10 minutes usually spent in a gallery (and certainly not in the few seconds usually spent contemplating a single museum object.) If you reflect on anything you have learned, you soon realize that it is the product of repeated exposure and thought.*
9. *Motivation is a key component in learning. Not only is it the case that motivation helps learning, it is essential for learning.*

Hein (1998, p 216) discusses that learning can only occur when visitors can connect to what they already know, can make an association between what they bring to the exhibition and what is presented. He argues that Visitors do “make meaning” in museums; they construct an understanding from what they see, touch, and manipulate. Bitgood et al (1994) states that exhibits function best when they relate to visitors´ prior interests. Roschelle (1995) expresses that a large body of findings show that learning proceeds primarily from prior knowledge and only secondary from the presented materials. Perry (1992) argues six factors for a successful museum experience that leads to learning: curiosity..confidence, challenge, control, play, and communication.

The contextual model of learning (Falk and Dierking, 2000) outlines three overlapping contexts each contributing to the interactive experience. The contexts are: the personal context, the sociocultural context, and the physical context. These three contexts contribute to and influence the interactions and experiences that people have when engaging in free-choice

learning activities such as visiting museums. Thus, the experience, and any free-choice learning that results, is influenced by the interactions between these three contexts.

The personal context describes all the personal characteristics that a person brings to a free-choice learning situation including his or her interests and motivations, learning style preferences, prior knowledge and experience, each very critical component of successful experiences (and learning). Motivation and emotional connection also play an important role in this context. Falk and Dierking (2000) posits that all new learning is constructed from a base of pre-knowledge and so argues that in the museum context assimilative processes are far more frequent than accommodative. The personal context stipulates that people's learning is self- motivated (ibid.). Visitors have to feel free, be connected with meaningful activities and be able to control their activity and learning. Visitors need many choices and challenges that match their skills and use current knowledge to construct new knowledge (ibid.). Learning is aided when expectations are realised (ibid.). Furthermore, visitors' expectations open doors to the curiosity and desire to explore (Blossom, 2004). In short, prior knowledge, interests and beliefs make learning highly personal (Falk and Dierking, 2000).

The sociocultural context encompasses factors that recognize that learning is both an individual and a group experience. What someone experiences and learns let alone why and how someone engages in such experiences, are inextricably bound to the social, cultural and historical context in which that experience and learning occurred. The sociocultural context is apparent when social groups in the science center share information and beliefs, help each other understand and interpret the exhibits and experiences (ibid.).

The physical context is related to both the architecture of the science center building, the interior decoration and the design and form of exhibits. The physical context also a contributing factor to learning (ibid.). Visitors feel safe, comfortable in the science center and they know what others expect from them, so the learning occurs more easily and they obtain the experiences more fully (ibid.).

The above-presented theories of learning and contextual model of learning were used in this research for understanding learning in a science center.

1.6 Acknowledgments

The author of the current research wishes to express his thanks to Professor Lars Broman, main supervisor of this research project as well as the chair and coordinator of Master's program in Science Communication for giving me the opportunity to study the program at Dalarna University. The author also thanks him for his effective and useful lectures during performing the program as well as his effective efforts, help, support, advice, guidance, and suggestions throughout doing internship and planning my investigation and writing the dissertation.

The author also wishes to thank to his local supervisor Ernst van Groningen, Associate Professor, Science Communication, Dalarna University. The completing of this thesis would not have been possible without the assistance, guidance, advice of my local supervisor. The author also thanks him for translating the English texts to Swedish (such as knowledge testing questions and interview questions for students) and Swedish text to English (such as comments of visitors appeared on the interview questionnaire sheets).

The researcher expresses his appreciation to his internship supervisor Per Broman, Lecturer, Science Communication, Dalarna University for his lectures during performing the programs

and also for his help for learning how to run the planetarium of Dalarna University (Stella Nova).

He would like to thank warmly to Professor Hannu Salmi of Science Communication and Head of research and Development at Heureka, the Finish Science Center for his valuable and practical lectures about Research Methodology during the program. The author of this study would also like to thank Maria Björkroth, Lecturer Science Communication, Dalarna University for her support and guidance and valuable comments about my thesis.

The writer of this dissertation would like to thank all the teachers and students of Jakobsgårdskolan, Borlänge, Sweden for their cooperation during visiting the science center, filling out the questionnaires and taking part in interviews.

The researcher also wants to thank his two fellow students: Salah Uddin and Joseph Bayeck for their cooperation during internship. He would like to thank all the students of science communication program, the university staff and everybody who has been helpful to him during doing the program and writing this dissertation.

2. Method

2.1 The Title of the Research

The title of this current research is “Pupils' Interaction with a Science Center: Communication Perspective Analysis**”.** Here the most important word ‘interaction’ means how many times and why the students visit science centers, what they achieved from their visit (the achievement may be learning something new, getting entertainment and fun), how they deal with exhibits, how much time they spend with every exhibit. Other important words of this research are ‘communication perspective analysis’ meaning the effectiveness of science center as a science communicator especially in learning.

2.2 Field Study

The field research of this project was conducted in the science center at Dalarna University in Borlänge from April to June 2005.

2.3 Study Population and Sampling

The sample size of the study was 178, students and teachers of an urban school in Borlänge, Sweden, both male and female. There were 173 students (Girls 79, Boys 74) of class 7 and 8, aged between 13 to 16 years and 5 teachers (Female 4, Male 1, aged between 36 to 46 years). The justification of selecting this sample size is to make the study truly representational of the complex mix of young people. This group of persons is very important for any society in the world. The reasons underlying selecting school students as subject of study being their age level. Some studies reveal, in the western world young peoples decreasing interest in science in particular the women (Quistgaard, 2005). After a certain period of time, these students leave the school to enter university or the job market. Therefore, the awareness of science and technology among this segment of population has an impact upon their career choice. So it is important to measure the knowledge of students about science, to investigate the sources of science information and their effectiveness. It is also important to find out how science communicator can spread science information effectively among mass people especially school students.

2.3.1 Sampling Method

In this study for pre and posttest all students (173) of class 7 and 8 of an urban school in Borlänge were selected but in pretest 153 and in posttest 130 students participated, rest of the students didn't participate either in pre or post test due to sickness, bad weather and another reasons. Among of them 110 students participated both in pre and posttest.

For student's interviews 42 students (girls 21 and boys 21) were chosen by using random sampling method.

For teacher's interviews all the teachers who visited with the students in the science center at Dalarna University were chosen.

2.4 Data Collection

Data for this research was collected in May-June 2005 in the science center at Dalarna University in Borlänge. The science center includes different exhibits and planetarium (Stella Nova). Most of the exhibits of the science center have been built by the students of science communication.

2.5 Data Collection Method

The researcher of this project used different methods such as pre and posttest and interviews for data collection.

2.5.1 Pre and Posttest

To get an insight into some of the student's pre-knowledge about science and technology a pretest was conducted. The test was made by questionnaires. There were 10 questions and they were multiple choice system. The students were asked to put circle (O) which they think the correct answer of each question.

These questions were handed out to the students some days ago before their visit in the science center at Dalarna University. The questionnaire was divided up into 3 parts:

Part 1: There were 2 questions related to general science.

Part 2: There were 4 questions related to planetarium.

Part 3: In this part there were another 4 questions related to exhibits.

These questions were as follows:

Part-1: Questions about General Science

1. According to modern research approximately how old is our good mother ‘Earth’?

A. 5 billion years
B. 15 billion years
C. 25 billion years
D. 50 billion years
E. 500 billion years

2. Dinosaurs extinct 65 million years ago but why?

A. Collision between an Earth Crossing Asteroid and Earth
B. Devastating floods
C. Drinking much alcohol
D. Environmental pollution
E. Lack of food

Part-2: Questions about Planetarium

3. What is the closest star to Earth?

A. Venus
B. Sirius
C. Spica
D. Proxima Centauri
E. Sun

4. Which constellation resembles a large ‘W’?

A. Big Dipper
B. Gemini (the twins).
C. Cassiopeia
D. Andromeda
E. Orion

5. We know that we live in a galaxy. What is the name of our galaxy?

A. The Milky Way
B. Andromeda
C. The Cartwheel galaxy
D. The Magellanic Clouds
E. The Triangulum galaxy

6. Comet Halley was close to the Earth in the year 1986, but when it will return again?

A. 2051
B. 2080
C. 2091

D. 2041
E. 2061

Part-3: Questions about Exhibits

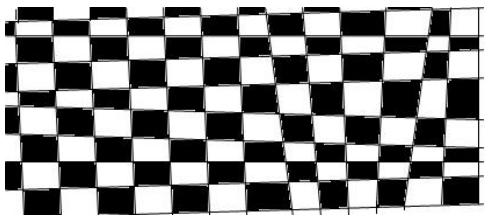
7. What is the normal reaction time for human being?

A. 0.05 seconds
B. 0.15 seconds
C. 0.45 seconds
D. 0.75 seconds
E. 1.00 seconds

8. We can measure the force or strength of our hand by pressing the handles of the two pincers. What is the metric unit of force?

A. Pound
B. Ton
C. Newton
D. Gram
E. Newton-Pounder

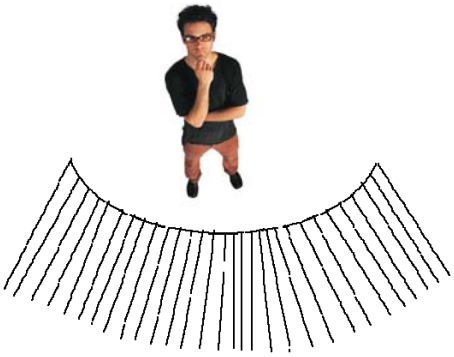
9. If we set several black and white boxes in several straight lines then they will look like curve. Because



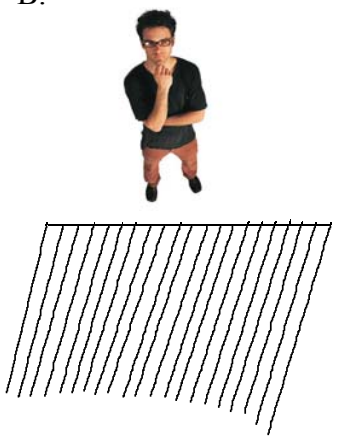
A. they are not straight
B. of our eyes
C. the visitors don't use glasses
D. the brain interprets black boxes to become bigger than white boxes
E. they are curve

10. In the figure below, you see 5 persons that look in strangely formed mirrors. In which image will the person see himself as he really is (i.e. not mirrored), with his right side to the right and his left side left)

A.

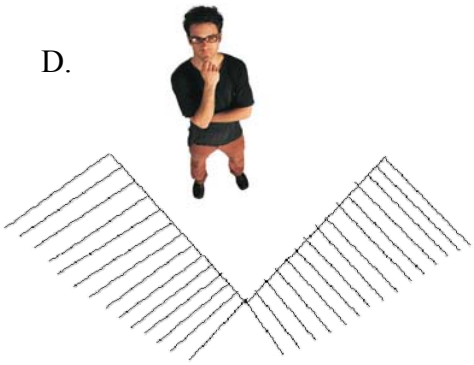


B.



C.

D.



E.

In order to investigate what students learn by their visit in science center a posttest were made after their visit in the science center at Dalarna University. This test consisted of the same questions as the pretest.

2.5.2 Interviews

In order to find out effective medium for science communication and pattern of visitor's interaction with exhibits/science centers, interview was performed with 42 students (Girls 21, Boys 21) and 5 teachers after their visit in the science center at Dalarna University in Borlänge. The interview was conducted with at least 3 and at most 6 students from each class and all teachers who visited with the students. They were interviewed on the basis of written questions.

2.6 Data Analysis

Data from pre and posttest were entered into an Excel file to be analyzed statistically. Then SPSS computer program was used in order to make the various statistical analyses of the data.

2.6.1 Statistical Analysis of Pre and Posttest Data

The data of this study were analyzed by using various statistical methods like dependent *t* tests, Analysis of Variance (ANOVA).

In this study we made t-Test of the data of pre and posttest because we want to investigate what students learnt from their visit in the science center at Dalarna University. So we need to make a compare between post and pretest. This test supplied us the mean scores of students both in pre and posttest and this test also help us to assess whether the means of pre and posttest are statistically different from each other. This analysis is appropriate whenever we want to compare the means of two tests.

t-Test Formula

$$t = \frac{\overline{X}_T - \overline{X}_c}{\sqrt{\frac{Var_T}{n_T} + \frac{Var_c}{n_c}}}$$

The formula for the t-Test is a ratio. The top part of the ratio is just the difference between the two means or averages. The bottom part is a measure of the variability or dispersion (Dispersion refers to the spread of the values around the central tendency. There are two

common measures of dispersion, the range and the standard deviation. The range is simply the highest value minus the lowest value of the scores).

The top part of the formula is easy to compute -- just find the difference between the means. The bottom part is called the standard error of the difference.

Formula for the Standard error of the difference between the means

$$SE\left(\overline{X}_T - \overline{X}_C\right) = \sqrt{\frac{Var_T}{n_T} + \frac{Var_C}{n_C}}$$

$$\text{t-value} = \frac{difference\ between\ group\ means}{variability\ of\ groups}$$

The t-value will be positive if the first mean is larger than the second and negative if it is smaller. After computing the t-value we have to look it up in a table of significance to test whether the ratio is large enough to say that the difference between the groups is not likely to have been a chance finding. To test the significance, we need to set a risk level (called the alpha level). In most social research, the "rule of thumb" is to set the alpha level at .05. This means that five times out of a hundred we would find a statistically significant difference between the means even if there was none (i.e., by "chance"). In this study we also set the alpha level at 0.05.

p-value: The p-value is the smallest level at which we can reject the null hypothesis in favour of the alternative with the given data.

Degrees of Freedom: In this study, the degrees of freedom are the sum of the students in both pre and posttest minus 2.

Variance: The variance is simply the square of the standard deviation.

One-Way ANOVA In order to investigate the age effect on test score we used One-Way ANOVA method. This method compares the mean of one or more groups based on one independent variable (or factor). Some important features of this analysis are as follows:

Between Age: In One-Way ANOVA method, between age means the variance of different age groups. In this study there are 4 age group of students (13, 14, 15 and 16 years) so here between age means the variance of these 4 groups of students.

Within Age: It means the variance among one age group of students. For example in this study in 13 years age group there are several students. The variance among the students of 13 years is within age.

F is a ratio of Sum of Squares between age divided by degrees of freedom and Sum of Squares within age divided by degrees of freedom.

2.6.2 Analysis of Student's and Teacher's Interviews Data

Data of interviews both from students and teachers also entered into an Excel file. Then the data of student's interviews were analyzed by dividing girls and boys separately.

3. Pre and Posttest and Interview

Data that were collected from the students and teachers can be divided into four main categorizes: (1) Data of pretest: this was collected from the students before their visits in the science center at Dalarna University (2) Data of posttest: It was also collected from the students after their visit to the science center, (3) Data of student's interview: This type of data was obtained from the students after their visit in the science center and (4) Data of teacher's interview after their visit.

3.1 Pretest

To get an insight into some of the student existing knowledge about science the researcher of this study handed-over questionnaire among the students of class seven and eight of an urban school in Borlänge. This test was conducted some days before their visit to the science center at Dalarna University. A total of 153 student participated in the pretest, among them there were 79 girls and 74 boys of different classes. Table 3.1shows the number of collected data based on class and gender of students in pretest.

Table 3.1: The number of collected data based on class and gender of students in pretest

Class	Pretest		Total
	Girl	Boy	
7A	12	6	18
7B	5	7	12
7C	5	9	14
7D	7	9	16
7E	11	8	19
8A	6	6	12
8B	6	9	15
8C	6	7	13
8D	13	4	17
8E	8	9	17
Total	79	74	153

All the data from pretest were transferred to an Excel file for data analysis. Table A.1 in appendix A, shows the final arranged data. B.1 in appendix B shows the questionnaires of pretest.

3.2 Posttest

The posttest was made after the science center at Dalarna University visit and it consisted of the same questions as the pretest. A total of 130 student participated in the posttest, among them there were 65 girls and 65 boys of different classes Table 3.2 shows the number of collected data based on class and gender of students in posttest.

Table 3.2: The number of collected data based on class and gender of students in posttest

Class	Posttest		Total
	Girl	Boy	
7A	5	4	9
7B	6	8	14
7C	5	8	13
7D	8	9	17
7E	8	8	16
8A	7	3	10
8B	4	10	14
8C	5	4	9
8D	10	4	14
8E	7	7	14
Total	65	65	130

All the data from posttest were transferred to an Excel file for data analysis. Table A.2 in appendix A, shows the final arranged data. B.1 in appendix B shows the questionnaires of posttest.

3.3 Interviews of Students

After their visit in the Borlänge Science Center 42 students (girls 21 and boys 21) of different classes were interviewed. Table 3.3 shows the number of collected data based on class and gender of student's interview.

Table A.3 in appendix A, shows the complete data of student's interview. Section no B.2 in appendix B shows the questionnaires of student's interview. Some prime answers of student's interview have been presented in section 3.3.1.

Table 3.3: The number of collected data based on class and gender of student's interview

Class	Gender		Total
	Girl	Boy	
7A	1	2	3
7B	3	2	5
7C	2	2	4
7D	2	2	4
7E	2	2	4
8A	2	2	4
8B	2	2	4
8C	2	2	4
8D	3	3	6
8E	2	2	4
Total	21	21	42

3.3.1 Typical Answers of Students to Different Questions of Interview

In this study 42 students were chosen for interview. The interviews were conducted on the basis of written questions. The answers of student's interview have been arranged in table A3 in appendix A and questions of interview were presented in section no B.2 of appendix B Here we are presenting most typical answers of students.

(1). How can you get information about science and technology?

By reading books, from mass media, visiting science centres and museums, talking with parents, friends and relatives, from school.

(2). How did you first learn about science?

From teachers, visiting science centres and museums, from mass media, from parents, friends, relatives, by reading books.

(3). Have you ever visited science centres (such as Framtidsmuseet or Tom Tits in Södertälje) and museums?

Never visit at science centers and museums, Only visit at museum, Only visit at science center, Science centers and museums both visit.

(4). If your answer is 'yes' please mention how many times?

One time, Two times, Three times, Four times, 5-9 times, 10 times, 11-above times, I can't remember.

(5). Why do you visit science centres and museums? Because

They give us fun, They teach us science in a understandable way, There we can learn more than to class room, They present many new things, More enjoyable than Class, It was mandatory from school.

(6). If your answer of question no 3 is ‘no,’ please mention why you didn’t visit science centres and museums?

Lack of time, Lack of interest, Lack of information.

(7). How do you spend your leisure time?

Using internet, playing computers games, going to friends and relatives, Playing Games, Reading books/ Newspapers, Watching TV/Movies.

(8). In Dalarna University you have visited several exhibits. Please mention or describe the names of three exhibits that you enjoyed most and give them grade (best=1, second best=2, third best=3).

The Ring On The Stick, Strength Of My Hand, Reaction Time, Gravity Cone, Nail Chair, T-Puzzle, Pyramid, Flat Mirror, Images Mixer (Zebra Mirror), The Ames Room, Periscope, Up-Down Mirror.

(9). Can you tell why did you enjoy those three exhibits? (Please mention the reasons).

Funny, Easy to understand (need not to read label for understand, one can try by himself/ herself), It is new and new things can be learned**,** for good instructions and labels**,** Interesting/ These exhibits are concrete and capture interest.

(10). During your visit in Dalarna University how many exhibits attracted you to visit them? (Please mention the number or the approximate number).

1-3, 4-6, 7-10, 11-Above exhibits.

(11). On average how much time did you spend in every exhibit that attracted you? (Please mention the approximate average time).

1-60, 61-120, 121-180, 181-220, 221-280, 281-320 and 321-Above seconds.

(12). Have you learnt anything by visiting the exhibits of Dalarna University?

I learnt, I didn’t learn.

(13). If your answer is ‘yes’, please mention what have you learnt?

Lot about science, Lot about different things/ Mirrors, How to measure reaction time and strength of hand, How to build a T with puzzle parts and How P works for perpendicular triangles.

(14). If your answer is ‘no’, please mention the reasons?

Boring, Difficult to understand, Lack of new things and the exhibits labels are in English.

(15). Do you think the exhibits labels of Dalarna University supplied you enough information regarding their operation?

Yes, I think the exhibits labels of Dalarna University supplied me enough information regarding their operation
No, the exhibits labels of Dalarna University didn’t supply me enough information.

(16). Which part of the planetarium program of Dalarna University did you like best?

The astronomy history show, the starry sky and the constellations, both of the astronomy history show and the starry sky and the constellations I like best.

(17). Did you learn anything new by watching the planetarium program of Dalarna University?

Yes, I learnt, No, I didn't learn.

(18). If your answer is 'yes', please mention what did you learn?

Lot about stars/ planets/ astronomy/ space/, Name of different constellations and what they look like, Galaxy and its contents.

