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Primary school student teachers' views about making observations

Abstract

Scientific observation plays a central part in the formation of scientific knowledge and thus it has an important role in the teaching and learning of science. Despite its importance there are only a few studies that focus on the problems in making observations. The paper begins with the collection of factors effecting scientific observation. In order to find out primary school student teachers' conceptions of scientific observation 110 student teachers were asked to write what things they connect to making scientific observations. For the majority of the student teachers making observations seems to mean in the first place just noticing things. Only about 30% of the student teachers connected earlier experiences and knowledge with observations and only 30% of the student teachers mentioned processing of information. To become efficient at it, student teachers need plenty of practice and experience of the different features of scientific observation.

Introduction

Observations play an important role in the formation of scientific knowledge. Thus making observations is central when pupils are taught the process skills (e.g. Harlen, 2000, Johnston, 2005). Furthermore, science curriculum documents reveal that student observation is held central to the learning of science. For example, US National Science Education Standards (Standard, 1996) emphasizes that "When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others". Respectively, in the Finnish National Core Curriculum for Basic

Education (2004) one of the objectives for pupils in grades 1-4 in Environmental and natural sciences, is "to learn to make observations using the different senses and simple research tools, and to describe, compare, and classify their observations".

In everyday life observation is simply seen as "looking at things". However, in science observations are used to generate further explanations and theories about observed phenomena; they require skills associated with collecting and interpreting data and are influenced by the observer's assumptions and domain knowledge (Haury, 2002). Many researchers have strongly stressed that it is impossible to learn science or more specifically to understand the nature of science just by studying the process skills as such. Learning about science – developing an understanding of the nature and methods of science, and an awareness of the complex interactions among science, technology, society and environment – includes essentially the unification of conceptual and procedural knowledge (Millar, 1989; Gott & Duggan, 1994; Hodson, 1996; Metz, 2004). This means that at school the process skills have to be introduced jointly in the connection of authentic inquiries or scientific investigations. On the other hand, in order to help prospective teachers in teacher education to communicate about the nature of science they have to be guided to recognize the many facets related to the process skills and how to use them in doing science.

Very few studies on learning and teaching science pay attention to problems pupils have in making observations and how the skill of observation will develop over the course of pupils' studies. Howes (2008) concludes that young children are good at observing if observing is defined as noticing and following behaviours or phenomena that are intriguing or important to them. However, to write about, or otherwise represent what one sees is not a skill that comes easily. She stresses that observing and recording are intimately connected in learning to do both. These ideas are close to the findings of Tomkins and Tunnicliffe (2001). They found that 12-year-old pupils' observations were largely based on salient features but that sustained observations may provide a base for clearer hypothesis making. They also asserted that 'pupil talk' or 'diary reflection' is of considerable learning value for it allows a formative juggling of the evidence and through that a seeking for meaningful pattern. Smith and Reiser (2005) describe a methodology for assisting high school biology students in the processes of observational inquiry and theory articulation. They stress that tracking the various actions that lead to final outcomes is necessary in order to help students understand the importance of accounting for causality during observations. Learners often ignore the causal, intermediate interactions that could be observed, focussing primarily on final outcomes (Kuhn, Black, Keselman, & Kaplan, 2000). Smith and Reiser (2005) suggest that in order to support student-directed observations teachers should provide students with structured tasks that facilitate complex analysis and reasoning around observed materials. These tasks should help students to understand that observation is not a goal in itself. It is a method of inquiry that provides data for articulating explanatory hypotheses and models.

Park and Kim (1998) analysed high school students' responses to contradictory results obtained by simple observation. They found that the majority of students preserved their own preconceptions. This means that when students directly observe some experiments they may neglect, distort or reject the observed results. Learning does not happen automatically without learners' cognitive effort. According to Haslam and Gunstone (1996, 1998) many high school science student teachers saw observation as a teacher directed process. However, in some cases this seemed to be a learned response, derived from coping with some teachers. Altogether, the impact of the teacher on students' ideas and beliefs about observation was strong. Observation was seen by students to be important to their learning. If the content associated with the observation was familiar, the observation was taken more seriously. Also students' interest in the topic affected their attention to the task.

Teachers' role as a facilitator of learning is gaining more emphasis. In the school environment teachers' awareness concerning the purpose of observations, the rules governing observations and

the possibilities observations offer for pupils' learning, are crucial. It is the teacher whose interpretations set the framework to pupils' interpretations about their role as observers. However, the research literature has focused mainly on pupils' learning while there is rather little research focusing on student teachers. Our research orientation directs attention to improve student teachers' knowledge and skills in teaching science especially in the connection with practical work in primary school. The focus is on the complexity of observations. Observations have an essential role both in construction and verification of scientific models. Making observations is also the first step in doing investigations as it contains all the components of a science inquiry process. Scientific observation is one of the process skills like classification, measurement, making inference, prediction, recording, planning or communicating (see cf. Padilla 1990).

The research questions of this study are: (i) How do student teachers understand the skill of observation in the context of school science; and (ii) What features of the skill of observation are identified initially?

Views of scientific observation

Scientific observation

Norris (1984, 1985) has put forward a generalized theory of scientific observation defined mainly in terms of human intentions and purposes and thus not taking human perception into account. He proposes that scientific observation is inherently heuristic because it is best conceived in its function as an aid and guide to scientific discovery. In reporting something as an observation a scientist intends: (i) to report on some event or state of affairs which the scientist considers to have been reliably witnessed using some sensory apparatus; and (ii) to indicate that this report is to play a foundational role in building knowledge in the field in question. One should note also that scientific observation is a function of the current state of knowledge, it is theory-laden, burdened with interpretations and assumptions, and that observations are not infallible or beyond the possibility of doubt (see also Hodson, 1986). Every statement in science is in principle open to question. Furthermore, deciding whether or not a statement is a report of an observation must be done knowing the context of its production and the nature and intentions of its producer.