(19). If your answer is 'no', please mention why didn't you learn?

It was boring, Difficult to understand, higher number of constellations**.**

(20). Did you enjoy your visit at Dalarna University?

I enjoyed, In between, not enjoyed.

(21). What did you like best during your visit at Dalarna University?

The exhibitions, the planetarium show, both, other things.

3.4 Interviews of Teachers

Five teachers (Female 4, Male 1) of an urban school in Borlänge, Sweden, were interviewed by written questions after their visit in the science center at Dalarna University. The answers of teacher's interview have been arranged in table A4 in appendix A and questions of interview were presented in section no B.3 of appendix B. Some prime answers of teacher's interview have been presented in section 3.4.1.

3.4.1 Prime Answers of Teachers to Different Questions of Interview

(1). How can you get information about science and technology?

By reading books, from mass media, visiting science centres and museums, talking with parents, friends and relatives.

(2). How did you first learn about science?

From teachers, visiting science centres and museums, from mass media, from parents, friends, relatives.

(3). Have you ever visited science centres (such as Framtidsmuseet or Tom Tits in Södertälje) and museums?

I visited at Science Centers and Museums,
I never visited at Science Centers and Museums.

(4). If your answer is ‘yes’ please mention how many times?

Four times, 10 times, 16 times.

(5). Why do you visit science centres and museums? Because

They give us fun, they teach us science in an understandable way, there we can learn more than to class room, and they present many new things.

(6). If your answer of question no 3 is ‘no,’ please mention why you didn’t visit science centres and museums?

No one answered this question.

(7). How do you spend your leisure time?

Using internet, visiting science centers 6 museums, playing computers games, going to friends and relatives, playing games, gardening, walking outside.

(8). In Dalarna University you have visited several exhibits. Please mention or describe the names of three exhibits that you enjoyed most and give them grade (best=1, second best=2, third best=3).

Mathematical exhibits, Flat Mirror, Images Mixer (Zebra Mirror), Periscope, Up-Down Mirror, 3-D shadow.

(9). Can you tell why did you enjoy those three exhibits? (Please mention the reasons).

Funny, Easy to understand (need not to read label for understand, one can try by himself/ herself), It is new and new things can be learned**,** for good instructions and labels**,**
Interesting/ These exhibits are concrete and capture interest.

(10). During your visit in Dalarna University how many exhibits attracted you to visit them? (Please mention the number or the approximate number).

1, 3, 5, 7, 15 exhibits.

(11). On average how much time did you spend in every exhibit that attracted you? (Please mention the approximate average time).

180, 240, 300 seconds.

(12). Have you learnt anything by visiting the exhibits of Dalarna University?

I learnt,
I didn’t learn.

(13). If your answer is ‘yes’, please mention what have you learnt?

About mathematics,
About mirrors.

(14). If your answer is ‘no’, please mention the reasons?

Lack of new things.

(15). Do you think the exhibits labels of Dalarna University supplied you enough information regarding their operation?

Yes, I think the exhibits labels of Dalarna University supplied me enough information regarding their operation
No, the exhibits labels of Dalarna University didn’t supply me enough information.

(16). Which part of the planetarium program of Dalarna University did you like best?

The astronomy history show,
The starry sky and the constellations.

(17). Did you learn anything new by watching the planetarium program of Dalarna University?

Yes, I learnt,
No, I didn’t learn.

(18). If your answer is ‘yes’, please mention what did you learn?

About star signs, about constellations.

(19). If your answer is ‘no’, please mention why didn’t you learn?

It was boring,
I knew it before.

(20). Did you enjoy your visit at Dalarna University?

I enjoyed,
I didn’t enjoy.

(21). If your answer is ‘yes’, please mention the reasons.

The exhibits were interesting, the planetarium program was great, and People were nice.

(22). If your answer is ‘no’, please mention the reasons.

No one answered this question.

(23). What did you like best during your visit at Dalarna University?

The exhibitions,
The planetarium show.

(24). Do you find any difference between the exhibits of Dalarna University and Framtidsmusset in Borlänge?

Yes, I find difference between the exhibits of Dalarna University and Framtidsmusset in Borlänge.
No, I don't find any difference both of them.

(25) If your answer is 'yes', please mention the differences.

The exhibits of Framtidsmuset are more meaningful,
The exhibits of Framtidsmuset are more attractive and educational,
The exhibits of Framtidsmuset are in a better environment.

(26) Do you have any plan to visit the exhibits of Dalarna University again with new students?

Yes, I plan to visit the exhibits of Dalarna University again with new students.
No, I don't have any plan to visit it again.

(27) If your answer is 'yes', please mention the reasons.

I want more of my students will learn from these exhibits and planetarium program,
It is stimulating for pupils.

(28) If your answer is 'no', please mention the reasons.

Nothing new for students,
All of my students have been there.

(29) Which type of environment is best for the students to learn?

Class room, Science centers and museums,
Both class room and Science centers and museums,
Real World.

(30) Please mention some reasons in favour of your answer of question no 29.

You can't learn everything in a one place,
Science centers give entertainment and education at a time.

4. Results

In reporting results, various statistical methods like Analysis of Variance (ANOVA), dependent *t* tests, and Pearson *r* Statistical analysis have been used. The results of this study can be divided into 4 categories: (1). Results from pretest, (2). from posttest, (3). Results of student's interviews and (4) teacher's interviews.

4.1 Results of Pre and Posttest

In order to get an idea about student's knowledge on science a pretest was conducted among the students of class seven and eight of an urban school in Borlänge, Sweden before their visit in the science center at Dalarna University. A total of 153 student participated in the pretest, and 130 in the posttest, among them 110 students participated both in pre and posttest, the rest of them didn't participate (due to sickness, rough weather, going to another place and busy with other activities) either pre or posttest.

In this study we want to investigate what students learn from their science center visit, so we need to compare the results between post and pretest. Therefore, the students who have participated only pre or posttest their results are not useful for this study. For this reason in this chapter we will present the results of 110 students who participated both in pre and posttest. The students were asked to answer 10 different questions related to science. To measure what the students learn from their visits to the science center, the same 10 questions of pretest were also asked the students in posttest.

4.1.1 Mean Score of Students in Pre and Posttest

In the pretest the overall mean score is 4.15 (maximum score 10). Among the classes the highest mean score (6.08) obtained by the class 8D and the lowest (3.13) by 7E. Table 4.1 shows the mean scores of students in pretest of different classes.

In posttest overall mean score is 5.02 (maximum score 10). Among the classes the highest mean score (6.67) obtained by the class 8C and the lowest (3.36) by 7B. Among the students of class 7 the highest mean score gained by the students of 7C (5.73) and the lowest by 7B (3.36). On the other hand among the students of class 8 the highest and lowest mean score gained by the students of class 8C (6.67) and 8E (3.5) respectively. Table 4.1 shows the mean score of students in posttest of different classes.

Table 4.1: Mean Score of Students in Pre and Posttest

Class	Pretest Mean Score	Posttest Mean Score	Difference of Mean Score between Pre and Posttest
7A	3.89	4.56	0.67
7B	3.91	3.36	-0.55
7C	3.73	5.73	2.00
7D	3.69	5.15	1.46
7E	3.13	5.06	1.94
8A	4.00	4.29	0.29
8B	4.63	4.38	-0.25
8C	5.78	6.67	0.89
8D	6.08	5.83	-0.25
8E	3.50	4.86	1.36

4.1.2 Difference of Mean Score between Post and Pretest among Different Classes

The difference between overall mean score of post and pretest is (5.02-4.15) 0.87. Students of 7 different classes increased their mean scores in posttest (table 4.1). The students of class 7C had the highest increase in the mean score (In pretest the mean score 3.73 and in posttest 5.73, difference of mean score 2.00). The students of class 7B (pre 3.91, post 3.36), 8B (pre 4.63, post 4.38) and 8D (Pre 6.08, post 5.83) decreased their mean scores in posttest (table 4.1).

From table 4.1 we find that students who obtained comparatively better mean scores in pretest (Class 8C, pre 5.78, post 6.67, 8D) increased their post scores very limited even in some cases they decreased their score in post test like the students of class 8D (Who obtained the highest score in pretest). On the other hand, the students who obtained relatively lower scores(For example students of class 7C, 7D and 7E) in pretest they increased their scores better than who (For example students of class 8A, 8B and 8C) obtained higher scores. But it is not applicable for all cases like class 7B, students of this class obtained relatively low score (3.91 in pretest); they decreased their score in posttest (3.36).

So above results indicate that students learn from their science center visit but learning does not occur in all cases in all times because learning depends on many factors such as Hein (1998:216) mentioned that learning can happen only when visitors can connect to what they already know with what is presented in the science center. One of the most important factors of learning in science center is curiosity of the students (Perry, 1992). If the students are eager to learn something in the science center then learning can occur.

4.1.3 t-Test of Mean Score among Classes

Though the students of 7 classes out of 10 classes increased their mean scores after their visit in the science center at Dalarna University, all increased mean scores are not statistically significant. The significant mean scores are the scores of students 7E and 8E (0.0001), 7C (0.003) and 7D (0.011). Table 4.2 shows p-value of mean scores of different classes.

The above mentioned results indicate that students learn from their visit in science center. In some cases their learning is statistically significant and other cases are not significant. Actually significant learning in science center depends on various contexts such as personal context, sociocultural context and physical context (Falk and Dierking, 2000). These 3 contexts play important role in visiting science center and successful interaction with exhibits that leads significant learning in science center.

Table 4.2: t-Test of Mean Score among Classes

Class	Mean Score		t-value	Degrees of freedom	p-value (One sided)
	Pretest	Posttest			
7A	3.89	4.56	-1.414	8	0.096
7B	3.91	3.36	0.875	10	0.201
7C	3.73	5.73	-3.496	10	0.003*
7D	3.69	5.15	-2.656	12	0.011*
7E	3.13	5.06	-4.581	15	0.0001*
8A	4.00	4.29	-1.00	6	0.178
8B	4.63	4.38	0.509	7	0.313
8C	5.78	6.67	-1.735	8	0.0605
8D	6.08	5.83	0.897	11	0.1945
8E	3.50	4.86	-6.032	13	0.0001*

* Significant at less than 5% level. ($P<0.05$)

4.1.4 Comparison of Mean Score between Girls and Boys in Pretest

In pretest the overall mean score of girls and boys are 4.05 and 4.24 respectively. It indicates that boys have slightly better knowledge than girls. Both the girls and boys of class 8 scored higher (girls mean score 5.00, boys 4.5) than that (girls 3.07, boys 4.06) of class 7 (Table 4.3). It indicates that the students of class 8 have better knowledge than that of class 7.

As can be seen from table 4.4, the boys in most classes scored higher than girls. The girls of class 8A and 8E scored better than boys (ibid). The highest and lowest mean score by girls of class 8D and 7C are 6.00 and 2.80 respectively. The difference between the highest and lowest mean score by girls is 3.20. It means the gap of knowledge on science exists among the girls of different classes.

On the other hand, boys of class 7A, 7B, 7C, 7D, 7E, 8B, 8C and 8D scored higher than the girls. The highest score by boys is 6.33 of class 8D and the lowest mean score is 2.67 by the boys of class 8A. The difference of mean score between highest and lowest mean score is 3.66. It indicates there is a gap of knowledge on science among the boys of different classes.

The above findings indicate that the gap of existing knowledge on science exists not only between girls and boys but also among themselves.

Table 4.3: t-Test of overall Mean Score between Girls and Boys of class 7 and 8

Class	Gender	Pretest Mean Score	Posttest Mean Score	Increased Mean Score	t-value	Degrees of Freedom	p-value (One sided)
Class 7	Girl	3.07	4.41	1.34	0.462	58	0.323
	Boy	4.06	5.15	1.09			
Class 8	Girl	5.00	5.75	0.75	1.737	48	0.1835
	Boy	4.5	4.64	0.14			

Table 4.4: Mean Score by Girls and Boys in Pre and Posttest in Different Classes

Class	Mean Score in Pretest		Mean Score in Posttest	
	Girls	Boys	Girls	Boys
7A	3.40	4.50	4	5.25
7B	3.00	4.43	2.5	3.86
7C	2.80	4.50	6.2	5.33
7D	3.40	3.88	4.4	5.63
7E	2.87	3.38	4.5	5.63
8A	5.00	2.67	5.25	3
8B	4.33	4.80	4.33	4.4
8C	5.40	6.25	7	6.25
8D	6.00	6.33	6	5.33
8E	3.71	3.29	5.43	4.29

4.1.5 Comparison of Mean Score between Girls and Boys in Posttest

In posttest the overall mean score of girls and boys are 5.09 and 4.95 respectively. It means girls scored higher than boys though they scored worse than boys in pretest. From table 4.3 we find that in posttest the girls of class 8 scored higher (girls mean score 5.75) than that of (girls 4.41) class 7. On the other hand the boys of class 7 scored higher (boys mean score 5.15) than that of class 8 (4.64).

In class 7 boys scored better (5.15) than girls (4.41) and in class 8 girls scored better (5.75) than boys (4.64). This indicates that the boys of class 7 and the girls of class 8 learnt better than the girls and boys of class 7 and 8 respectively from their visit in the science center at Dalarna University.

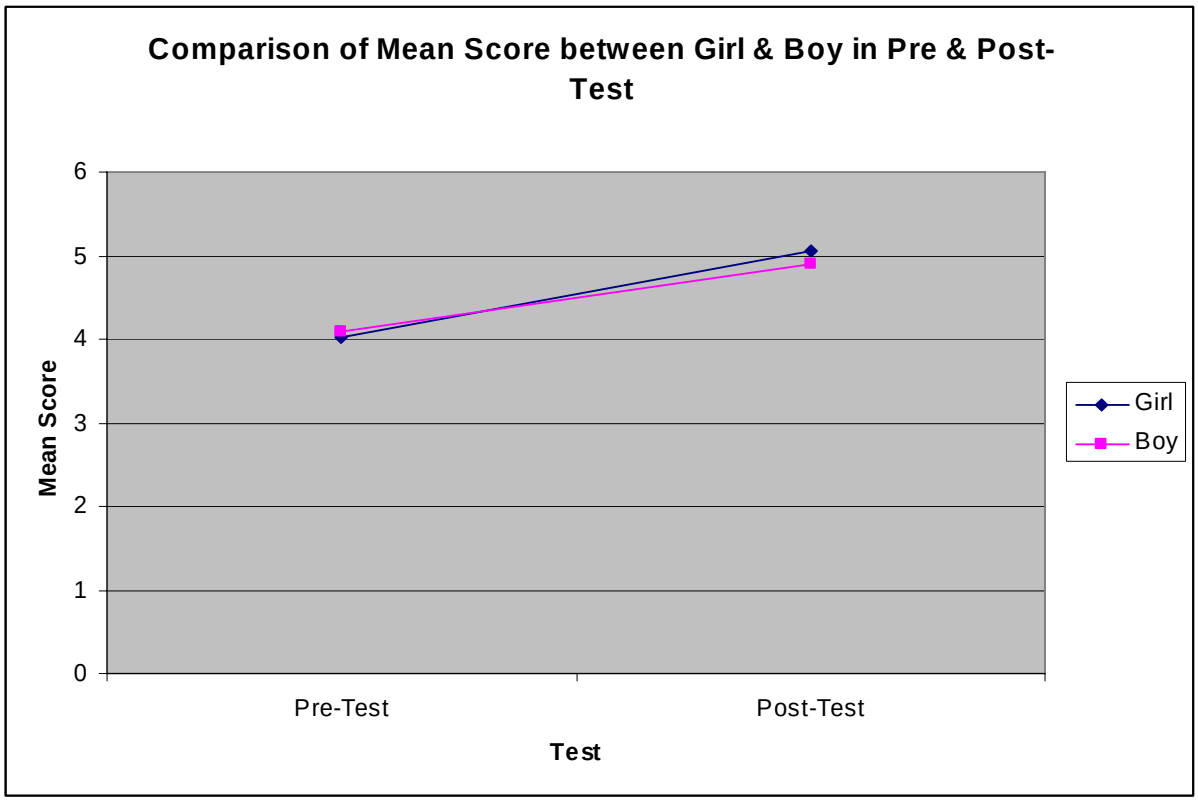
From table 4.4 we can find that in posttest the girls of class 7C, 8A, 8C, 8D and 8E scored better than boys. The highest and lowest mean score by girls are 7.00 and 2.50 by class 8C and 7B respectively. The difference between the highest and the lowest mean score is 4.50. It indicates that learning in science center varies among girls. On the other hand, boys of class 7A, 7B, 7D, 7E, and 8B scored higher than the girls. The highest score by boys is 6.25 of class 8C and the lowest mean score is 3.00 by the boys of class 8A. The difference is 3.25 between the highest and lowest mean score. It indicates that boys learn in science center differently.

The above results indicate that girls and boys learn in science center differently and there are differences of learning not only between girls and boys but also among themselves.

4.1.6 Comparison of overall Mean Score between Girls and Boys in Pre and Posttest

Both in pre and posttest the girls and boys obtained almost equal mean score (in pretest girl's mean score 4.02 and boy's 4.08 and in posttest girl's mean score 5.06 and boy's 4.91.Line diagram 4.5 shows that in pretest the mean score of boys slightly higher than that of girls but in posttest the mean score of boys slightly lower than that of girls.

Line Diagram 4.5: Comparison of overall Mean Score between Girls and Boys in Pre and Posttest



4.1.7 Increased of Mean Score between Post and Pretest by Girls and Boys

From table 4.3 we find that the girls of class 7 increased the highest mean score (increased mean score 1.34). It indicates that they learnt in the science center at Dalarna University better than other boys of class 7 and girls and boys of class 8. The girls (1.34) and boys (1.09) of class 7 both increased better than that of class 8 (increased mean scores of girls 0.75 and boys 0.14).These findings indicate that the students of class 7 learnt better than that of class 8 in the science center.

From table 4.6 we can find that among different classes the girls of class 7A, 7C, 7D, 7E, 8A, 8C and 8E increased their mean scores after their visit in the science center at Dalarna University .The mean score of girls of class 8B and 8D remained unchanged. The girls of class 7B decreased their mean score (pretest mean score 3.00, posttest 2.50).

On the other hand, the boys of class 7A, 7C, 7D, 7E, 8A and 8E increased their mean score. The mean score of boys of class 8C unchanged. The boys of class 7B, 8B and 8D decreased their mean score. Among all the girls and boys the highest mean score increased by the girls of class 7C (increased mean score 3.40). Among the boys the highest mean score increased by the boys of class 7E (increased mean score 2.25).

From the above findings we can find that the majority of mean scores of students of different classes increased. It indicates that learning in science center is highly individual.

Table 4.6: Increased of Mean Score between Post and Pretest by Girls and Boys

Class	Gender	Test		Increased of Mean Score
		Pretest	Posttest	
7A	Girl	3.40	4.00	0.60
7A	Boy	4.50	5.25	0.75
7B	Girl	3.00	2.50	-0.50
7B	Boy	4.43	3.86	-0.57
7C	Girl	2.80	6.20	3.40
7C	Boy	4.50	5.33	0.83
7D	Girl	3.40	4.40	1.00
7D	Boy	3.88	5.63	1.75
7E	Girl	2.87	4.50	1.63
7E	Boy	3.38	5.63	2.25
8A	Girl	5.00	5.25	0.25
8A	Boy	2.67	3.00	0.33
8B	Girl	4.33	4.33	0.00
8B	Boy	4.80	4.40	-0.40
8C	Girl	5.40	7.00	1.60
8C	Boy	6.25	6.25	0.00
8D	Girl	6.00	6.00	0.00
8D	Boy	6.33	5.33	-1.00
8E	Girl	3.71	5.43	1.71
8E	Boy	3.29	4.29	1.00

4.1.8 t-Test of Increased Mean Score by Girls and Boys

The girls of class 7A, 7C, 7D, 7E, 8A, 8C and 8E increased their mean scores in posttest, but not all increased mean scores are statistically significant. The significant p-values are 0.007 (7C), 0.017(7D), 0.021(7E), 0.008 (8C) and 0.0005(8E). So the mean scores (6.20, 4.40, 4.50, 7.00 and 5.43) that were increased by the girls in posttest are statistically significant.

On the other hand, the boys of class 7A, 7C, 7D, 7E, 8A and 8E increased their mean score and not all of them are statistically significant. The significant p-values are 0.0435 (7D), 0.0025 (7E) and 0.009 (8E). So the mean scores (5.63, 5.63 and 5.43) that were increased by the boys in posttest are statistically significant. Table 4.7 shows t-Test of increased mean scores by girls and boys of different classes.

From the results of t-Test we can find that the girls of 7 different classes increased their mean scores in posttest among 5 are statistically significant. On the other hand the boys of 6 different classes increased their mean scores among 3 are significant. It indicates that a

significant number of girls learnt more than boys from their visit in the science center at Dalarna University.

Table 4.7: t-Test of Increased Mean Scores by Girls and Boys

Class	Gender	Test		t-value	Degrees of freedom	p-value (One sided)
		Pretest	Posttest			
7A	Girl	3.40	4.00	-0.885	4	0.213
7A	Boy	4.50	5.25	-1.00	3	0.1955
7B	Girl	3.00	2.50	0.333	3	0.3885
7B	Boy	4.43	3.86	0.934	6	0.193
7C	Girl	2.80	6.20	-4.185	4	0.007*
7C	Boy	4.50	5.33	-2.076	5	0.0465
7D	Girl	3.40	4.40	-3.162	4	0.017*
7D	Boy	3.88	5.63	-1.986	7	0.0435*
7E	Girl	2.87	4.50	-2.489	7	0.021*
7E	Boy	3.38	5.63	-4.025	7	0.0025*
8A	Girl	5.00	5.25	-0.522	3	0.319
8A	Boy	2.67	3.00	-1.000	2	0.2115
8B	Girl	4.33	4.33	_ **	_ **	_ **
8B	Boy	4.80	4.40	0.492	4	0.324
8C	Girl	5.40	7.00	-4.000	4	0.008*
8C	Boy	6.25	6.25	0.000	3	0.5
8D	Girl	6.00	6.00	0.000	8	0.5
8D	Boy	6.33	5.33	1.732	2	0.1125
8E	Girl	3.71	5.43	-6.000	6	0.0005*
8E	Boy	3.29	4.29	-3.240	6	0.009*

* Significant at less than 5% level. (P<0.05)

** The correlation and t cannot be computed because the standard error of the difference is 0.

4.1.9 t-Test of Mean Score between Girls and Boys

From table 4.8 we find that the girls increased more (1.0364) than the boys (0.7091). Though both the girls and boys increased their mean score in posttest but this increase in test score is not statistically significant science p>0.05.

Table 4.8: t-Test of Overall Mean Score between Girls and Boys

Mean Score Increased		t-value	Degrees of freedom	p-value (One sided)
Girls	Boys			
1.0364	0.7091	0.986	108	0.163

Significant at less than 5% level. (P<0.05)

If we compare the t-Test results between class 7 and 8 then we can find that the girls and boys of this 2 classes increased their mean scores in posttest but the p-values of increased score are not statistically significant. From table 4.3, the p-values of class 7 and 8 are 0.323 and 0.1835, both of them are greater than 0.05. So these are not significant.

From table 4.9 we find that both in pre and posttest there are differences in mean score between girls and boys. The differences are not significant in all classes. In pretest the girls and boys of class 7C obtained mean score 2.80 and 4.50 respectively. The p-value of their t-Test is 0.0104 and it is statistically significant. The girls and boys of class 8A in pretest their mean score are 5.00 and 2.67 and in posttest their mean score are 5.25 and 3.00 respectively. The difference of mean score between girls and boys both in pre and posttest are statistically significant because the p-value of pretest 0.0045 and posttest 0.0145 both are <0.05.

In posttest the girls and boys of class 8E obtained mean score 5.43 and 4.29 respectively and the p-value is 0.0085 which is also significant. For other classes the differences of mean scores in pre and posttest between girls and boys are not statistically significant because they are > 0.05.

The above mentioned results indicate that overall there is no significant difference between girls and boys in learning in science center but some significant differences exist between some groups of girls and boys.

Table 4.9: t-Test of Mean Score between Girls and Boys

Class	Test	Mean Score by Girls and Boys		t-value	Degrees of freedom	p-value (One sided)
		Girls	Boys			
7A	Pre	3.40	4.50	-0.921	7	0.194
7A	Post	4.00	5.25	-1.139	7	0.147
7B	Pre	3.00	4.43	-1.254	9	0.1205
7B	Post	2.50	3.86	-1.745	9	0.0575
7C	Pre	2.80	4.50	-2.624	9	0.0104*
7C	Post	6.20	5.33	0.913	9	0.1925
7D	Pre	3.40	3.88	-0.504	11	0.312
7D	Post	4.40	5.63	-1.278	11	0.1135
7E	Pre	2.88	3.38	-0.698	14	0.2485
7E	Post	4.50	5.63	-1.037	14	0.1585
8A	Pre	5.00	2.67	4.183	5	0.0045*
8A	Post	5.25	3.00	3.022	5	0.0145*
8B	Pre	4.33	4.80	-0.573	6	0.294
8B	Post	4.33	4.40	-0.65	6	0.475
8C	Pre	5.40	6.25	-1.374	7	0.106
8C	Post	7.00	6.25	0.902	7	0.1985
8D	Pre	6.00	6.33	-0.277	10	0.394
8D	Post	6.00	5.33	0.664	10	0.261
8E	Pre	3.71	3.29	0.933	12	0.1845
8E	Post	5.43	4.29	2.771	12	0.0085*

* Significant at less than 5% level. (P<0.05)

4.1.10 Mean Score in Pre and Posttest by Different Age Group Students

From table 4.10 we find that both the students of class 7 and 8 of different age groups increased their overall mean score in post test (class 7 pre=3.62, post= 4.82 and class 8 pre=4.78, post= 5.26). The students of class 8 obtained better mean score both in pre and post test than that of class 7. The students of class 7 increased higher mean score (1.2) after their visit at the science center than that of class 8 (increased mean score 0.48).

Among different age groups of students16 years of class 8 obtained the highest mean score (6.00) in posttest. The students of 14 years of class 8 obtained the highest mean score (4.41) in pretest but they obtained the lowest mean score (4.79) in posttest.

From table 4.11 we find that the girls of class 7 scored the lowest mean score (3.62) in pretest but in posttest they increased the highest mean score (1.34).

Table 4.10: Overall Mean Score in Pre and Posttest by Different Age Group Students

Age Groups	Mean Score in Pretest		Mean Score in Posttest	
	Class 7	Class 8	Class 7	Class 8
13	3.81	-	4.93	-
14	3.52	4.83	4.74	5.43
15	2.50	4.74	4.50	4.95
16	-	4.00	-	6.00
Total Mean Score	3.62	4.78	4.82	5.26

Table 4.11: Overall Mean Score in Pre and Posttest by Different Age Groups of Girls and Boys

Age Groups	Mean Score in Pretest				Mean Score in Posttest			
	Class 7		Class 8		Class 7		Class 8	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
13	3.18	4.90	-	-	4.41	5.80	-	-
14	2.90	3.81	5.00	4.62	4.40	4.91	5.76	5.00
15	-	2.50	5.10	4.33	-	4.50	5.70	4.11
16	-	-	4.00	-	-	-	6.00	-
Total Mean Score	3.07	4.06	5.00	4.50	4.41	5.15	5.75	4.63

4.1.11 Age Effect on Pre and Posttest Score

From table 4.12 we find that overall there is no age effect in test score because both in class 7 and 8, their p-values 0.83 and 0.28 respectively which are > 0.05. So both the p-values of class 7 and 8 are not statistically significant.

If we analyze the age effect among different classes and different gender then we find from table 4.13 that in some cases (Class 7A, boy, p-value 0.038, 8C, girl, p-value 0.052 and 8E, boy, p-value 0.046) there are statistically significant age effects.

It indicates that there are age effect on student's pre and posttest scores but in some cases this effect is statistically significant and other cases it is not statistically significant (for example the p-values 0.696, 0.808 of girls of class 7A and 7B respectively).

Table 4.12: One way ANOVA (Analysis of Variance) for Age Effect in Test Score

Class	Sum of Squares		F	p-value
	Between Age	Within Age		
7	1.51(2)*	236.08 (57)	0.183	0.83
8	4.12 (2)	74.36 (47)	1.30	0.28

* Figures within parenthesis shows the respective degree (s) of freedom.
Significant at less than 5% level. (P<0.05)

Table 4.13: One way ANOVA (Analysis of Variance) for Age Effect among Class and Gender

Class	Gender	Sum of Squares		F	p-value
		Between Age	Within Age		
7A	Girl	0.533 (1)*	8.667 (3)	0.185	0.696
7A	Boy	6.250 (1)	0.500 (2)	25.000	0.038**
7B	Girl	1.000 (1)	26.000 (2)	0.077	0.808
7B	Boy	0.381 (1)	15.333 (5)	0.124	0.739
7C	Girl	0.033 (1)	13.167 (3)	0.008	0.936
7C	Boy	0.833 (2)	4 (3)	0.313	0.753
7D	Girl***				
7D	Boy	14.700 (1)	28.800 (6)	3.062	0.131
7E	Girl	1.875 (1)	22.000 (6)	0.511	0.501
7E	Boy	4.200 (2)	13.300 (5)	0.789	0.504
8A	Girl	0.083 (1)	2.667 (2)	0.063	0.826
8A	Boy***				
8B	Girl***				
8B	Boy	6.533 (1)	6.667 (3)	2.940	0.185
8C	Girl	2.450 (1)	0.750 (3)	9.800	0.052**
8C	Boy***				
8D	Girl	0.000 (1)	6.000 (7)	0.000	1.000
8D	Boy	0.000 (1)	2.000 (1)	0.000	1.000
8E	Girl	2.229 (2)	1.200 (4)	3.714	0.122
8E	Boy	2.333 (1)	1.667 (5)	7.000	0.046**

* Figures within parenthesis shows the respective degree (s) of freedom.
** Significant at less than 5% level. (P<0.05)
***There are fewer than two groups for dependent variable dif in split file. No statistics are computed.

4.2 Results of Student's Interviews

In order to find out effective medium for science communication and pattern of visitor's interaction with exhibits/science centers, interviews were conducted with 42 students (Girls 21, Boys 21) of an urban school in Borlänge, Sweden after their visit in the science center at Dalarna University. The interviews were conducted with at least 3 and at most 6 students

from each class. They were interviewed on the basis of written questions (Section no B.2 in appendix B shows the questionnaires of student's interview).

4.2.1 Source of Information about Science and Technology

Most of the students get information about science and technology from books (26 students) and from mass media (25 students). 13 students mentioned science centers and museums as a source of scientific information (Table 4.14)). As a source of information books and mass media have some advantages such as both are often far less expensive and available at home. But according to Persson (2000), science centres have an advantage to different kinds of electronic media that is people's visit in a science center is a social event.

From table 4.14 we can find that the source of information varies between girls and boys. 11 girls mentioned mass media as a source of information on the other hand 14 boys mentioned it. There is a significant gap between girls and boys in mentioning school as source of information-6 girls and only one boy mentioned it. But in mentioning science centers and museums the number is almost the same for girls and boys (girls 7, boys 6).

The above results indicate that different medium inform students about science and technology. Among them books and mass media are playing a more significant role than other media such as science centers and museums.

Table 4.14: Source of Information about Science and Technology

Source	Number of Students		Total
	Girls	Boys	
Books	13	13	26
Mass media	11	14	25
Science centers and museums	7	6	13
School	6	1	7
Parents, friends and relatives	2	4	6
Total	39	38	77

* Students mentioned one more sources at a time

4.2.2 Learning Science First Time and Source of Learning

Most of the students first learnt science from their teachers (Table 4.15). The 2nd highest number of students mentioned parents, friends and relatives. In both cases interpersonal communication is playing vital role in teaching science first to the students. On the other hand, mass media, science centers and other sources are playing fewer roles in teaching science first. Interpersonal communication has some advantages in this perspective. The interpersonal communicator like teachers, parents, friends and relatives always available to the students, they can easily ask them about their curiosities and they can get immediate response. It means this type of communication takes place face to face and students can get feedback instantly. So interpersonal communication is very effective to teach students science in the beginning of their learning time.

From table 4.15 we can find that most of the girls and boys learnt science first from their teachers but number of girls (14) is higher than the boys (9). There are also differences between girls and boys in learning science first from various sources like parents, friends and relatives (girls 4, boys 8), science centers (girls 3, boy 1). It indicates first source of learning varies in the perspective of different gender.

Table 4.15: First Learning Source about Science

Source	Number of Students		Total
	Girls	Boys	
Teachers	14	9	23
Parents, friends and relatives	4	8	12
Mass media	4	6	10
Science centers and museums	3	1	4
Books	1	0	1
Total	26	24	50

4.2.3 Student's Visit at Science Centers

From table 4.16 we can find that most of the students (39 out of 42) visited science centers and museums. Among them the highest number of students (17) visited both science centers and museums. Among them there were 4 girls and 13 boys. It indicates that the number of boys, visited both science centers and museums is greater than that of girls. 14 students (10 girls and 4 boys) visited only at museum on the other hand 8 students (5 girls and 3 boys) visited only at science centers. It indicates that the higher number of students visited at museums more than to science centers and the large number of girls visited at museums and science centers than boys.

Students visit science centers but there are differences in number of visit. From table 4.17 we can find that the highest number (8 out of 39) of students visited 10 times at science centers on the other hand 4 students visited one time. It indicates that students' frequency of science centers visit is very high. In lower frequency (from 1time to 4 times) of science centers visit higher number of boys visited than girls on the other hand in higher frequency (from 5times to 11-above times) higher number of girls visited at science centers than boys. It indicates that girls visited at science centers more times than boys.

Table 4.16: Student's Centers Visit

Pattern of Visit	Number of Students		Total
	Girls	Boys	
Both Science center and museum visit	4	13	17
Museum visit	10	4	14
Science center visit	5	3	8
Never visit	2	1	3
Total	21	21	42

Table 4.17: Frequency of Science Centers Visit

Times of Visit	Number of Students		Total
	Girls	Boys	
1 time	2	2	4
2 times	1	3	4
3 times	1	5	6
4 times	2	3	5
5-9 times	5	0	5
10 times	5	3	8
11-above times	2	2	4
Can't remember	1	2	3
Total	19	20	39

Students visit science centers for different reasons. From table 4.18 we can find that the highest number of students (22 out of 57) visits science centers for getting fun. Another important reason for visiting science centers is viewing new things and learning from it. It means students visit science centers to fulfil their needs.

Most of the reasons for science centers visit are related to free choice learning but there is a reason (mandatory visit by school) is not related to free choice learning. So we can say in most cases students visit science centers willingly but in some cases they are forced to visit at science centers and this is totally opposite from open learning environment's philosophy.

The girls and boys visit science center almost for the same motivations. There are very little differences between the motivation of girls and boys for visiting science center.

Most of the students visit science centers but there are some students who don't want to visit due to lack of time, lack of interest and lack of information (Table 4.19).

Table 4.18: Motivation for Science Centers Visit

Causes for Visit	Number of Students		Total
	Girl	Boy	
Supplying fun	11	11	22
Presenting new things	5	7	12
Teaching science in an understandable way	4	5	9
Mandatory visit	3	3	6
Learn more than to class	2	2	4
More enjoyable	2	0	2
Others	1	1	2
Total	28	29	57

Table 4.19: Reasons for not Visiting Science Centers

Reasons	Number of Students		Total
	Girls	Boys	
Lack of time	1	0	1
Lack of interest	1	0	1
Lack of information	0	1	1
Too expensive	0	0	0
Others	0	0	0
Total	2	1	3

4.2.4 Leisure Time Activities of Students

From table 4.20 we can find that students pass their free time by doing various activities. The highest numbers of students (29 out of 69) go to friends and relatives during this time. It means interpersonal relationship or human relationship activities play dominant role in leisure time. The 2nd highest number of students (22) use internet during this time. It indicates that dependency on technology is increasing day by day and it was predicted by Marshall McLuhan in his famous book 'The Global Village' (Mcluhan etal, 1992).

In leisure time higher number of girls goes to friends and relatives than boys. It indicates that girls maintain more social relationship during leisure time than boys. In other activities during this period the difference between girls and boys is very limited. No student visit science centers during their leisure time.

Table 4.20: Leisure Time Activities of Students

Activities	Number of Students		Total
	Girls	Boys	
Going to friends and relatives	18	11	29
Using internet	12	10	22
Playing computer games	3	5	8
Playing games	1	6	7
Watching TV/movies	1	1	2
Reading books/ newspapers	1	0	1
Visiting science centers	0	0	0
Total	36	33	69

* Students mentioned one more activities at a time

4.2.5 Grades Given by the Students to the Exhibits

Students visited several exhibits in the science center at Dalarna University and they were asked to give them grade (best=1, second best = 2, third best= 3).

From table 4.21 we can find that the students graded 'The Ring on the Stick' as the best exhibit of the science center at Dalarna University. 16 students graded it as the best exhibit. By considering girls and boys separately, it can be seen that among 16 students there were highest number of girls (7 out of 14) and boys (9 out of 16). It means girls and boys separately

graded 'The Ring on the Stick' as the best exhibit of the science center. It indicates that there is no significant gender difference in selecting the best exhibit.

Images Mixer (Zebra Mirror) is the 2nd best exhibit of the science center. It was selected by 6 students. By considering girls and boys separately, it can be seen that among 6 students there was highest number of girls (5 out of 12). On the other hand only one boy graded it as the 2nd best exhibit. The highest number of boys (4 out of 13) graded Gravity Cone as the 2nd best exhibit but no girl graded it as the 2nd best exhibit. It means girls and boys separately Images Mixer (Zebra Mirror) is not the 2nd best exhibit of the science center but girls and boys together it is the 2nd best exhibit. It indicates that in selecting the 2nd best exhibit there are significant gender difference.

Reaction Time and Gravity Cone jointly secured the position of 3rd best exhibit. This selection was made on the basis of how many grades in total they got as best, 2nd best and 3rd best exhibit.

Pictures of the best, 2nd best and 3rd best exhibits of the science center in Dalarna University. The pictures of 'The Ring on the Stick', 'Images Mixer (Zebra Mirror)' and 'Gravity Cone' were taken from the research by Asgari and Nejadian (2004).

The Ring on the Stick

Images Mixer (Zebra Mirror)

Gravity Cone

Reaction Time, photo by Reza Saheban

Table 4.21: Grades Given by the Students to the Exhibits

Name of the Exhibit	The Best Exhibit		The 2nd Best Exhibit		The 3rd Best Exhibit		Total	Overall Grade
	Number of Students		Number of Students		Number of Students			
	Girls	Boys	Girls	Boys	Girls	Boys	Number of Students	1=Best 2=2nd best 3=3rd best
The Ring on the Stick	7	9	0	1	0	1	18	1
Images Mixer (Zebra Mirror)	1	1	5	1	2	3	13	2
Gravity Cone	1	1	0	4	2	0	8	3
Reaction Time	2	1	2	2	0	1	8	3
Pyramid	2	0	0	0	3	2	7	
Strength of My Hand	0	2	1	1	1	0	5	
T- Puzzle	0	1	3	1	0	0	5	
The Ames Room	1	1	1	0	1	0	4	
Flat Mirror	0	0	0	0	1	2	3	
Periscope	0	0	0	1	0	0	1	
Up-Down Mirror	0	0	0	1	0	0	1	
Nail Chair	0	0	0	1	0	0	1	
Total	14	16	12	13	10	9	74	

* All students didn't answer the question

4.2.6 Reasons for Enjoying Exhibits

Table 4.22 shows different reasons for enjoying exhibits. Majority of the students (24 out of 57) mentioned fun as the reason for enjoying exhibits. There are other reasons such as easy to understand, new, good labels and interesting-these were mentioned by almost same number of students.

By considering girls and boys separately, it can be seen that both highest number of girls (14 out of 26) and boys (10 out of 31) enjoyed exhibits due to getting fun from it. In other cases there is very little difference between girls and boys in mentioning reasons for enjoying exhibits.

Table 4.22: Reasons for Enjoying Exhibits

Reasons	Number of Students		Total
	Girls	Boys	
Fun	14	10	24
New	4	5	9
Easy to understand	3	5	8
Good labels	4	4	8
Interesting	1	7	8
Total	26	31	57

* Students mentioned one more reasons at a time

4.2.7 Attracting and Holding Power of Exhibits

From table 4.23 we can find that most of the students (19 out of 39) were attracted by 4-6 exhibits. By considering girls and boys separately, it can be seen that both highest number of girls (8 out of 18) and boys (11 out of 21) were attracted by 4-6 exhibits. In other cases there are also differences between girls and boys in number of exhibits that were attracted by them.

Table 4.23: Number of Exhibits Attracted by Students (According to Their Own Judgements)

Number of Exhibits	Number of Students		Total
	Girls	Boys	
4-6	8	11	19
1-3	6	3	9
7-10	2	5	7
11-Above	2	2	4
Total	18	21	39

From Table 4.24 we can find that majority of the students (15 out of 37) spent on an average 4.5-5.5 minutes in every exhibit. By considering girls and boys separately, it can be seen that both highest number of girls (8 out of 19) and boys (7 out of 18) spent on an average 4.5-5.5 minutes. It means holding power of exhibits don't very due to gender differences.

Table 4.24: Time Spent by Students in Every Exhibit (According to Their Own Judgements)

Average Time in Minutes	Number of Students		Total
	Girls	Boys	
5.5-Above	3	6	9
4.5-5.5	8	7	15
3.5-4.5	1	0	1
3	3	0	3
2	2	1	3
1	2	4	6
Total	19	18	37

4.2.8 Learning in Science Center

Learning power means what the students actually learn by interaction with exhibits/ by their visits at science centers. In this study learning in a science center was investigated by conducting pre and post -test and by conducting interviews with students. On the basis of student's opinion they learnt from their visit at the science center at Dalarna University.

In this study most of the students (34 out of 42) learnt something in the science center. By considering girls and boys separately, we find that girls are more positive in learning science center than boys (19 girls out of 21 learnt in the science center on the other hand 15 boys out of 21 learnt there).It indicates that in science center girls learnt more than boys and this result is similar that was found in posttest (Section 4.1.8).

Table 4.25 shows that students learn different things in science center. From their visit at the science center at Dalarna University, the highest number of students (15 out of 35) learnt about mirrors. The 2nd highest number of students (11) learnt about science.

From table 4.25 we can also find that girls learnt more than boys about science and mirrors. On the other hand, boys learnt more than girls about measuring reaction time, building T with puzzle parts. It means there are differences between girls and boys on learning subjects in science center.

Table 4.25: Learning Subjects in Science Center (Student's Own View)

Learning Subjects	Number of Students		Total
	Girls	Boys	
Lot about different things/ Mirrors	10	5	15
Lot about science	6	5	11
How to measure reaction time and strength of hand	1	2	3
How to build a T with puzzle parts	0	3	3
How P works for perpendicular triangles	0	3	3
Total	17	18	35

Most of the students learn in the science center but there are also some students (8 out of 42) didn't learn anything from their visit at the science center at Dalarna University. It means learning does not occur in science center all times even we found from pre and post test student's knowledge on science decreased after their visit at science center (in table 4.1, students of class 7B, 8B and 8D decreased their score in post test).

From table 4.26 we can find that students didn't learn in the science center for different reasons such as they feel visits in science center as boring due to lack of new things, they couldn't understand the exhibits (for difficulties in operating exhibits and hard to read exhibit's label and understand it).

By considering girls and boys separately, we found that the highest number of boys (4 out of 11) mentioned 'boring' as the number one cause for not learning in the science center but no girl mentioned it as a cause. On the other hand all girls mentioned 'difficult to understand'

as the only one cause for not learning in the science center but only one boy mentioned it as a cause for not learning. It means reasons for not learning in science center vary between girls and boys.

Table 4.26: Reasons for Not Learning in Science Center (Student's Own View)

Reasons	Number of Students		Total
	Girls	Boys	
Boring	0	4	4
Difficult to understand	2	1	3
Lack of new things	0	2	2
The exhibits labels are in English	0	2	2
Total	2	9	11

4.2.9 Evaluation of Exhibits Labels (On the Basis of Information Supplying Function)

One of the main functions of exhibits labels is to inform visitors about the exhibit and how to handle it. Always there is a communication between exhibits labels and visitors. If exhibits labels is capable to supply enough information regarding the exhibit then communication becomes effective and visitors can easily understand what the exhibit wants to say, what's about it, how to operate it.

In the science center at Dalarna University there are some labels in some exhibits. Most of the students (33 out of 42) mentioned that the exhibits labels of this science center supplied them enough information. By considering girls and boys separately, we found that boys (18 out of 21) were more positive on information supplying function than girls (15 out of 21).

4.2.10 Learning in Planetarium

There were two different kinds of planetarium programs during the student's visit at the science center at Dalarna University. They are the astronomy history show and the starry sky and the constellations. From table 4.27 we can find that most of the students (34 out of 42) liked the starry sky and the constellations. Very few students (5 out of 42) liked the astronomy history show.

By considering girls and boys separately, we found that the highest number of girls (19 out of 21) and the highest number of boys (15 out of 21) preferred the starry sky and the constellations. It means both girls and boys liked the same planetarium program so there is no gender difference in preferring planetarium program.

Table 4.27: Student's Favourite Planetarium Program

Planetarium Programs	Number of Students		Total
	Girls	Boys	
The Starry Sky and the Constellations	19	15	34
The Astronomy History Show	1	4	5
Both programs	1	2	3
Total	21	21	42

From student's interviews we found that most of the students (38 out of 42) mentioned that they learnt new things by watching planetarium programs the science center at Dalarna University. There are very few students (4 out of 42) mentioned they didn't learn anything new by watching the programs.

By considering girls and boys separately, we found that the highest number of girls (20 out of 21) and the highest number of boys (18 out of 21) learnt new things by watching planetarium programs. It indicates there is no gender difference in learning by watching it.

From table 4.28 we find that the highest number of students (19 out of 41) mentioned that they learnt about constellations. The 2nd highest number of students (17 out of 41) mentioned by watching planetarium programs the science center at Dalarna University they learnt a lot about stars, planets, astronomy and space.

By considering girls and boys separately, we found that the highest number of girls (13 out of 22) learnt about constellations on the other hand the highest number of boys (10 out of 19) learnt a lot about stars, planets, astronomy and space by watching planetarium programs. It indicates that there is gender difference in learning subjects by watching planetarium programs.

Table 4.28: Learning Subjects by Watching Planetarium Programs

Learning about	Number of Students		Total
	Girls	Boys	
Constellations	13	6	19
Stars/planets/astronomy/space	7	10	17
Galaxy	2	3	5
Total	22	19	41

* Students mentioned one more learning matter at a time

In this study we found that most of the students learnt something new by watching planetarium programs but there were also very few students who didn't learn anything new by watching it. From table 4.29 we can find that the highest number of students (3 out of 6) mentioned that they didn't learn due to the boringness of the programs. The 2nd highest number of students (2 out of 6) mentioned the programs were difficult to understand.

By considering girls and boys separately, we found that there are differences between girls and boys in mentioning the reasons regarding not learning.

Table 4.29: Reasons for not learning by Watching Planetarium Programs

Reasons for not learning	Number of Students		Total
	Girls	Boys	
Boring	1	2	3
Difficult to understand	0	2	2
Higher number of constellations	0	1	1
Total	1	5	6

4.2.11 Student's Evaluation about Their Visit at the Science Center at Dalarna University

From table 4.30 we can find that majority of the students (25 out of 42) enjoyed their visit at the science center at Dalarna University. The 2nd highest number of students (17 out of 42) mentioned that their visit was in between enjoyment and not enjoyment. It means in some cases they enjoyed the visit and in some cases they didn't enjoy it. It is interesting that there was no student who didn't enjoy the visit at all.

By considering girls and boys separately, we found that the highest number of girls (12 out of 21) and the highest number of boys (13 out of 21) mentioned they enjoyed the visit. It indicates that there is no significance difference between girls and boys in the pattern of enjoyment at the science Center.

Table 4.30: Student's Pattern of Enjoyment from Their Visit

Pattern of Enjoyment	Number of Students		Total
	Girls	Boys	
Enjoyed	12	13	25
In between	9	8	17
Not enjoyed	0	0	0
Total	21	21	42

From table 4.31 we can find that the highest number of students (19 out of 42) preferred exhibitions of the science center at Dalarna University. The 2nd highest number of students (15 out of 42) liked planetarium show. So students liked exhibitions slightly more than planetarium show.

By considering girls and boys separately, we found that boys liked exhibitions more than girls (11 boys and 8 girls). Almost equal number of girls and boys (girls 8, boys 7) liked planetarium show. It indicates that in some cases girls and boys liked different things but overall their liking is almost same.

Table 4.31: Student's Liking Matter during Their Visit

Liking Matter	Number of Students		Total
	Girls	Boys	
Exhibitions	8	11	19
Planetarium Show	8	7	15
Exhibitions and Planetarium Show (Both)	4	3	7
Other things	1	0	1
Total	21	21	42

4.3 Results of Teacher's Interviews

In order to explore effective medium for science communication and pattern of visitor's interaction with science centers, interviews were conducted with 5 teachers (Female 4, Male 1) of an urban school in Borlänge, Sweden after their visit at the science center at Dalarna University. The interviews were conducted on the basis of written questions (Section no B.3 in appendix B shows the questionnaires of teacher's interview).

4.3.1 Source of Information about Science and Technology

From table 4.32 we can find that as a source of scientific information books and mass media secured the topmost position. This result is almost similar that we have found from student's interviews (Section 4.2.1, Table 4.14). 3 teachers mentioned science centers and museums as a source of scientific information Table 4.32 shows various sources of information about science and technology. So we can say different medium inform teachers about science and technology. Among them books and mass media are playing more significant role than other medium like science centers and museums.

Table 4.32: Source of Information about Science and Technology

Source	**Number of Teachers**
Books	5
Mass Media	5
Science Centers and Museums	3
Parents, Friends and Relatives	2
Total	15

* Teachers mentioned one more sources at a time

4.3.2 Learning Science First Time and Source of Learning

From table 4.33 we can find that the highest number of teachers (3 out of 8) first learnt science from their teachers. The 2nd highest number of teachers mentioned two sources: parents, friends and relatives and science centers and museums. This result is almost similar that was found from student's interview (Section 4.2.2, Table 4.15). So we can say teachers play most important role in teaching science first to students.

Table 4.33: First Learning Source about Science

Source	Number of Teachers
Teachers	3
Science Centers and Museums	2
Parents, Friends and Relatives	2
Mass media	1
Total	8

* Teachers mentioned one more sources at a time

4.3.3 Teacher's Visit at Science Centers

From the teacher's interviews we found that all 5 teachers visited science centers and museums. If we compare this result with students then we find that there were few students who didn't visit science centers (Section 4.2.3, Table 4.16). It indicates that teachers are more positive in visiting science centers than students but it is important to mention that in this case age is a factor, the average age of the 5 teachers are 41 years on the other hand the average age of the students are about 14 years, so teachers have more chance to visit science centers than students.

All the teachers have visited science centers but there are differences in number of visit. The highest number (3 out of 5) of teachers visited 10 times at science centers and other 2 teachers visited 4 times and 16 times. From table 4.17 we found that the highest number of students also visited at science centers 10 times. It means there are similarities between teachers and students in frequency of science centers visit.

From table 4.34 we can find that teachers visit science centers for different reasons. The most important reason for visiting science centers is to get fun. Another important reason for visiting science centers is viewing new things. Similar results were found from student's interviews (Section 4.2.3, table 4.18). It means both teachers and students visit science centers for same reasons.

Table 4.34: Motivation for Science Centers Visit

Causes for Visit	Number of Teachers
Supplying Fun	4
Teaching Science in a Understandable Way	3
Presenting New things	3
Learn More Than to Class Room	2
Total	12*

* Teachers mentioned one more causes for visit at a time.

4.3.4 Leisure Time Activities of Teachers

From table 4.35 we find that the highest numbers of teachers pass their free time by using internet. If we compare it with students then we can find that the highest numbers of students go to friends and relatives during this time (Section 4.2.4, Table 4.20). It indicates that the highest numbers of teachers are becoming dependent on technology during leisure time on the other hand during this time the highest number of students maintain interpersonal relationship or human relationship. Another important finding from teachers and students interviews that during leisure time teachers visit science centers but no student visits it.

Table 4.35: Leisure Time Activities of Teachers

Activities	Number of Teachers
Using Internet	3
Playing games	2
Playing computer games	2
Going to friends and relatives	2
Visiting science centers	1
Gardening	1
Walking outside	1
Total	12

* Teachers mentioned one more activities at a time

4.3.5 Grades Given by the Teachers to the Exhibits

In the science center at Dalarna University teachers visited several exhibits and they were asked to give them grade (best=1, second best = 2, third best= 3).

From Table 4.36 we can find that most of the teachers graded mathematical exhibits is the best exhibit of the science center at Dalarna University. This selection is very close to their profession. 4 teachers out of 5 teach mathematics (Section A.4, Appendix A) in their school. Most probably their background knowledge inspired them to give such grade.

If we compare the above result with student's interviews then we can find that the students graded the ring on the stick as the best exhibit (Section 4.2.5, Table 4.21). This selection is very much related with their motivation of science centers visit. Most of the students visit science centers to get fun (Section 4.2.6, Table 4.22). The ring on the stick gave them a lot of fun most probably for this reason they gave the highest grade to this exhibit.

From table 4.36 we find that majority teachers selected 3-D Shadow as the 2nd best exhibit. On the other hand the students graded the Images Mixer as the 2nd best exhibit (Section 4.2.5, Table 4.21).

In selecting the 3rd best exhibit, Teachers graded 3 different exhibits as the 3rd best exhibit. The selected exhibits are, Flat Mirror, Periscope and Up-Down Mirror. On the other hand the students graded 2 different exhibits (Reaction Time and Gravity Cone) as the 3rd best exhibit (Section 4.2.5, Table 4.21).

The above results from teacher's and student's interviews indicate that both of them graded different exhibits as the best, 2nd best and 3rd best exhibits of the science center at Dalarna University.

Table 4.36: Grades Given by the Teachers to the Exhibits

Name of Exhibits	Number of Teachers			Total	
	Best Exhibit	2nd best Exhibit	3rd best Exhibit	Teachers	Grade
Mathematical Exhibits	4	-	1	5	1
3-D Shadow	1	1	1	3	2
Up-Down Mirror	-	1	1	2	3
Flat Mirror	-	1	1	2	3
Periscope	-	1	1	2	3
Images Mixer (Zebra Mirror)	-	1	-	1	
Total Teachers	5	5	5	15	

4.3.6 Reasons for Enjoying Exhibits

Table 4.37 shows different reasons for enjoying exhibits. The main reasons for enjoying are: exhibits are interesting, they are new and they are easy to understand. Other reasons are they supply fun and they have good labels. If we compare these reasons with students then we can find that both teachers and students enjoy exhibits for same reasons (Section 4.2.6, Table 4.22).

Table 4.37: Reasons for Enjoying Exhibits

Reasons	Number of Teachers
Interesting	4
Easy to understand	4
New	4
Good labels	3
Fun	3
Total	18

* Teachers mentioned one more reasons at a time

4.3.7 Attracting and Holding Power of Exhibits

Table 4.38 shows that each teacher was attracted by different number of exhibits. The highest numbers of exhibits are 15 and lowest number is single exhibit. Other numbers of exhibits are 3, 5 and7.On an average every teacher was attracted by about 6 exhibits during their visit in the science center at Dalarna University.

Table 4.38: Number of Exhibits Attracted by Teachers (According to Their Own Judgement)

Number of Exhibits	Number of Teachers
15	1
7	1
5	1
3	1
1	1
Total	5

From table 4.39 we can find that 5 teachers spent 3 different average times at each exhibit. Each teacher on an average spent 2.4 minutes.

Table 4.39: Time Spent by Teachers in Every Exhibit (According to Their Own Judgement)

Average Time in Minutes	Number of Teachers
5	2
4	1
3	2
Total	5

4.3.8 Learning in Science Center

Most of the teachers (4 out of 5) learnt something by their visit in the science center at Dalarna University and one teacher mentioned she/he didn't learn anything. The same result was found from student's interviews (Section 4.2.8).

The teachers learnt about mathematics and mirrors from their visit. Their subject of learning is much related with their preferred exhibits and with their profession. Most of the teachers preferred mathematical exhibits (Table 4.36) and most of them teach mathematics in school (Section A.4, Appendix A). There is no significant difference between teacher's subjects of learning and student's subject of learning (student's subjects of learning, section 4.2.8, Table 4.25).

The only one teacher who didn't learn in the science center, in the interview he mentioned that the reasons for not learning is lack of new things in the science center. If we compare the reasons for not learning between teachers and students then we can find that students also mentioned this reason. Besides this they mentioned several reasons (Section 4.2.8, Table 4.26).

4.3.9 Evaluation of Exhibits and Planetarium Programs

From teacher's interviews we found that most of the teachers mentioned the exhibits labels of the science center at Dalarna University supplied enough information about the operation of exhibits. This result is similar that were found in student's interviews (Section 4.2.9).

There were two different kinds of planetarium programs during the teacher's visit at the science center. They are the astronomy history show and the starry sky and the constellations. Most of the teachers liked the starry sky and the constellations, only one teacher liked the astronomy history show. If we compare this result with student's interviews result then we can find both teachers and students liked the same planetarium program (Section 4.2.10, Table 4.27).

4.3.10 Learning by Watching Planetarium Programs

From teacher's interviews we found that majority of the teachers (3 out of 5, 60%) mentioned they learnt new things by watching planetarium programs in the science center at Dalarna University. Other 40% teachers didn't learn anything new. This result is slightly difference from student's learning by watching planetarium programs. From section 4.2.10 we found that most of the students (38 out of 42, 90.48%) learnt new things by watching planetarium programs in the science centetr. It indicates that in more students learnt more than teachers by watching this program.

The highest number of teachers (3 out of 5, 60%) mentioned they learnt about star signs and other 40% teachers learnt about constellations by watching planetarium programs. If we compare this result with students then we find that the highest number of students (19 out of 41, 46.34%) learnt about constellations. The 2nd highest number of students (17 out of 41, 41.46%) learnt a lot about stars, planets, astronomy and space (Table 4.28, section 4.2.10). It indicates that there are some differences between teachers and students in subjects of learning by watching planetarium programs. Majority of the teachers learnt about star signs on the other hand majority of the students learnt about constellations.

From teacher's interviews this study reveals that 40% of teachers didn't learn anything new. The main reason is the teachers knew the information that was supplied by these programs so they didn't find anything new to learn. Other reason is the programs were boring. If we compare this result with students then we can find that the highest number of students (3 out of 6, 50%) didn't learn due to the boringness of the programs. The 2nd highest number of students didn't learn due to difficulties to understand it (Section 4.2.10, Table 4.29). It indicates that there are some similarities and dissimilarities among the causes for not learning by watching planetarium programs between teachers and students. The main cause for not learning for teachers was absences of newness on the other hand for students it was boringness of the programs.

4.3.11 Teacher's Evaluation about Their Visit in the Science Center at Dalarna University

From teacher's interviews we found that all the teachers enjoyed their visit in the science center at Dalarna University. Almost same result was found from student's interviews (Section 4.2.11, Table 4.30). It indicates that there is no difference between teachers and students regarding their enjoyment at the science center.

Teachers enjoyed their visit for different reasons. The highest number of teachers mentioned they enjoyed their visit because the planetarium program was great. According to them the 2nd important cause was the exhibits of the science center were very interesting. The 3rd reason was the people of this science center were very nice.

During their visit in the science center majority of the teachers (3 out of 5, 60%) liked exhibitions and another 40% (2 out of 5) liked planetarium show. If we compare this result

with students we can find from table 4.31 that the highest number of students (19 out of 42, 45.24%) preferred exhibitions. The 2nd highest number of students (15 out of 42, 35.71%) liked planetarium show. It indicates that both teachers and students liked mostly exhibitions and their 2nd choice was planetarium show.

4.3.12 Comparison between the Exhibits of Dalarna University and Framtidsmuseet

From teacher's interviews we found that most of the teachers (4 out of 5, 80%) mentioned there are differences between the exhibits of the science center at Dalarna University and the exhibits of Framtidsmuseet, Borlänge. Only one teacher (1 out of 5, 20%) mentioned she/ he didn't find any difference between the exhibits of this two science centers.

The teachers mentioned 3 differences between the exhibits of the science center at Dalarna University and Framtidsmuseet. According to them the most important difference is the exhibits of Framtidsmuseet are more meaningful than that of Dalarna University. The 2nd important differences are (1) the exhibits of Framtidsmuseet are more attractive and educational than that of Dalarna University; (2) the exhibits of Framtidsmuseet are kept in better environment than that of Dalarna University. It indicates that the teachers gave better grade to the exhibits of Framtidsmuseet than that of the scienece center at Dalarna University.

4.3.13 Teacher's Future Plan Their Visit in the Science Center at Dalarna University

Most of the teachers (4 out of 5, 80%) want to visit the exhibits the science center at Dalarna University and only one teacher don't have any future plan to visit it again with students.

From teacher's interviews we found that the teachers want to visit the exhibits of the science center for 2 reasons. According to them the most important reason is the students will learn by their visit at this science center. Another reason is the future planned visit will be stimulating for students.

We found that only one teacher don't have any plan to visit the exhibits of this science center for two reasons. The most important reason is there is nothing new for students to learn. Another reason is all students already visited these exhibits so they need not to visit it again.

4.3.14 Best Environment for Student's Learning

From table 4.40 we can find that the most of the teachers mentioned the best environment for student's learning is both class room and science centers. It means teachers want to establish a communication between class room and science centers to teach students properly. If we compare the science center and class room separately the we can find that according to one teacher science center is the best environment for student's learning but no teacher mentioned class room as best environment for learning.

Table 4.40: Best Environment for Student's learning

Environment	Number of Teachers
Both science center and class room	4
Science centers	1
Real World	1
Class room	0
Total	6

* Teachers mentioned one more environment at a time

From table 4.41 we can find that the teachers mentioned two reasons for selecting best environment for student's learning. According to them the most important reason is everything can't be learning in one place. It means only class room or science centers are not enough for student's learning. For proper education we need to maintain combination between formal and informal learning.

Table 4.41: Reasons of Best Environment for Student's Learning

Reasons	Number of Teachers
Everything can't be learn in one place	4
Science centers give edu-entertainment at a time	3
Total	7

* Teachers mentioned one more reasons at a time

4.4 Validity and Reliability

4.4.1 Validity

Validity determines whether the research truly measures that which it was intended to measure or how truthful the research results are. In this study the validity of results have been maintained in these ways:

The population of this study did not know about their forth-coming visit in the science center at Dalarna University and posttest, when the questions of pretest were delivered several days before the visit.

Researchers generally ensure validity by asking a series of questions, and will often look for the answers in the research of others. Starting with the research question itself, we need to ask ourselves whether we can actually answer the question we have posed with the research

instrument selected. In this study the researcher also followed the method to ensure the validity of the research questions.

In order to ensure the validity of questionnaire, instrument of this study was pre-tested. We first asked a number of people who know little about the subject matter whether the questions are clearly worded and easily understood (whether they know the answers or not). We also looked to other research and determined what it has found with respect to question wording or which elements need to be included in order to provide an answer to the specific aspect of our research. Sometimes, we asked the same question in different ways or repeated it at a later stage in the questionnaire to test for consistency in the response. This was done to confirm criterion validity.

All of these approaches have ensured the validity of our research instrument.

4.4.2 Reliability

Reliability means that the findings would be consistently the same if the study were done over again. In order to ensure the reliability of research we must first have reliable measures, i.e., stable and/or repeatable measures. If the random error variation in our measurements is so large that there is almost no stability in our measures, we can't explain anything.

There are three major categories of reliability for most instruments: test-retest, equivalent form, and internal consistency. Each measures consistency a bit differently and a given instrument need not meet the requirements of each. Test-retest measures consistency from one time to the next. Equivalent-form measures consistency between two versions of an instrument. Internal-consistency measures consistency within the instrument (consistency among the questions).

Test-retest method could not be applied in this study due to possibility of the subjects learning from the test. This study is based on repeated measures analysis with pretest and posttest. The reliability of such kind of study can be ensured by only conducting the whole study again with new students.

The use of longer tests is often recommended as a method for increasing reliability (Cook and Campbell 1979). In this study each subject had to complete pretest, posttest and interview questions and number of items could not be increased without danger of frustrating the students.

In this study we have worked out mean scores of students of different classes and different age group of students. A group mean is more stable than individual scores. Cook and Campbell (1979) mentioned that “using more aggregated units, e.g. groups instead of individual” is recommended as a way of ensuring reliability. Testing groups instead of individuals is the main approach in pretest and posttest of this study. It is worth to mention that group analysis may not reveal individual differences but the normal characteristics of statistical analysis such as mean, variance and standard deviation reveal individual differences and make it possible to control the effect of individual differences (Salmi, 1993).

5. Discussion

The main results of this study are: (1) Learning is achieved through a visit to a science center. (2) Learning in a science center varies in different school classes, gender and age groups of students. (3). The school classes that have less pre-knowledge on science learnt better by their visit in the science center at Dalarna University than the school classes that have better pre-knowledge. (4). Science center is playing significant role as a science communicator and (5) There are differences between girls and boys in interaction with the science center and planetarium.

The above results support 1st, 2nd, 4th and 5th hypothesis of this study and don't support the 3rd hypothesis. The hypotheses of the study are: (1) Learning is achieved through a visit to a science center. (2) Learning in a science center varies in different school classes, gender and age groups of students. (3). School classes that have better pre-knowledge about science before a visit to a science center learn better than other classes having less pre-knowledge. (4). Science center plays significant role as a science communicator. 5. Girls and boys interact with a science center in different ways.

The discussion in this chapter is made on the basis of the results of the pre and posttest, interviews of student's and teachers. The findings of this research have been compared with hypotheses of this study in order to find out whether these findings support the hypotheses or not. The results of this research are also discussed compared with previous results and theory to find the differences and similarities between the results of this study and previous studies.

5.1 Students' Existing Knowledge on Science

In this study a pretest was conducted to get an idea about the existing knowledge of students on science. Normally the students of class seven and eight don't work a lot with science and technology so we used general questions to test their knowledge. We have found from this study that the existing knowledge of students is in a medium position (on an average their mean score is 4.15 (maximum score 10).

This study explored that knowledge on science varies among the students of different classes. In pretest the highest mean score (6.08) obtained by the students of class 8D and the lowest (3.13) by the students of class 7E. It indicates that there is a clear difference between the knowledge of students of class 8D and 7E (the difference between the highest and lowest mean score is 2.95).

This study indicates that boys have slightly better knowledge about science than girls (overall average mean score of girls 4.24 and boys 4.05 respectively).One of the reasons for less knowledge of girls is that they have decreased interest in science and it was found in some studies in the western world (Quistgaard, 2005).

From this study we have found that in pretest the students (both girls and boys) of class 8 (girls mean score 5.00, boys 4.5) scored better than that of class 7 (girls 3.07, boys 4.06). This

result indicates that the students of class 8 have better pre-knowledge about science than that of class 7.

This study reveals that the differences of pre-existing knowledge on science exist between the girls and boys of different classes. This study also explores that the differences of pre-existing knowledge exist not only between girls and boys but also themselves. Among the girls, the girls of class 8D have the highest and 7C have the lowest knowledge on science (the highest and lowest mean score by girls of class 8D and 7C are 6.00 and 2.80 respectively). Among the boys, the boys of class 8D have the highest knowledge and the lowest is by the boys of 8A (the highest score by boys is 6.33 of class 8D and the lowest mean score is 2.67 by the boys of class 8A).

From this study we have also found that knowledge on science varies among different age group students and generally older students have better knowledge than younger (mean scores of 13, 14, 15 and 16 years students are 3.67, 4.07, 4.41 and 4.00 respectively).

From the above discussion we can find some important results about students' pre-existing knowledge on science. They are: (1). The students of class 8 have better pre-knowledge on science than the students of class 7 and (2). Boys have better pre-knowledge than girls.

5.2 Learning in a Science Center

People learn all the time and throughout their lives. Learning can be formal or informal. The formal learning occurs usually in educational institutions. On the other hand the informal learning can be obtained by watching television, reading books, talking to other people and visiting in science centers and museums (Crane et al., 1994).

The main purpose of this study was to find out students' science center interaction pattern and learning from their visit to a science center. In order to investigate what students learn from their visit to a science center at first we conducted a pretest on the basis of 10 multiples choice questions relating to general science, planetarium and exhibits. Then we invited them to visit the science center at Dalarna University. To measure what they learnt from their visit in the science center we conducted a posttest after their visit. This test consisted of the same questions as the pretest.

From the posttest we found that the students increased their mean score in posttest (in pretest overall mean score 4.15 and in posttest 5.02, so the difference between overall mean score of posttest and pretest is 0.87). This result indicates that students learnt by their visit in the science center at Dalarna University.

From the students and teachers interviews we have found that most of the students (34 out of 42) and most of the teachers (4 out of 5) learnt something by their visit in the science center.

From the results of pre and posttest and interviews of students and teachers we can say that learning occurs during their visit in a science center.

This learning can be achieved by playing or interacting with exhibits or by viewing planetarium shows. From students and teachers interviews we found that they learnt about science and technology by playing with different exhibits. Play is considered a significant part of learning (Hodgkin, 1985). Real learning begins with play (Parpert, 1980). Perry (1993) has specified that the precondition for learning in the science centre is a playful experience with the exhibits.

According to Hein (1993), learning is an active process and time is needed to learn. In this study from students and teachers interviews we found that most of the students on an average played or interact 4.5-5.5 minutes with every exhibit and teachers played on an average 2.4

minutes. It indicates that students and teachers learnt in the science center at Dalarna University by playing with exhibits and they spent several minutes to play with every exhibit. This finding confirms 'The Contextual Model of Learning'; in this model Falk (2002) states that,

> *"Learning is a continues process, a state of becoming, rather than a unique product with distinct and totally quantifiable outcomes*".

One of the hypotheses of this study is 'learning is achieved through a visit to a science center'. This result confirms the hypothesis. Similar results were found in previous studies (Semper, 1990; Wellington, 1990; Falk and Dierking, 1992; Davis and Gardner, 1993; Rennie and McClafferty, 1996; Falk and Dierking, 2000). This result also confirms the findings of the study conducted by Crane et al., (1994).

It is important to mention that there are debates among the researchers about the learning in a science center. There are two reasons for this debate. They are: (1) The measurement of learning: learning which occurs in a science center is very difficult to measure, (2) The definition of learning: Gilbert and Priest (2001) stated these two points in this way:

> "*It has often been debated that measurement of learning which occurs at a science centre is difficult; it is further debated the definition of learning, with one set of workers making a distinction between formal and informal learning while others indicate that this definition is too stringent, learning being influenced by many factors apart from the formal and informal settings".*

Though the students learnt by their visit in the science center at Dalarna University, their learning is not statistically significant (in this study to find out significant learning we used t-Test method. We have discussed about this method in chapter 2, section 2.6.1) in all classes. If we compare the posttest scores of students of different classes with pretest then we can find that the students of 7 classes out of 10 classes increased their mean scores after their visit in the science center at Dalarna University, all increased mean scores are not statistically significant. The significant mean scores are the scores of students 7E and 8E (0.0001), 7C (0.003) and 7D (0.011).

Significant learning in a science center depends on various contexts. According to 'Contextual Model of Learning' by Falk and Dierking (2000) these contexts are:

(1) The personal context: every visitor comes in a science center with some knowledge about science. In this study in pretest we have found that all the students of class 7 and 8 of an urban school in Borlänge obtained mean scores from 3.13 to 6.08 and no student was found who scored 0. It indicates that every student have some pre-knowledge before their visit in the science center at Dalarna University. All new learning is constructed from a base of pre-knowledge (Falk and Dierking, 2000). Every student has some pre-knowledge in science before their visit in the science center but there are differences on pre-knowledge among the students. From pretest we found that 10 different classes scored 10 different mean scores. So they carried different pre-existing knowledge during their visit in the science center at Dalarna University and it may be influenced their learning in the science center. This result confirms 'Principles of Learning' that were mentioned by Hein (1993). He mentioned nine principles of learning. Among of them the two principles are: learning is contextual and one needs knowledge to learn.

According to Falk and Dierking (2000), prior knowledge is the raw material that fuels learning. Learning also depends on pre-interests of the visitors. They mentioned that most of the learning is self-motivated and emotionally and personally satisfying. In this study from student's interviews we have found that though most of the students visit science center to have fun, it means they want to fulfil their personal needs but there are some students who visited the science center at Dalarna University because this visit was mandatory from their school. It indicates they didn't visit from self motivation or pre-interests. Maybe this factor also influenced their learning in the science center.

(2) The sociocultural context: Science center visit always happens in a social context. Usually people visit science center in a group or alone. Falk and Dierking (2000) mentioned that those who do come alone will most likely interact in some way or another with museum staff or other visitors. In this study though the students of different classes visited the science center in groups but during interaction with exhibits there were differences among their interaction pattern with exhibits. Some students interacted within a group and some of them alone. It may be influenced their learning in the science center.

(3).The physical context: This context is related to both the architecture of the science center building and the interior decoration and the design and form of exhibits. The science center at Dalarna University doesn't have any separate building or special place for exhibits. All the exhibits were kept in class room and corridor. Maybe the physical context was not very much attractive to the students and this is proved from teacher's interviews.

In this study teachers were asked to make a comparison between the exhibits of Dalarna University and Framtidsmuseet, Borlänge. From teacher's interviews we found that the teachers mentioned 3 differences between the exhibits of the science center at Dalarna University and Framtidsmuseet. According to them the most important difference is the exhibits of Framtidsmuseet are more meaningful than those of Dalarna University. The 2nd important differences are (1) the exhibits of Framtidsmuseet are more attractive and educational than that of Dalarna University; (2) the exhibits of Framtidsmuseet are kept in better environment than that of Dalarna University. It indicates that the teachers gave better grade to the exhibits of Framtidsmuseet than that of the scienece center at Dalarna University. This factor may have influenced students' learning in the science center.

The above 3 contexts may have played important role in visiting science center and successful interaction with exhibits that leads to significant learning in the science center.

This study explored that students learn from their visit to a science center but learning varies among different classes of students. If we compare the posttest and pretest scores of students of different classes then we can find that the students of class 7C increased the highest mean score (in pretest the mean score 3.73 and in posttest 5.73, difference of mean score 2.00). On the other hand the students of class 8A increased the lowest mean score in posttest (pretest mean score 4.00, posttest mean score 4.29 and increased mean score 0.29). It indicates that learning varies in different class of students.

This study also investigated that learning in a science center varies between girls and boys. From posttest we have found that overall mean score of girls and boys are 5.09 and 4.95 respectively. On the other hand in pretest their mean scores are 4.02 and 4.08 respectively. Increased of mean scores between post and pretest by girls and boys are 1.07 and 0.87 respectively. If we compare the mean scores of girls and boys of post and pretest we can find that in pretest the mean score of boys slightly higher than that of girls but in posttest the mean score of boys slightly lower than that of girls. It indicates that girls learnt better than boys in the science center at Dalarna University.

From students interviews we found that girls are more positive to learn in science center than boys (19 girls out of 21 learnt in the science center on the other hand 15 boys out of 21 learnt there). It indicates that in science center girls learnt more than boys and this result is similar that was found in posttest.

From the current study we have found that learning in a science center varies in different age groups of students. From pre and posttest we found that the students of class 7 of 15 years age group and the students of class 8 of 16 years age group both increased (age group 15 of class 7 pre and post test scores are 2.50 and 4.50 respectively, age group 16 of class 8 pre and posttest scores are 4.00 and 6.00 respectively) the highest mean score (2.00) in posttest than other age groups of students. On the other hand the 15 years age group of students of class 8

increased the lowest mean score (pretest 4.74, posttest 4.95, increased mean score 0.21) in posttest. It means the 15 years age group students of class 7 and 16 years students of class 8 learnt better in the science center at Dalarna University than other age groups of students and the 15 years age group of students of class 8 learnt less than other groups of students. It indicates that learning in a science center varies among different age groups of students.

The 2nd hypothesis of this study is 'learning in a science center varies in different school classes, gender and age groups of students'. Therefore, the above results from pre and posttest confirm this hypothesis.

This study revealed that the school classes that obtained comparatively better mean scores in pretest (class 8C, pre 5.78, post 6.67, 8D, pre 6.08, post 5.83) increased their post scores very limited even in some cases they decreased their scores in posttest like the students of class 8D (They obtained the highest score in pretest). On the other hand, the students who obtained relatively lower scores (for example students of class 7C, 7D and 7E and their scores are 3.73, 3.69 and 3.13 respectively) in pretest they increased their scores (posttest scores of class 7C, 7D and 7E are 5.73, 5.15 and 5.06 respectively) better than who (for example students of class 8A, 8B and 8C and their pretest scores 4.00, 4.63, 5.78 and posttest scores are 4.29, 4.38 and 6.67 respectively) obtained higher scores in pretest.

This study also revealed that overall the students of class 8 have better pre-knowledge (pretest mean score 4.78) than that of class 7 (pretest mean score 3.62) but the students of class 7 learnt better (posttest mean score 4.82 and increased mean score 1.2) than that of class 8(posttest mean score 5.26 and increased mean score 0.48).

The above findings indicate that the school classes that have comparatively lower pre-knowledge on science before their visit in the science center at Dalarna University but they learnt better than the school classes having better pre-knowledge.

The learning that occurs in a science center depends on a variety of characteristics of the learner. Such as (1) prior knowledge and interest of the learner, (2) mediation by other people like friends, parents teachers and (3) influence of other sources of information in the student's life like books, TV programs, school, the Internet, friends, family (Anderson 1999).

The 3rd hypothesis of this study is 'School classes that have better pre-knowledge about science before a visit to a science center learn better than other classes having less pre-knowledge'. The findings of this study don't confirm this hypothesis and 'The Contextual Model of Learning' (Falk and Dierking, 2000). In this model one of the key elements in learning science center is 'prior knowledge' but in this case this element most probably didn't play any role in learning**.** Maybe the students of those classes were not very curious to learn something by their visit in the science center at Dalarna University. Perry (1992) mentioned six essential factors for a successful museum experience. These factors are: curiosity , confidence, challenge, control, play, and communication. According to Perry these six factors play significant role in learning. Curiosity can be considered as the fundamental drive in learning (Semper, 1990).

5.3 Role of Science Center as Science Communicator

According to Berlo (1960) there are four functions of communication. These functions are: to inform, to educate, to entertain and to persuade. In this study we tried to investigate the role of science center as a science communicator on the basis of above four functions of communication.

From student's and teacher's interviews we found that they get information about science and technology from different communication medium such as books, mass media, science centers and museums, parents, friends, relatives and schools. Both for students and teachers

books and mass media are playing more important role as a source of scientific information than science centers and museums. Science centers and museums ranked 3rd, after books and mass media.

As a source of information science center has an advantage over books and mass media; the advantage is that people visit science center as a social event (Persson, 2000). Perry (1993) found that very often, social interaction is a reason for coming to the science center.

On the other hand, books and mass media have some advantages over science centers such as both are often far less expensive and available at home. Mass media, especially TV and radio can reach millions of people within very short time. In this study we have found that some students didn't visit science center due to lack of time. It indicates that science center is not as available as books and mass media.

The 2nd function of communication is to educate. As a medium of science education a science center has some advantages; (1) the visitors come to science center with a fairly clear expectation. Here the visitors expect to see science and to do something with science, (2) Science center can present science in an understandable and interesting way that makes the environment of science center funny, joy and playful. So science center can educate people by supplying entertainment (Nursall, A. 2003). Science center can educate people because in a science center people can learn by interacting with exhibits and science center is an open study environment, where people can learn without following strict curriculum (Salmi, 2003). Actually a science center educates people through play.

The current study revealed that learning occurs in a science center. The educational function of science center is proved from pre and posttest and from student's and teacher's interviews. From their interviews we found that they learnt about science, mathematics and astronomy. This function of science center is also proved from previous studies (Semper, 1990; Wellington, 1990; Falk and Dierking, 1992; Davis and Gardner, 1993; Rennie and McClafferty, 1996; Falk and Dierking, 2000). This result also confirms the findings of the study conducted by Crane et al., (1994).

From the above discussion it is established that science center educate people but from student's and teacher's interviews we have found that most of the students first learnt science from their teachers. The 2nd highest number of students mentioned parents, friends and relatives. In both cases interpersonal communication is playing vital role in teaching science first to the students. On the other hand, mass media, science centers and other sources are playing fewer roles in teaching science first. Interpersonal communication has some advantages in this perspective. The interpersonal communicator like teachers, parents, friends and relatives are always available to the students, they can easily ask them about their curiosities and they can get immediate response. It means that this type of communication takes place face to face and students can get feedback instantly. So interpersonal communication is very effective to teach students science in the beginning of their learning time.

In a previous study (Falk 2002b) also found that as a science educator, science center is playing comparatively less role than medium of interpersonal communication. In this study museums/science centers ranked fourth, after books, life experiences, TV and school.

The 3rd function of communication is to entertain. From the student's and teacher's interviews we have found that most of the students and teachers visit science center because it provides them entertainment. Almost similar results were found in some previous studies. For instant, adults visit science centers to satisfy their intellectual curiosity and stimulation, and to fulfil their need for relaxation, enjoyment and even spiritual fulfilment (Ballantyne and Packer, 2005). Adults take their children to science centers because they feel such experiences are worthwhile, educational and fun (Borun et al, 1996, Dierking and Falk, 2003, Rounds, 2004).

Dierking and Falk (2000) have stated that visitors come to the science center mainly to have fun or to learn.

According to the judgement of the teachers of this study both science center and class room are the best environment for student's learning but separately science center is the best environment because it supplies education and entertainment at the same time.

The 4th function of communication is to persuade. By informing, educating and supplying entertainment science center can persuade people in favour of science especially it can influence students to take science as their future career. In this study from teacher's interviews we found that they enjoyed their visit in the science center at Dalarna University and they wanted to visit this science center again because this will stimulate students to choice science career in future.

The above discussions indicate that science center is playing significant role in science communication by performing the four functions of communication and it confirms the 4th hypothesis of this study 'Science center plays significant role as a science communicator'.

5.4 Pupils' Interaction with a Science Center

From student's interviews we found that majority of the students visited science centers. Among them the number of boys is higher than girls. Students visited a science center at least once in their life. The highest number of students visited 10 times. It indicates that students' frequency of science center visit is very high. Girls visited at science center more times than boys. Girls and boys visit science center almost for the same motivations. There are very little differences between the motivations of girls and boys for visiting science center. Some students didn't visit science center due to lack of time, lack of interest and lack of information. No student visited science center during their leisure time.

The students selected 'The Ring on the Stick' as the best exhibit of the science center in Dalarna University. 7 girls and 9 boys graded it as the best exhibit. Although this exhibit does not look educational, but visitors spent much time to try them and learned something. Visitors have the opportunity to learn from playing with Stick on the Ring that how to concentrate on something and to control their actions. They could learn how to make a relation between what they thought and what they did.

The question is why do the students select it as the best exhibit? Csikszentmihalyi and Hermanson (1995) outlined several criteria for selecting best exhibit. They are: easy to operate/understand, a social event. From this study the causes for selection best exhibits/reasons for enjoying exhibits that we found are: funny, easy to understand, new, good labels and interesting. So the result of this current study confirms the criteria as outlined by Csikszentmihalyi and Hermanson.

From this study we found that on an average most of the students were attracted by 4-6 exhibits. The exhibits that attracted the attention of students all were interactive. On average students spent about 4.7-5.3 minutes per exhibit. If we compare this result with previous studies then we can find that in the science center at Dalarna University students spent more time than the average time 1.5 minutes that was found in Sandifer's study ((Sandifer, 1997) but less than Judy Diamond's (Diamond, 1986) study (a short period of time less than a minute and longer period of time 5 to 30 minutes).

This current study demonstrates that both students and teachers like the Starry Sky and the Constellations Program than the Astronomy History Show. Girls were more interested in Starry Sky Program than boys, although the difference is not remarkable. This confirms the

results of research which have been done by Åsa Schedin and Ylva Egebark (2001) and Asgari and Nejadian, (2004). The research by Åsa Schedin and Ylva Egebark indicates that girls are more interested in stars and planets but boys like rockets, satellites and space journey. The research by Asgari and Nejadian indicates that children (both girls and boys) like the Starry Sky program more than Slide Show, although the Starry Sky is more difficult than Slide Show for them. Both also shows that children like to see and learn scientific facts even if the facts are more difficult than fictions.

The current study reveals that the highest number of students learnt about constellations. The 2nd highest number of students learnt a lot about stars, planets, astronomy and space. There are differences between girls and boys in learning by watching planetarium programs. The highest number of girls learnt about constellations on the other hand the highest number of boys learnt a lot about stars, planets, astronomy and space. This study also investigated that a majority of the teachers (60%) learnt new things by watching planetarium programs in the science center at Dalarna University. These results partially confirm the result that was found in the study by Chariandy (2004). The finding of Chariandy's study was that more than half the students who visited the science center felt that they gained knowledge of aspects of astronomy as derived from the planetarium experience.

The results of student's and teacher's interviews of this project indicate that a majority of the students enjoyed their visit in the science center at Dalarna University. The 2nd highest number of students mentioned that their visit was in between enjoyment and not enjoyment. It is interesting that there was no student who didn't enjoy the visit at all. There is no significant difference between girls and boys in the pattern of enjoyment in the science center at Dalarna University. All the teachers enjoyed their visit and no difference was found between teachers and students regarding their enjoyment at this science center. These results confirm the findings that were found in a study conducted by Asgari and Nejadian, (2004). In their study they found that Falun Science Center has been successful in providing an educational and exciting environment for children. Among one hundred comments on questionnaires, about 50% stated that they had fun or were satisfied with their visit. The opinions of teachers, who were interviewed, indicate that they are satisfied with their visit to Falun Science Center. Among 420 replies to the questionnaires, 26% gave the overall grade 3 to the Falun Science Center against only 7.6 % who gave zero.

The above results indicate that there are differences between girls and boys in interacting with science center but differences don't exist in all cases. The 5th hypothesis of this study is '. Girls and boys interact with a science center in a different way' and this result partially confirms the hypothesis.

In conclusion, we can say that pupils learn from their visit in a science center and it is playing significant role as a science communicator.

References

Anderson, D. (1999). The development of science concepts emergent from science museum and post-visit activity experiences: Students' construction of knowledge. Brisbane, Australia, Queensland University of Technology.

Asgari, Hamid & Nejadian, Kayvan Seyed (2004). Important parameters in Designing and Presenting Exhibits and Planetarium Programs in Science Centers. A Visitor-Based Framework, Master Thesis in Science Communication, Dalarna University, Sweden, p. 72.

Ballantyne, R. and Packer, J. (2005). Promoting environmentally sustainable attitudes and behaviour through free-choice learning experiences: what is the state of the game? *Environmental Education Research* 11(3): 281-296.

Berlo, David K. (1960). *The Process of Communication: An Introduction to Theory and Practice*. USA Holt, Rinehart and Winston Inc.

Bitgood S, Serrel B and Thompson D (1994). *The Impact of Informal Education on Visitors to Museums.* in Crane V et al., *Informal Science Learning: What the Research Says about Television, Science Museums, and Community Based Projects*. Delham, Mass.: Research Communications, Ltd, 61-106.

Borun, M., Chambers, M., and Cleghorn, A. (1996). Families are learning in science museums. *Curator* 39(2): 123-138.

Brown, J.S., Collins, A. and Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher* 18(1): 32-42.

Chariandy, Celeste A (2004), The Impact of the NIHERST/NGC National Science Centre,Trinidad and Tobago on Visiting Student Groups, Master Thesis in Science Communication, Dalarna University, Sweden, p. 27.

Cook, T. and Campbell, D (1979). Quasi-experimentation. Design and Analysis for Field Settings. Chicago: Rand McNally: 43-44.

Coventry, V. (1997). Major influences on career choice: a study conducted on behalf of Scitech Discovery Center, Perth, Western Australia. Perth, Western Australia, SciTech Discovery Center, 4. In Garnett, Robin (2001), *The Impact of Science Centers/Museums on their Surrounding Communities: Summary Report.*

Crane, V., Chen, M., Bitgood, S., Serrell, B., Thompson, D., Nicholson, H., Weiss, F. and Campbell, P. (1994). *Informal science learning: What research says about television, science museums and community-based projects*. Dedham, MA: Research Communication Ltd.

Csikszentmihalyi, M. and Hermanson, K. (1995). Intrinsic motivation in museums: Why does one want to learn? In Falk J.H. and Dierking L.D. (Eds.), *Public institutions for personal*

learning: establishing a research agenda (pp. 67-77). Washington, DC: American Association of Museums.

Davis, J. and Gardner, H. (1993). Open windows open doors. *Museum News*, 71, pp. 34-37, 57.

Diamond, J. (1982). Ethology in Museums: understanding the Learning Process. *The Journal of Museum Education, Rountable Reports*, vol 7/4, pp. 13-15.

Diamond, Judy (1986). *Curator* 29 (2), p.139.

Diamond, Judy (1999). *Practical Evaluation Guide: Tools for Museums and Other Informal Educational Settings.* Oxford: Alta Mira Press.

Dierking, Lynn D. and Falk, John H. (1994). Family Behavior and Learning in Informal Science Settings: A Review of the Research. *Science Education* Vol. 78, pp. 57-72.

Dierking, L.D. and Falk, J.H. (2003). Optimizing out-of-school time: The role of free-choice learning. *New Directions for Youth Development* 97: 75-89.

Duensing, S. (2002). The object of experience. In Paris, S.G. (ED.), *Perspectives on object-centered learning in museums* (pp. 351-363). Mahwah, NJ: Erlbaum.

Erickson, F. (1986). Qualitative Methods in Research on Teaching. In *Handbook of Research on Teaching*, ed. Wittrock, M. New York: Macmillan.

Gilbert, J.K. and Priest, M. (2001) What do primary students gain from discussion about exhibits? In: *Using museums to popularise science and technology*. S. Errington, S. Stocklmayer and B. Honeyman (Eds.) London: Commonwealth Secretariat.

Falk, J. H. (1982). *Journal of Museum*. Ed. 7 (4), p. 22.

Falk, J.H. (1983). Time and behaviour as predictors of learning. *Science Education*, 67(2), pp. 267-276.

Falk, J.H., Koran, J.J. & Dierking, L.D. (1986). The things of science: Assessing the learning potential of science museums. *Science Education*, 70(5), pp. 503-508.

Falk, J. H. and Dierking, L.D. (1992). *The museum experience*. Washington, DC: Whalesback Books.

Falk, J.H. and Dierking, L.D. (2000). *Learning from museums: visitor experiences and the making of meaning*. Altamirz Press.

Falk, J.H. (2002a). Foreword. In Paris, S.G. (Ed.), *Perspectives on object-centered learning in museums* (pp.ix-xiii). Mahwah, NJ: Erlbaum.

Falk, J.H. (2002b). The contribution of free-choice learning to public understanding of science.*Interciencia 27*, 62-65.

Gardner, H (1991). *The Unschooled Mind*, New York Basic Books.

Hein G E (1993). Evaluating Teaching and Learning in Museums, Presented at the Leicester University Museum Studies Conference, April, 1993, and published as Chapter 17 (pp. 189-203) in E. Hooper-Greenhill, editor, (1995) *Museum: Media: Message*, London: Routledge.

Hein G E (1995). The Constructivist Museum, in *Journal for Education in Museums* No. 16, p.21-23.

Hein G E (1998). *Learning in the Museums*. Routledge, p. 216. 36. Hein, G.E (1993). 'The significance of constructivism for museum education', in *Museums and the Needs of the People*, Jerusalem. Israel ICOM Committee, 1993.

Hodgkin, R.A (1985). *Playing and Exploring*, Methuen, New York.

Hoffstadt, Rita Mukherjee (2002). Learning Theory and Current Science. *Informal Learning Review* Vol. 57, pp. 14-18.

Hofstein, Avi and Rosenfeld, Sherman (1996). Bridging the Gap between Formal and Informal Science Learning. *Studies in Science Education* Vol. 28, pp. 87-112.

Insulander, Eva (2005).Museum and Learning-A Research Overview. http://www.smvk.se/content/1/c4/54/70/Museer%20och%20l%C3%A4rande%20%C3%B6vers%C3%A4ttning%20(3).pdf

McLuhan, Marshall and Bruce R. Powers (1992). *The Global Village: Transformations in World Life and Media in the 21st Century* (Communication and Society (New York, N.Y.).)

Nursall, A. (2003). 'Building public knowledge: collaborations between science centers, universities and industry', *Int. J. Technology Management*, vol. 25, no. 5, p. 382.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York: Basic Books

Perry D L (1992). *Designing Exhibits that motivate*. Association of Science-Technology Centers, Newsletter, 20(1): 9-10, 12.

Perry, Deborah L. (1993). Designing Exhibits That Motivate. *What Research Says about Learning in Science Museums* Vol. 2, pp. 25-29.

Persson, Per-Edvin (2000) Science centres are thriving and going strong! *Public Understanding of Science,* No 9, 2000. pp 449-460. UK: IOP Publishing Ltd and The Science Museum

Quistgaard, Nana (2005). Engagement and reflections at science centers: A study of upper secondary students. *NNORSC*, *Proceedings of the First Conference of the Nordic Network of Researchers in Science Communication*, University of Southern Denmark, June 11-12, 2004. p. 67.

Quin, Melanie (1990). What is hands-on science and where can I find it? *Physic Education* Vol. 25, pp. 243-247.

Rennie, L. J. and T. P. McClafferty (1995). Using visits to interactive science and technology centers, museums, aquaria, and zoos to promote learning science. *Journal of Science Teacher Education*: 175-185.

Rennie, L. J., and McClafferty, T.P. (1996). Science centers and science learning. *Studies in Science Education,* 27, pp. 53-98.

Rennie, L.J., Feher, E., Dierking, l.D. and Falk, J. H. (2003). Toward an agenda for advancing research on science learning in out-of-school settings. . *Journal of Research in Science Teaching*, 40 (2), pp 112-120.

Roschelle J (1995). *Learning in Interactive Environments: Prior Knowledge and New Experience.* in Falk J H and Dierking L D (Eds) Public Institutions for Personal Learning: Establishing a Research Agenda, American Association of Museums, 37-52. Washington, DC.

Rounds, J. (2004). Strategies for the curiosity-driven museum visitor. *Curator* 47: 389-412.

Salmi, H. (1993). *Science Center Education: Motivation and Learning in Informal Education,* Department of Teacher Education, University of Helsinki, Finland.

Salmi, Hannu (2003). Science centers as learning laboratories: experiences of Heureka, The Finnish Science Center. *Int. J. Technology Management* Vol. 25, pp. 460-476.

Sandifer, C. (1997). Time-based behaviors at an interactive science museum: Exploring the differences between weekday/weekend and family/nonfamily visitors. *Science Education*, 81, 689–701.

Schedin Åsa and Egebark Ylva (2001). *Vad vill barn I de yngre skolåren att en planetarieföreställning ska innehålla?.* Science Communication, Dalarna University.

Semper, R.J. (1990). Science museums as environments for learning. *Physics Today*, (November, 1990), pp. 2-8.

Siegel, E. (1998). The Science Career Ladder at the New York Hall of Science. *Curator* 41(4): 246-290.

Tunnicliffe, S. D. (1999). Science out of the school classroom. *Proceedings of the 23rd Annual Meeting of JSSE and JSSE-ICASE-PME International Joint Conference-August 8-10,* 1999 ICASE pre-secondary Officer and Homerton College, Cambridge.pp. 71-74.

Vigotsky. L S (1962). *Thought and Language*, the MIT Press, Cambridge, MA.

Wellington, J. (1990). Formal and informal learning in science: the role of the interactive science centers. *Physics Education*, 25, pp. 247-252.

Woolnough, B. (1994). Factors affecting students' choice of science and engineering. *International Journal of Science Education* 16: 659-676.

Appendices

Appendix A

A.1 Data of Questionnaires of Pretest

(1= Girl, 2= Boy, A= Pretest, Q1-Q10= Number of questions and given answers by the students to each question, 999=Answer was not given).

ID	Class	Age	Gender	Pretest	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	7A	13	1	A	E	A	E	B	A	C	E	A	B	D
2	7A	14	1	A	D	A	E	B	A	A	D	B	A	B
3	7A	14	1	A	D	A	E	B	A	A	B	B	B	B
4	7A	13	2	A	D	A	E	C	A	E	C	D	E	A
5	7A	14	2	A	E	E	E	B	A	A	B	D	E	B
6	7A	14	2	A	A	A	B	C	A	B	B	B	A	D
7	7A	13	2	A	C	A	E	C	A	E	B	D	E	D
8	7A	13	1	A	E	A	E	B	A	E	B	C	D	D
9	7A	13	1	A	E	A	E	B	A	C	E	A	B	B
10	7A	13	1	A	A	E	A	A	A	B	A	C	E	E
11	7A	14	1	A	E	B	A	B	A	C	A	D	A	E
12	7A	14	1	A	E	A	E	B	A	B	E	D	B	C
13	7A	14	1	A	B	D	E	B	A	B	D	A	D	D
14	7A	14	1	A	D	E	E	B	A	B	A	D	E	D
15	7A	14	1	A	E	E	E	C	A	A	B	C	D	B
16	7A	13	1	A	D	A	A	B	A	D	D	C	A	D
17	7A	13	2	A	D	A	E	C	A	D	C	B	A	A
18	7A	14	2	A	D	A	B	C	A	B	C	C	A	A
19	7B	14	2	A	D	A	E	B	A	C	B	C	B	C
20	7B	13	1	A	E	A	E	C	A	D	C	A	D	D
21	7B	14	2	A	A	A	A	E	A	C	B	C	A	B
22	7B	14	2	A	A	A	A	B	A	C	B	C	A	D
23	7B	14	2	A	A	A	E	D	A	A	B	C	C	B
24	7B	14	2	A	A	A	E	D	A	A	B	C	C	B

25	7B	13	2	A		E	A	D	A	C	B	C	D	D
26	7B	14	2	A	D	A	E	B	A	D	A	C	B	B
27	7B	13	1	A	C	E	A	B	A	C	A	D	A	B
28	7B	14	1	A	E	A	E	C	A	E	C	E	D	D
29	7B	14	1	A	999	999	999	A	999	999	999	999	B	999
30	7B	13	1	A	999	999	999	999	A	999	999	999	B	999
34	7C	14	2	A	A	A	E	C	A	D	C	D	D	D
35	7C	14	1	A	E	A	E	E	A	B	E	B	D	B
36	7C	14	2	A	D	A	E	C	A	D	D	B	E	C
37	7C	13	1	A	D	A	B	B	A	D	C	C	A	D
38	7C	14	2	A	D	A	B	B	A	B	B	C	D	D
39	7C	13	2	A	E	A	E	C	A	A	B	D	D	D
40	7C	14	1	A	D	E	E	D	A	B	D	A	D	E
41	7C	13	1	A	E	A	A	B	A	B	A	D	D	B
42	7C	14	1	A	D	E	E	D	A	B	D	A	D	E
43	7C	13	2	A	E	E	E	B	A	B	A	C	999	D
44	7C	15	2	A	E	E	E	B	D	B	A	A	D	D
45	7C	14	2	A	D	A	E	C	A	D	D	D	E	C
46	7C	14	2	A	E	E	E	B	A	B	A	C	D	D
47	7C	13	2	A	E	A	E	C	A	B	C	D	A	D
50	7D	13	2	A	E	A	E	B	A	E	B	D	B	D
51	7D	14	2	A	D	A	E	C	A	B	B	D	E	D
52	7D	13	1	A	D	A	E	E	A	B	D	D	D	B
53	7D	13	1	A	C	A	E	D	A	D	D	D	B	B
54	7D	13	1	A	D	A	E	B	A	A	C	E	A	E
55	7D	14	2	A	E	A	A	B	A	D	E	D	D	D
56	7D	13	1	A	A	E	E	C	A	E	C	D	A	B
57	7D	13	2	A	A	A	E	C	A	A	C	A	E	D
58	7D	14	2	A	C	E	E	B	A	D	A	D	B	B
59	7D	13	1	A	D	A	E	C	A	A	E	C	D	B
60	7D	13	2	A	A	A	E	B	A	A	B	D	A	C
61	7D	14	2	A	D	A	E	C	A	C	B	D	D	D
62	7D	14	2	A	E	A	A	D	A	D	C	D	B	B
63	7D	14	1	A	A	A	B	D	A	D	E	A	D	A
64	7D	13	1	A	C	A	A	A	A	E	D	D	B	C
65	7D	13	2	A	A	A	999	999	A	A	D	A	B	A
70	7E	13	1	A	E	B	A	B	E	B	B	D	A	B
71	7E	14	1	A	E	A	E	B	A	D	A	D	A	E
72	7E	14	1	A	E	B	E	E	A	B	B	D	B	C
73	7E	14	2	A	E	A	A	C	A	A	C	D	E	D
74	7E	13	2	A	C	A	E	A	A	D	B	D	B	D
75	7E	14	2	A	D	A	E	C	A	A	C	B	B	E
76	7E	13	1	A	D	A	A	B	A	B	A	C	D	D

77	7E	14	2	A	E	A	A	A	A	A	C	D	A	A
78	7E	13	1	A	D	A	E	B	A	B	D	A	B	A
79	7E	13	1	A	D	A	E	B	A	B	A	D	D	A
80	7E	14	2	A	E	A	E	A	A	B	E	D	A	E
81	7E	15	2	A	E	A	A	B	A	A	A	D	A	D
82	7E	13	1	A	E	A	E	E	A	C	A	D	A	D
83	7E	14	1	A	E	A	E	B	E	C	A	D	D	D
84	7E	13	2	A	C	A	E	C	A	E	A	D	D	D
85	7E	14	2	A	C	A	E	C	A	E	A	D	D	D
86	7E	14	1	A	E	A	A	D	A	D	E	B	E	B
87	7E	13	1	A	C	E	E	B	A	E	A	D	A	A
88	7E	14	1	A	E	B	A	B	A	B	E	D	A	E
89	8A	15	2	A	D	A	E	D	A	D	D	A	B	D
90	8A	15	1	A	D	A	E	B	A	A	D	C	A	D
91	8A	14	1	A	C	A	B	C	A	D	C	C	D	D
92	8A	14	2	A	D	A	E	E	A	B	E	D	B	999
93	8A	14	1	A	C	A	E	B	A	B	C	C	D	D
94	8A	14	1	A	C	A	E	B	A	E	D	C	D	D
95	8A	14	2	A	C	A	E	999	A	B	C	D	D	A
96	8A	15	2	A	999	A	E	999	A	E	C	D	D	A
97	8A	14	2	A	D	A	E	C	A	A	C	C	B	A
98	8A	14	1	A	999	A	A	B	A	B	B	C	B	D
99	8A	14	1	A	C	E	E	D	A	C	D	B	D	A
100	8A	15	2	A	C	A	E	A	A	A	B	D	B	B
104	8B	15	2	A	D	A	E	B	A	D	B	D	D	B
105	8B	14	1	A	E	B	E	B	A	E	C	E	B	D
106	8B	15	1	A	E	B	E	B	A	E	C	E	B	D
107	8B	15	1	A	E	A	E	E	999	A	B	C	A	B
108	8B	15	2	A	E	A	E	B	A	B	B	C	D	D
109	8B	14	2	A	A	A	D	B	A	D	B	C	B	C
110	8B	15	2	A	E	A	E	B	A	D	B	C	D	D
111	8B	14	2	A	E	B	E	B	A	B	A	C	A	B
112	8B	15	1	A	E	A	D	E	D	C	D	E	A	B
113	8B	15	2	A	E	A	E	C	A	A	B	C	D	D
114	8B	15	2	A	B	A	A	B	A	B	B	C	A	A
115	8B	14	1	A	E	B	D	C	A	E	B	D	A	D
116	8B	15	1	A	E	B	D	C	A	E	A	E	A	D
117	8B	14	2	A	D	A	E	A	A	E	D	C	B	A
118	8B	15	2	A	C	A	D	E	A	B	B	E	A	B
125	8C	14	1	A	A	A	E	B	A	E	B	D	A	D
126	8C	14	1	A	A	A	E	C	A	E	D	C	A	E
127	8C	14	1	A	A	A	E	B	A	E	B	E	D	C
128	8C	14	2	A	A	A	E	A	A	E	C	C	D	D

129	8C	15	1	A	E	A	E	C	A	E	A	D	B	B
130	8C	14	1	A	A	A	E	E	A	B	B	D	A	D
131	8C	14	2	A	B	A	C	B	A	E	B	D	D	D
132	8C	14	2	A	A	A	E	B	A	E	C	C	D	D
133	8C	14	2	A	A	A	E	E	A	E	B	D	A	D
134	8C	14	2	A	E	E	A	B	A	D	C	A	A	D
135	8C	15	2	A	A	A	E	B	A	E	B	C	B	D
136	8C	14	2	A	D	A	E	E	A	E	C	D	A	D
137	8C	14	1	A	A	B	E	B	A	B	B	D	A	D
138	8D	14	1	A	D	A	A	C	A	A	A	C	B	B
139	8D	14	1	A	A	A	E	C	A	B	B	C	D	D
140	8D	15	1	A	D	B	D	C	A	D	D	C	D	D
141	8D	14	1	A	A	B	E	D	A	A	B	C	D	D
142	8D	15	1	A	A	E	E	C	A	A	B	C	D	D
143	8D	15	1	A	A	A	E	C	A	C	C	C	A	C
144	8D	14	2	A	A	A	E	C	A	D	B	C	A	A
145	8D	14	1	A	A	A	A	C	B	A	A	C	A	E
146	8D	15	1	A	A	A	E	D	A	D	B	C	A	D
147	8D	15	2	A	A	A	E	C	A	B	B	C	A	E
148	8D	15	1	A	A	A	E	C	A	B	B	C	A	D
149	8D	14	2	A	A	A	E	C	A	D	B	C	D	A
150	8D	14	1	A	A	A	A	C	A	A	B	C	D	D
151	8D	13	1	A	A	E	E	C	A	A	B	C	D	D
152	8D	15	1	A	A	B	E	D	A	A	B	C	D	D
153	8D	14	2	A	D	A	A	C	A	A	A	C	B	B
154	8D	14	1	A	E	A	E	C	A	E	C	C	D	D
157	8E	14	2	A	E	A	E	D	A	D	C	A	A	E
158	8E	14	2	A	E	E	E	B	B	C	E	C	A	D
159	8E	14	1	A	E	E	E	C	A	D	C	C	B	C
160	8E	14	1	A	B	A	E	E	A	A	B	C	A	B
161	8E	15	1	A	E	E	E	C	A	A	A	A	A	C
162	8E	16	1	A	E	E	E	C	A	D	C	C	A	C
163	8E	15	2	A	A	A	E	C	A	D	A	A	A	B
164	8E	15	2	A	C	A	E	C	A	D	C	B	A	B
165	8E	14	1	A	C	A	E	B	A	C	B	C	A	B
166	8E	14	1	A	D	E	A	E	A	C	B	D	E	C
167	8E	15	2	A	D	A	E	E	A	D	B	C	E	C
168	8E	14	2	A	E	A	E	B	A	D	C	C	B	D
169	8E	14	1	A	A	E	E	A	A	C	B	C	A	A
170	8E	15	2	A	E	A	E	C	A	A	C	A	A	E
171	8E	15	2	A	D	E	E	D	A	C	E	B	B	B
172	8E	15	1	A	A	A	E	A	A	C	B	C	E	B
173	8E	14	2	A	A	A	E	E	A	C	E	B	A	D

A.2 Data of Questionnaires of Posttest

(1= Girl, 2= Boy, B= Posttest, Q1-Q10= Number of questions and given answers by the students to each question, 999=Answer was not given).

ID	Class	Age	Gender	Posttest	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
1	7A	13	1	B	E	A	E	C	A	E	A	D	B	D
2	7A	14	1	B	C	A	A	D	A	E	B	B	A	B
3	7A	14	1	B	C	A	A	D	A	E	B	B	B	D
4	7A	13	2	B	A	A	E	C	A	E	C	C	A	A
5	7A	14	2	B	E	E	E	B	A	C	B	D	E	B
6	7A	14	2	B	E	A	B	C	A	E	A	C	A	999
7	7A	13	2	B	A	A	E	C	A	E	B	C	A	D
8	7A	13	1	B	E	E	E	D	A	E	A	C	B	D
9	7A	13	1	B	E	A	E	B	A	E	E	A	B	999
19	7B	14	2	B	D	A	E	C	A	E	C	C	D	A
20	7B	13	1	B	A	D	D	D	B	D	E	A	B	D
21	7B	14	2	B	A	A	A	E	A	C	B	D	B	B
22	7B	14	2	B	A	A	A	B	A	E	B	A	A	D
23	7B	14	2	B	C	A	E	D	A	A	C	C	C	B
24	7B	14	2	B	A	A	A	B	A	A	A	A	C	B
25	7B	13	2	B	C	E	A	C	A	E	B	B	E	D
26	7B	14	2	B	D	A	A	B	A	A	A	C	A	D
27	7B	13	1	B	B	E	A	B	A	C	B	D	A	B
28	7B	14	1	B	D	E	A	E	A	D	B	C	C	C
29	7B	14	1	B	999	A	999	999	A	E	999	C	999	999
31	7B	14	1	B	E	A	A	B	A	D	B	A	D	D
32	7B	13	2	B	A	A	A	E	A	C	B	D	D	B
33	7B	14	1	B	E	A	E	D	A	D	B	C	D	D
34	7C	14	2	B	D	A	E	C	A	D	B	D	D	D
35	7C	14	1	B	E	E	E	C	A	A	E	A	D	B
36	7C	14	2	B	A	A	E	C	A	A	C	999	E	A
37	7C	13	1	B	D	A	B	C	A	D	B	C	E	D
38	7C	14	2	B	D	A	B	C	A	E	B	C	D	D
39	7C	13	2	B	D	A	E	D	A	E	B	D	D	D
40	7C	14	1	B	E	E	E	C	A	E	B	C	D	D
41	7C	13	1	B	E	A	E	C	A	B	B	C	D	D
42	7C	14	1	B	E	A	E	C	A	B	B	C	D	D
43	7C	13	2	B	E	E	E	C	A	B	B	C	D	A
44	7C	15	2	B	A	E	A	B	A	B	A	A	A	D
48	7C	14	2	B	D	A	E	C	A	E	B	D	B	B

49	7C	13	2	B	999	A	B	C	A	E	B	C	D	D
50	7D	13	2	B	D	A	E	B	A	D	B	C	A	D
51	7D	14	2	B	E	A	A	C	A	D	B	C	E	B
52	7D	13	1	B	D	E	E	D	A	B	B	D	B	B
53	7D	13	1	B	D	A	E	C	A	D	C	D	B	B
54	7D	13	1	B	D	A	E	C	A	C	B	A	A	E
55	7D	14	2	B	E	A	A	C	A	D	B	C	D	D
56	7D	13	1	B	D	A	E	C	A	B	B	C	A	D
57	7D	13	2	B	A	E	D	D	A	D	C	E	A	D
58	7D	14	2	B	A	A	E	C	A	B	B	C	E	B
59	7D	13	1	B	D	A	E	C	A	D	A	C	D	D
60	7D	13	2	B	A	A	E	D	A	D	B	C	A	D
61	7D	14	2	B	A	A	E	C	A	E	B	C	D	D
62	7D	14	2	B	D	A	E	C	A	D	B	C	B	D
66	7D	13	1	B	A	A	A	C	A	B	C	B	D	B
67	7D	13	1	B	E	A	E	C	A	A	B	C	A	D
68	7D	15	1	B	A	E	A	C	A	D	D	A	A	D
69	7D	14	2	B	D	A	A	B	A	A	B	D	B	C
70	7E	13	1	B	B	A	D	D	A	A	B	A	A	D
71	7E	14	1	B	E	A	E	E	A	B	A	D	A	E
72	7E	14	1	B	D	A	B	C	A	E	B	C	B	D
73	7E	14	2	B	E	A	E	C	A	E	B	D	D	D
74	7E	13	2	B	D	A	B	C	A	E	B	C	B	D
75	7E	14	2	B	D	A	E	C	A	A	E	999	B	D
76	7E	13	1	B	A	A	E	C	A	E	B	C	D	D
77	7E	14	2	B	D	A	E	C	A	E	D	A	A	D
78	7E	13	1	B	D	A	E	C	A	A	B	A	A	A
79	7E	13	1	B	D	A	E	C	A	C	B	D	D	D
80	7E	14	2	B	C	C	B	C	C	C	B	A	A	E
81	7E	14	2	B	E	A	E	C	A	A	B	C	A	D
82	7E	13	1	B	B	A	D	D	A	A	A	A	A	D
83	7E	14	1	B	E	A	E	C	E	C	A	C	B	D
84	7E	13	2	B	E	A	E	C	A	E	B	C	B	D
85	7E	14	2	B	E	A	E	C	A	E	B	C	D	D
89	8A	15	2	B	D	A	E	E	A	A	D	A	D	D
90	8A	15	1	B	D	A	C	C	A	B	C	C	A	D
91	8A	14	1	B	D	A	E	D	A	E	A	C	D	D
92	8A	14	2	B	C	A	E	E	A	D	E	A	A	999
93	8A	14	1	B	C	A	E	D	A	A	B	C	D	D
94	8A	14	1	B	C	A	E	D	A	A	B	C	B	D
95	8A	14	2	B	B	A	E	C	A	A	E	D	A	C
101	8A	15	1	B	C	A	E	999	A	B	B	D	C	D
102	8A	14	1	B	E	E	A	C	A	A	E	D	D	A

103	8A	15	1	B	C	A	E	B	A	B	B	C	B	D
104	8B	15	2	B	B	A	D	B	A	E	B	D	B	B
105	8B	14	1	B	B	A	B	C	A	A	B	C	B	D
106	8B	15	1	B	B	A	B	C	A	A	B	C	B	D
107	8B	15	1	B	E	A	D	B	A	A	A	C	E	D
108	8B	15	2	B	E	C	D	E	B	B	B	C	C	D
109	8B	14	2	B	A	C	D	C	D	E	B	B	C	C
110	8B	15	2	B	D	A	E	C	A	B	B	C	D	B
111	8B	14	2	B	E	A	E	B	A	A	B	C	D	D
119	8B	14	2	B	D	A	D	B	A	A	B	C	D	D
120	8B	15	2	B	999	A	E	B	A	A	B	999	D	D
121	8B	14	2	B	D	A	E	E	A	D	A	D	D	B
122	8B	14	2	B	E	A	E	D	A	A	B	C	D	D
123	8B	14	1	B	B	A	E	B	A	A	B	C	D	D
124	8B	14	2	B	E	A	E	D	A	A	B	C	D	B
125	8C	14	1	B	A	A	E	C	A	E	B	B	D	D
126	8C	14	1	B	A	A	E	C	A	E	B	B	D	C
127	8C	14	1	B	A	A	E	C	A	E	B	B	D	C
128	8C	14	2	B	A	A	E	D	A	D	B	C	D	B
129	8C	15	1	B	A	A	E	C	A	E	B	B	D	B
130	8C	14	1	B	A	A	E	C	A	E	B	E	A	B
131	8C	14	2	B	A	A	E	C	A	E	B	C	A	A
132	8C	14	2	B	A	A	E	C	A	D	B	C	D	D
133	8C	14	2	B	E	A	C	C	B	E	B	D	B	D
138	8D	14	1	B	C	A	D	B	A	D	B	C	E	D
139	8D	14	1	B	A	A	E	B	A	B	B	C	D	D
140	8D	15	1	B	D	B	A	C	A	A	B	C	D	D
141	8D	14	1	B	D	B	A	C	A	A	B	C	D	D
142	8D	15	1	B	A	A	E	B	A	E	B	C	D	D
143	8D	15	1	B	A	A	E	C	A	B	D	C	B	C
144	8D	14	2	B	A	999	E	C	B	B	B	E	A	B
145	8D	14	1	B	A	A	E	D	A	A	A	C	E	B
146	8D	15	1	B	A	A	E	B	A	A	B	D	C	D
147	8D	15	2	B	A	A	E	B	A	A	B	C	A	E
148	8D	15	1	B	A	A	E	C	A	B	B	C	A	D
149	8D	14	2	B	A	A	E	C	A	D	B	C	D	A
155	8D	14	1	B	A	A	E	B	A	B	B	C	D	D
156	8D	16	2	B	A	B	E	B	A	A	D	B	E	D
157	8E	14	2	B	E	A	E	C	A	A	A	C	B	A
158	8E	14	2	B	E	A	E	B	A	A	B	C	B	D
159	8E	14	1	B	C	E	E	C	A	B	B	C	B	B
160	8E	14	1	B	A	A	E	C	A	A	B	C	A	B
161	8E	15	1	B	A	A	E	C	A	B	B	C	A	E

162	8E	16	1	B	A	A	E	C	A	B	B	C	A	E
163	8E	15	2	B	C	C	E	C	A	D	B	C	E	B
164	8E	15	2	B	C	A	E	D	A	B	B	C	A	B
165	8E	14	1	B	C	A	E	C	A	C	B	C	A	B
166	8E	14	1	B	C	A	A	C	A	B	B	C	B	B
167	8E	15	2	B	D	A	E	C	A	E	C	A	E	C
168	8E	14	2	B	E	A	E	C	A	E	D	C	A	A
169	8E	14	1	B	A	E	E	C	A	A	B	C	A	C
170	8E	15	2	B	E	A	E	B	A	E	C	A	A	C

A.3 Data of Student's Interview Questions and Answers.

(Question 1-3)

(Gender, 1= Girl, 2= Boy**,** Q1A, 1= books, Q1B, 2= mass media, Q1C, 3= science centres and museums, Q1D, 4= parents, friends and relatives, Q1E, 5= school, Q2A, 8=teacher, Q2B, 9= science centres and museums, Q2C, 10= mass media, Q2D, 11= parents, friends, relatives, 2QE, 12= books, 3QA, 13= no, Q3B, 14= Yes, but only at a museum, Q3C, 15= Yes, but only in a science centre, Q3D, 16= Yes, both).

ID	Class	Age	Gender	Q1A	Q1B	Q1C	Q1D	Q1E	Q2A	Q2B	Q2C	Q2D	Q2E	Q3A	Q3B	Q3C	Q3D
4	7A	13	2		2	3						11					16
7	7A	13	2	1	2		4		8								16
8	7A	13	1	1		3			8					13			
20	7B	13	1	1								11			14		
25	7B	13	2	1					8		10						16
26	7B	14	2	1	2	3	4					11					16
27	7B	13	1	1		3			8					13			
29	7B	14	1		2			5	8		10				14		
34	7C	14	2	1					8						14		
35	7C	14	1	1					8								16
37	7C	13	1			3	4					11				15	
38	7C	14	2	1		3						11			14		
50	7D	13	2	1					8								16
52	7D	13	1					5	8						14		
54	7D	13	1	1	2							11					16
62	7D	14	2	1	2			5				11			14		
72	7E	14	1	1	2				8	9	10					15	
74	7E	13	2	1	2							11					16
78	7E	13	1	1						9					14		
82	7E	13	2	1	2	3				9							16
91	8A	14	1	1	2	3		5		9							16
94	8A	14	1					5	8							15	
96	8A	15	2			3			8							15	
100	8A	15	2	1	2						10			13			
115	8B	14	1	1	2	3			8		10				14		
116	8B	15	1	1	2	3			8							15	
117	8B	14	2	1	2		4		8		10	11				15	
118	8B	14	2		2				8								16
125	8C	14	1	1					8						14		

130	8C	14	1	1	2	3	4								14		
131	8C	14	2		2						10						16
133	8C	14	2		2						10					15	
138	8D	14	1	1				5	8				12			15	
140	8D	15	1		2						10				14		
141	8D	14	1		2			5	8			11			14		
144	8D	15	2		2						10						16
149	8D	14	2	1	2		4					11					16
156	8D	16	2	1					8								16
163	8E	15	2			3						11			14		
164	8E	15	2		2				8								16
165	8E	14	1		2				8								16
166	8E	14	1		2				8						14		

A.3 Data of Student's Interview Questions and Answers (Question 4-5).

(Gender, 1= Girl, 2= Boy, Q4A, 17= 1 time, Q4B, 18= 2 times, Q4C, 19= 3 times, Q4D, 20= 4 times, Q4E1, 21= 5-9 times, Q4E2, 22=10 times, Q4E3, 23=11-above times, Q4E4, 24= I can't remember, Q5A, 25=fun, Q5B, 26= teach science in a understandable way, Q5C, 27= learn more than to class room, Q5D, 28=new things, Q5E1, 29=enjoyable than class, Q5E2, 30= mandatory, Q5E3, 31= others).

ID	Class	Age	Gender	Q4A	Q4B	Q4C	Q4D	Q4E1	Q4E2	Q4E3	Q4E4	Q5A	Q5B	Q5C	Q5D	Q5E1	Q5E2	Q5E3
4	7A	13	2			19						25	26	27				
7	7A	13	2	17								25						
8	7A	13	1															
20	7B	13	1			19								27				
25	7B	13	2							23			26					
26	7B	14	2						22			25			28			
27	7B	13	1															
29	7B	14	1								24	25			28	29		
34	7C	14	2		18												30	
35	7C	14	1						22						28			
37	7C	13	1						22			25		27				
38	7C	14	2								24	25						
50	7D	13	2		18													31
52	7D	13	1				20					25						
54	7D	13	1					21								29		
62	7D	14	2			19						25						
72	7E	14	1					21				25	26		28			
74	7E	13	2				20					25		27				
78	7E	13	1						22				26					
82	7E	13	2						22			25			28			
91	8A	14	1					21				25	26		28			
94	8A	14	1				20					25						
96	8A	15	2	17													30	
100	8A	15	2															
115	8B	14	1							23		25	26		28			
116	8B	15	1		18							25						
117	8B	14	2							23		25	26		28			
118	8B	14	2				20								28			
125	8C	14	1					21				25						

130	8C	14	1						22			25						
131	8C	14	2			19							26					
133	8C	14	2						22								30	
138	8D	14	1					21									30	
140	8D	15	1						22									31
141	8D	14	1	17													30	
144	8D	15	2								24	25						
149	8D	14	2			19						25	26		28			
156	8D	16	2			19						25						
163	8E	15	2				20								28			
164	8E	15	2		18										28			
165	8E	14	1							23		25						
166	8E	14	1	17													30	

A.3 Data of Student's Interview Questions and Answers (Question 6-8).

(Gender, 1= Girl, 2= Boy, Q6A, 32= expensive, Q6B, 33= lack of time, Q6C, 34= lack of interest, Q6D, 35= lack of information, Q6E, 36= others, Q7A, 37=internet, Q7B, 38=science centers and museums, Q7C, 39= computers games, Q7D, 40=going to friends and relatives, Q7E1, 41= playing , Q7E2, 42=reading, Q7E3, 43=watching TV, Q8A, Q8B and Q8C; 44= The Ring On The Stick, 45= Strength Of My Hand, 46= Reaction Time, 47= Gravity Cone, 48= Nail Chair, 49= T- Puzzle, 50= Pyramid, 51= Flat Mirror, 52= Images Mixer (Zebra Mirror), 53= The Ames Room, 54= Periscope, 55= Up-Down Mirror).

ID	Class	Age	Gender	Q6A	Q6B	Q6C	Q6D	Q6E	Q7A	Q7B	Q7C	Q7D	Q7E1	Q7E2	Q7E3	Q8A	Q8B	Q8C
4	7A	13	2									40				45	46	44
7	7A	13	2						37		39	40	41			44	47	51
8	7A	13	1			34			37			40				53	45	
20	7B	13	1						37									
25	7B	13	2						37			40	41					
26	7B	14	2										41			45	48	
27	7B	13	1		33							40						
29	7B	14	1						37			40						
34	7C	14	2						37							44		
35	7C	14	1								39	40						
37	7C	13	1						37			40				50	49	51
38	7C	14	2									40						
50	7D	13	2								39		41			46	47	
52	7D	13	1						37			40				47	53	50
54	7D	13	1								39			42		50		
62	7D	14	2												43	44	49	50
72	7E	14	1						37			40				44	49	53
74	7E	13	2						37		39					53	44	52
78	7E	13	1									40				44	46	52
82	7E	13	2						37			40				49	47	46
91	8A	14	1						37			40	41			46	52	47
94	8A	14	1						37			40				46	49	52
96	8A	15	2										41					
100	8A	15	2				35		37			40						
115	8B	14	1						37			40				44	52	50
116	8B	15	1												43	44	52	47
117	8B	14	2						37							44	46	52

118	8B	14	2									40						
125	8C	14	1									40						
130	8C	14	1									40						
131	8C	14	2						37			40				44	45	
133	8C	14	2								39					44	52	
138	8D	14	1						37		39	40				44	52	50
140	8D	15	1									40				44		
141	8D	14	1						37			40				44	52	45
144	8D	15	2									40						
149	8D	14	2									40				52	54	50
156	8D	16	2						37		39	40				44		
163	8E	15	2										41			44	47	52
164	8E	15	2						37							44	55	51
165	8E	14	1									40						
166	8E	14	1						37			40				52	46	

A.3 Data of Student's Interview Questions and Answers (Question 9-13).

(Gender, 1= Girl, 2= Boy, Q9A, 56= funny, Q9B, 57= easy to understand, Q9C, 58= it is new and new things can be learned, Q9D, 59= for good instructions and labels,Q9E, 60= interesting, Q10, 100= all, but other numbers indicate the respective number of exhibits, Q11, here all numbers indicate respective number in second, Q12, 61=yes, 62= no, Q13A, 63= lot about science, Q13B, 64= lot about different things/ mirrors, Q13C, 65= how to measure reaction time and strength of hand, Q13D, 66= how to build a T with puzzle parts, Q13E, 67= how P works for perpendicular triangles).

ID	Class	Age	Gender	Q9A	Q9B	Q9C	Q9D	Q9E	Q10	Q11	Q12	Q13A	Q13B	Q13C	Q13D	Q13E
4	7A	13	2	56	57	58		60	5	20	61	63				
7	7A	13	2		57		59	60	7		62					
8	7A	13	1	56				60	1	500	62					
20	7B	13	1						3	180	62					
25	7B	13	2						8	300	61					67
26	7B	14	2	56					5	300	61		64			
27	7B	13	1								61					
29	7B	14	1						10	600	61		64			
34	7C	14	2	56					4	60	61					
35	7C	14	1	56					1	60	61	63				
37	7C	13	1	56			59		3	300	61	63				
38	7C	14	2						100	300	62					
50	7D	13	2						5	600	62					
52	7D	13	1	56					5	300	61		64			
54	7D	13	1						100	90	61		64			
62	7D	14	2	56					6	60	62					
72	7E	14	1	56					6	300	61		64			
74	7E	13	2	56	57	58	59	60	7	300	61		64			
78	7E	13	1	56	57		59		6	75	61		64			
82	7E	13	2	56	57			60	10	60	61		64			
91	8A	14	1	56		58	59		7	240	61			65		
94	8A	14	1	56					6	300	61	63				
96	8A	15	2						5	300	62					
100	8A	15	2								61					
115	8B	14	1	56	57	58	59		5	300	61		64			

116	8B	15	1	56	57	58			5	300	61		64			
117	8B	14	2						5	600	61	63				
118	8B	14	2	56	57	58		60		300	61				66	
125	8C	14	1								61					
130	8C	14	1	56		58				300	61	63				
131	8C	14	2	56			59		5	420	61	63				
133	8C	14	2			58			10	120	61		64			
138	8D	14	1	56					100	600	61		64			
140	8D	15	1	56					3	180	61	63				
141	8D	14	1	56					3	300	61	63				
144	8D	15	2								61					
149	8D	14	2				59		100	600	61	63		65	66	67
156	8D	16	2	56					3	600	61	63				
163	8E	15	2			58		60	6	300	61		64	65	66	67
164	8E	15	2	56				60	3	600	62					
165	8E	14	1						5	60	61		64			
166	8E	14	1						5	180	61		64			

A.3 Data of Student's Interview Questions and Answers (Question 14-21).

(Gender, 1= Girl, 2= Boy, Q14A, 68= It was boring, Q14B, 69= Difficult do understand, Q14C, 70= Many things are the same ones in other science canters/ Lack of new things, Q14D, 71= the exhibits labels are in English, Q15, 72= yes, 73= no, Q16, 74= The astronomy history show, 75= The starry sky and the constellations, 76= both, Q17, 77= yes, 78= no, Q18A, 79= Lot about stars/ planets/ astronomy/ space/,Q18B, 80= Name of different constellations and what they look like, Q18C, 81= Galaxy and its contents, Q19A, 82= It was boring, Q19B, 83= Difficult to understand, Q19C, 84= Higher number of constellations, Q20, 85=yes, 86= in between, 87= no, Q20, 88= The exhibitions, 89= The planetarium show, 90= Other things).

ID	Class	Age	Gender	Q14A	Q14B	Q14C	Q14D	Q15	Q16	Q17	Q18A	Q18B	Q18C	Q19A	Q19B	Q19C	Q20	Q21
4	7A	13	2					72	75	77	79						85	88
7	7A	13	2	68				72	75	77		80					85	88
8	7A	13	1		69			73	75	77		80	81				86	88
20	7B	13	1		69			73	75	77		80					86	88
25	7B	13	2					72	75	77		80					86	91
26	7B	14	2					73	75	78				82	83	84	86	88
27	7B	13	1					72	74	77		80					85	88
29	7B	14	1					72	75	77		80					85	88
34	7C	14	2					72	74	77			81				85	89
35	7C	14	1					72	75	77	79						86	89
37	7C	13	1					72	76	77	79						86	89
38	7C	14	2			70	71	72	76	77	79						85	89
50	7D	13	2	68				72	75	77	79						85	89
52	7D	13	1					73	75	77		80					86	89
54	7D	13	1					72	75	77		80	81				85	89
62	7D	14	2	68				73	75	77		80					86	88
72	7E	14	1					72	75	77		80					85	88
74	7E	13	2					72	75	77		80					85	88
78	7E	13	1					72	75	77		80					85	89
82	7E	13	2					72	75	77			81				86	91
91	8A	14	1					72	75	78				82			85	88

94	8A	14	1					72	75	77	79						85	89
96	8A	15	2	68		70	71	72	75	77	79		81				86	89
100	8A	15	2					72	75	77	79						85	88
115	8B	14	1					73	75	77		80					85	91
116	8B	15	1					73	75	77		80					86	91
117	8B	14	2					72	75	77	79						85	89
118	8B	14	2					72	75	77		80					85	88
125	8C	14	1					73	75	77	79						86	88
130	8C	14	1					72	75	77		80					85	91
131	8C	14	2					72	76	77	79						85	91
133	8C	14	2					72	75	77	79						85	89
138	8D	14	1					72	75	77	79						85	90
140	8D	15	1					72	75	77	79						86	88
141	8D	14	1					72	75	77		80					85	89
144	8D	15	2					73	74	77	79						85	88
149	8D	14	2					72	74	77	79						85	89
156	8D	16	2					72	74	77		80					86	88
163	8E	15	2					72	75	78					83		86	88
164	8E	15	2	68	69			72	75	78				82			86	88
165	8E	14	1					72	75	77		80					86	91
166	8E	14	1					72	75	77	79						85	89

A.4 Data of Teacher's Interview Questions and Answers.

(Question 1-4)

(Gender, 1= Female, 2= Male, Q1A, 1= books, Q1B, 2= mass media, Q1C, 3= science centres and museums, Q1D, 4= parents, friends and relatives, Q2A, 5=teacher, Q2B, 6= science centres and museums, Q2C, 7= mass media, Q2D, 8= parents, friends, relatives, Q3, 9= Yes, Q4= number of time in the specific number).

ID	Subject	Age	Gender	Q1A	Q1B	Q1C	Q1D	Q2A	Q2B	Q2C	Q2D	Q3	Q4
174	Mathematics and Science	41	1	1	2	3	4				8	9	16
175	Manotk	40	1	1	2	3		5		7		9	10
176	Mathematics and Science	36	1	1	2				6		8	9	10
177	Mathematics and Woodwork	41	2	1	2	3	4	5				9	10
178	Mathematics and Science	46	1	1	2			5	6			9	4

A.4 Data of Teacher's Interview Questions and Answers (Question 5-7).

(Gender, 1= Female, 2= Male, Q5A, =fun, Q5B, 12= teach science in an understandable way, Q5C, 13= learn more than to class room, Q5D, 14=new things, Q7A, 16=internet, Q7B, 17=science centers and museums, Q7C, 18= computers games, Q7D, 19=going to friends and relatives, Q7E1, 20= playing games, Q7E2, 21=gardening, Q7E3, 22=walking outside.)

ID	Subject	Age	Gender	Q5A	Q5B	Q5C	Q5D	Q5E	Q6	Q7A	Q7B	Q7C	Q7D	Q7E1	Q7E2	Q7E3
174	Mathematics and Science	41	1	11	12								19	20		
175	Manotk	40	1	11	12	13	14			16		18				
176	Mathematics and Science	36	1	11	12	13				16					21	
177	Mathematics and Woodwork	41	2	11			14			16	17	18	19	20		
178	Mathematics and Science	46	1				14									22

A.4 Data of Teacher's Interview Questions and Answers (Question 8-13).

(Gender, 1= Female, 2= Male, Q8A, Q8B and Q8C; 23= Mathematical exhibits, 24= Images Mixer (Zebra Mirror), 25= Flat Mirror, 26= Periscope, 27= Up-Down Mirror, 28= 3-D shadow, Q9A, 29= funny, Q9B, 30= easy to understand, Q9C, 31= it is new and new things can be learned, Q9D, 32= for good instructions and labels,Q9E, 33= interesting, Q10= numbers indicate the respective number of exhibits, Q11= here all numbers indicate respective number in second, Q12, 34=yes, Q13A, 36= about mathematics, Q13B, 37= about mirrors).

ID	Subject	Age	Gender	Q8A	Q8B	Q8C	Q9A	Q9B	Q9C	Q9D	Q9E	Q10	Q11	Q12	Q13A	Q13B
174	Mathematics and Science	41	1	23	24	25	29	30	31	32	33	5	240	34	36	37
175	Manotk	40	1	23	28	26		30		32	33	7	300	34	36	
176	Mathematics and Science	36	1	28	27	23	29	30	31		33	15	180	34	36	37
177	Mathematics and Woodwork	41	2	23	25	28	29		31		33	1	300	35		
178	Mathematics and Science	46	1	23	26	27		30	31	32		3	180	34	36	

A.4 Data of Teacher's Interview Questions and Answers (Question 14-22).

(Gender, 1= Female, 2= Male, Q14, 38= Lack of new things, Q15, 39= yes, 40= no, Q16, 41= The astronomy history show, 42= The starry sky and the constellations, Q17, 43= yes, 44= no, Q18A, 45= about star signs ,Q18B, 46= about constellations, Q19A, 47= I knew it before, Q19B, 48= boring, Q20, 49=yes, Q21A, 51= The exhibits were interesting, Q21B, 52= The planetarium program was great, Q21C, 53= people were nice).

ID	Subject	Age	Gender	Q14	Q15	Q16	Q17	Q18A	Q18B	Q19A	Q19B	Q20	Q21A	Q21B	Q21C	Q22
174	Mathematics and Science	41	1		39	42	44			47	48	49	51	52	53	
175	Manotk	40	1		40	41	43	45	46			49	51	52		
176	Mathematics and Science	36	1		39	42	43	45				49	51	52	53	
177	Mathematics and Woodwork	41	2	38	39	42	44			47		49		52	53	
178	Mathematics and Science	46	1		39	42	43	45				49	51	52		

A.4 Data of Teacher's Interview Questions and Answers (Question 23-28).

(Gender, 1= Female, 2= Male, Q23, 54= The exhibitions, 55= The planetarium show, Q24, 56= yes, 57= no, Q25A, 58= The exhibits of Framtidsmuseet are more meaningful, Q25B, 59= The exhibits of Framtidsmuseet are more attractive and educational, Q25C, 60= The exhibits of Framtidsmusset are in a better environment, Q26, 61= yes, 62= no, Q27A, 63= Students will learn, Q27B, 64= Stimulating for students, Q28A, 65= Nothing new for students, Q28B, 66= All students have been there).

Subject	Age	Gender	Q23	Q24	Q25A	Q25B	Q25C	Q26	Q27A	Q27B	Q28A	Q28B
Mathematics and Science	41	1	54	56	58	59		61	63	64		
Manotk	40	1	55	57				61	63			
Mathematics and Science	36	1	54	56	58	59	60	61	63	64		
Mathematics and Woodwork	41	2	54	56	58			62			65	66
Mathematics and Science	46	1	55	56	58		60	61	63	64		

A.4 Data of Teacher's Interview Questions and Answers (Question 29-30).

(Gender, 1= Female, 2= Male, Q29B, 68= Science centers and museums, Q29C, 69=both class room and science centers, Q29D, 70= Real world, Q30A, 71= everything can't be learnt in one place, Q30B, 72= Science centers give edu-entertainment at a time).

ID	Subject	Age	Gender	Q29A	Q29B	Q29C	Q29D	Q30A	Q30B
174	Mathematics and Science	41	1			69		71	
175	Manotk	40	1			69		71	
176	Mathematics and Science	36	1		68				72
177	Mathematics and Woodwork	41	2			69	70	71	
178	Mathematics and Science	46	1			69		71	

Appendix B

B.1 Questionnaires of Student's Interview

Hello, my name is Md. Khademul Islam, Master's Student of Science Communication in Dalarna University. I have been conducting a thesis as a part of my masters program. I want to study how school students interact with exhibits and I need some information from you for my thesis. Would you please fill in the gaps and circle (○) the appropriate answer/ answers of the following questions? It should be mentioned that, although you will give your name, these will not be taken along to the final study!! That is, as soon as we know who has answered the questions (and who not), we have the statistics we need, and the answers will be "anonymized."

Thanking you for your cooperation.

Md. Khademul Islam

Demographic information

A. Name----------
B. Class----------
C. Age ----------
D. Boy/ Girl----------
E. Today's date----------

On the following questions you can give several answers!

(1). How can you get information about science and technology?

A. By reading books
B. From mass media (Television, Radio, Newspapers, Internet, Journals)
C. Visiting science centres and museums (such as Jussi Björling, Dalarnas museum in Falun)
D. Talking with parents, friends and relatives,
E. Others (please specify) -------

(2). How did you first learn about science?

A. From teachers
B. Visiting science centres and museums
C. From mass media
D. From parents, friends, relatives
E. Others ((please specify) ----------

(3). Have you ever visited science centres (such as Framtidsmuseet or Tom Tits in Södertälje) and museums?

A. No
B. Yes, but only at a museum
C. Yes, but only in a science centre
D. Yes, both

(4). If your answer is 'yes' please mention how many times?

A. One time
B.Two times
C. Three times
D. Four times
E. Others ((please specify if possible) ---------

(5). Why do you visit science centres and museums? Because

A. They give you fun
B. They teach you science in a understandable way
C. There you can learn more than to class room
D. They present many new things
E. Others ((please specify) ---------

(6). If your answer of question no 3 is 'no,' please mention why you didn't visit science centres and museums?

A It is too expensive
B. Lack of time
C. Lack of interest
D. Lack of information
E. Others ((please specify) -----------

(7). How do you spend your leisure time?

A. Using internet
B. Visiting science centres and museums
C. Playing computers games
D. Going to friends and relatives
E. Others ((please specify) ------------

(8). In Dalarna University you have visited several exhibits. Please mention or describe the names of three exhibits that you enjoyed most and give them grade (best=1, second best=2, third best=3).

A. ----------

B. ----------
C. ----------

(9). Can you tell why did you enjoy those three exhibits? (Please mention the reasons).

A. ----------
B. ----------
C. ----------
D. ----------
E. ----------

(10). During your visit in Dalarna University how many exhibits attracted you to visit them? (Please mention the number or the approximate number).

----

(11). On average how much time did you spend in every exhibit that attracted you? (Please mention the approximate average time).

----

(12). Have you learnt anything by visiting the exhibits of Dalarna University?

A. Yes
B. No

(13). If your answer is 'yes', please mention what have you learnt?

----

(14). If your answer is 'no', please mention the reasons?

----

(15). Do you think the exhibits labels of Dalarna University supplied you enough information regarding their operation?

A. Yes
B. No

(16). Which part of the planetarium program of Dalarna University did you like best?

A. The astronomy history show
B. The starry sky and the constellations
C. Both

(17). Did you learn anything new by watching the planetarium program of Dalarna University?

A. Yes
B. No

(18). If your answer is 'yes', please mention what did you learn?

---

(19). If your answer is 'no', please mention why didn't you learn?

---

(20). Did you enjoy your visit at Dalarna University?

A. Yes
B. In between
C. No

(21). what did you like best during your visit at Dalarna University?

A. The exhibitions
B. The planetarium show
C. Other things
D. Both

Thanks a lot indeed for spending your valuable time and answering the questions.

B.2 Questionnaires of Teacher's Interview

Hello, my name is Md. Khademul Islam, Master's student of Science Communication in Dalarna University. I have been conducting a thesis as a part of my masters program. I need some information from you for my thesis. Would you please fill in the gaps and circle (○) the appropriate answer/ answers of the following questions? It should be mentioned that, although you will give your name, these will not be taken along to the final study!! That is, as soon as we know who has answered the questions (and who not), we have the statistics we need, and the answers will be "anonymized."

Thanking you for your cooperation.

Md. Khademul Islam

Demographic information

A. Name----------
C. Subject that you teach in school----------
D. Age ----------
E. Female/ Male---------
F. Today's date---------

On the following questions you can give several answers!

(1). How can you get information about science and technology?

A. By reading books
B. From mass media (Television, Radio, Newspapers, Internet, Journals)
C. Visiting science centres and museums (such as Jussi Björling, Dalarnas museum in Falun)
D. Talking with parents, friends and relatives,

E. Others *(*please specify) ----------

(2). How did you first learn about science?

A. From teachers
B. Visiting science centres and museums
C. From mass media
D. From parents, friends, relatives
E. Others ((please specify) ----------

(3). Have you ever visited science centres (such as Framtidsmuseet or Tom Tits in Södertälje) and museums?

A. Yes
B. No

(4). If your answer is 'yes' please mention how many times?

A. One time
B.Two times
C. Three times
D. Four times
E. Others ((please specify if possible) ----------

(5). Why do you visit science centres and museums? Because

A. They give you fun
C. You need to go there with your students
D. There you can learn how to teach the students effectively
E. They present many new things
F. Others ((please specify) ----------

(6). If your answer of question no 3 is 'no,' please mention why you didn't visit science centres and museums?

A It is too expensive
B. Lack of time
C. Lack of interest
D. Lack of information
E. Others ((please specify) ----------

(7). How do you spend your leisure time?

A. Using internet
B. Visiting science centres and museums
C.Watching movies
D.Going to friends and relatives
E.Others ((please specify) ----------

(8). In Dalarna University you have visited several exhibits. Please mention or describe the names of three exhibits that you enjoyed most and give them grade (best=1, second best=2, third best=3).

A. ----------
B. ----------
C. ----------

(9). Can you tell why did you enjoy those three exhibits? (Please mention the reasons).

A. ----------
B. ----------
C. ----------
D. ----------
E. ----------

(10). During your visit in Dalarna University how many exhibits attracted you to visit them? (Please mention the number or the approximate number).

---

(11). On average how much time did you spend in every exhibit that attracted you? (Please mention the approximate average time).

---

(12). Have you learnt anything by visiting the exhibits of Dalarna University?

A. Yes
B. No

(13). If your answer is 'yes', please mention what have you learnt?

---

(14). If your answer is 'no', please mention the reasons?

---

(15). Do you think the exhibits labels of Dalarna University supplied you enough information regarding their operation?

A. Yes
B. No

(16). Which part of the planetarium program of Dalarna University did you like best?

A. The astronomy history show
B. The starry sky and the constellations

(17). Did you learn anything new by watching the planetarium program of Dalarna University?

A.Yes
B.No

(18). If your answer is 'yes', please mention what did you learn?

(19). If your answer is 'no', please mention why didn't you learn?

(20). Did you enjoy your visit at Dalarna University?

A. Yes
B.No

(21). If your answer is ‘yes’, please mention the reasons**.**

---

(22). If your answer is ‘no’, please mention the reasons**.**

---

(23). What did you like best during your visit at Dalarna University?

A. The exhibitions
B. The planetarium show

(24). Do you find any difference between the exhibits of Dalarna University and Framtidsmuseet in Borlänge?

A. Yes
B. No

(25) If your answer is ‘yes’, please mention the differences.

---

(26) Do you have any plan to visit the exhibits of Dalarna University again with new students?

A. Yes
B. No

(27) If your answer is ‘yes’, please mention the reasons.

---

(28) If your answer is ‘no’, please mention the reasons.

---

(29) Which type of environment is best for the students to learn?

A. Class room
B. Science centers and museums
C. Others ((please specify) ---------

(30) Please mention some reasons in favour of your answer of question no 29.

Thanks a lot indeed for spending your valuable time and answering the questions.