Observations play a fundamental role in scientific investigations. In some cases scientific observation is a rather simple activity - a matter of "looking at things" leading to concrete statements about the world like "it is snowing". In other cases scientific observation can be an extremely complex activity especially when used to generate further explanations and theories about observed phenomena. Then they require skills associated with collecting and interpreting data and are influenced by observers' assumptions and domain knowledge (Haury, 2002). Furthermore, as Hodson (1986) has warned knowing what to observe, knowing how to observe it, observing it and describing the observations are all theory-dependent. Scientific observations are not categorical statements about objects and events in the external world. They are rather reports of how things seem to the observer i.e. how the observer interprets them. Marking the distinction between what is doubtful and what is not doubtful is part of the motivation for science educators' emphasis on distinguishing observations from inferences and conclusions. Observations are to mark the beginning points of reasoning in the area of knowledge in question, the basis upon which other knowledge rests.

Thinking behind observations

Scientific thinking involves an interaction of conceptual and procedural understanding. Conceptual understanding is applied to facts and procedural understanding to skills. Procedural understanding is thinking-behind-doing. In the case of observing it includes, for example, the decisions that must be made about what to observe, how often and over what period. These two types of understanding are not mutually exclusive. Gott and Duggan (1994) emphasize that procedural

understanding is more than a matter of recalling and using skills. Likewise Warwick, Linfield and Stephenson (1999) draw a clear distinction between the concepts of 'process skills' and 'procedural understanding', the latter being related to the dialogue about evidence. Kuhn et al. (2000) conclude on the basis of their intervention study with 6th and 8th graders that a developmental hierarchy of skills and understanding underlies inquiry learning.

The main concern in the research of science teaching and learning has been the conceptual understanding whereas the procedural understanding has received considerably less attention. However, activities like observing, inferring, predicting, and controlling variables play a central role in the scientific research as well as in studying at school. Millar (1989) has argued that it is misleading to portray the method of science in terms of discrete processes as these are not linked by a set of rules and procedures into a method which will guide scientists on how to tackle a new problem. Scientific inquiry involves the exercise of skill for example in deciding what to observe or in selecting to which observations to pay attention. He has also stressed that it is scientific observing instead of mere observing that should be developed and promoted through school science. Furthermore, the exercise and development of these skills depend crucially on a basis of science content and concept knowledge. Millar (1989) emphasizes also the necessity of clarification the stages in developing these science skills.

Observing as a learning process

What happens when a person is making observations? According to the variation theory the starting point is the dynamical structure of awareness (Marton & Booth 1997, pp. 82-109). A person's awareness contains all his/her experiences. An experience is formed in the interactions between the person and a phenomenon. In order to experience something the person has to discern the target, to separate it from the background. This means that the person has to notice the visible and/or hidden features from the phenomenon and become aware of them. S/he discerns these aspects as entities or as details. Awareness can be guided to discern a certain target or some parts of the target while other parts remain hidden. The features of the target can be connected together or for example to a relevant feature of another phenomenon in many ways. The targets under observation can also alter very quickly. The target can vanish from awareness and it can be replaced with another thing that has originally been in the background. Even that awareness is a holistic experience from all the observations made in a certain situation some features may come forward and others may stay in the background.

When a person makes observations from a thing or a phenomenon s/he experiences a connection between a certain feature and its meaning. S/he forms an idea about the thing. This idea is a new state of awareness. Different people pay attention to different features when they are making observations about a target. At that moment they have also different knowledge and ways of thinking so that they form different conceptions (Marton & Booth, 1997; Marton, Runesson, & Tsui, 2004). Scientific observation is closely connected to procedural and conceptual understanding and in this way it is influenced by pre-existing knowledge and earlier experiences. Through processing new knowledge and skills are formed. However, the working memory with its limited capacity and visual information-processing theory set limitations to observations (Sweller, 1994).

While observing an object or a phenomenon one uses all senses or some equipment in order to identify similarities and differences as well as patterns in and between objects and phenomena. At the same time, when one becomes aware of something s/he will connect to the thing that s/he is observing some meaning that is activated simultaneously. The meaning has been formed on the basis of his or her earlier knowledge or experiences (Marton & Booth 1997). This means that one starts to interpret observations or sequences and patterns in phenomena that are being observed using the information that has activated in the working memory.

During a science lesson also other factors such as motivation, context or the pupil's perceived expectation have a significant effect on students' performance. Motivation is an important factor in the observation process, because it affects to the orientation towards the situation and to the observation process itself. Therefore, the situation should somehow increase curiosity or feeling of autonomy or should be personally meaningful (Deci & Ryan, 2002). Also, affective and emotional factors have to be taken into account.

In Figure 1, we have collected the main characteristics of scientific observation from a teacher's point of view when s/he is trying to improve teaching observation. In the first place, it is based on the four questions: What to observe, how to observe, how to treat observations, and what personal factors affect observations. Bransford, Brown and Cocking (2000) describe how internal representations can be built up through many opportunities for observing similarities and differences across the observed phenomena. Consequently the goal of these observing activities is to help students build internal representations – information stored in the memory that students can retrieve to generate inferences, solve problems, and make decisions. The nature of memory provides suggestions to how observations are processed in the working memory and stored in the long-term memory (Rapp & Kurby, 2008).

We have left out conceptual thinking that is connected with the concepts and theories related to the subject of observation. We have only briefly referred to the learning environment i.e. to the social, psychological and pedagogical contexts in which learning occurs and which affect students' attitudes and beliefs.

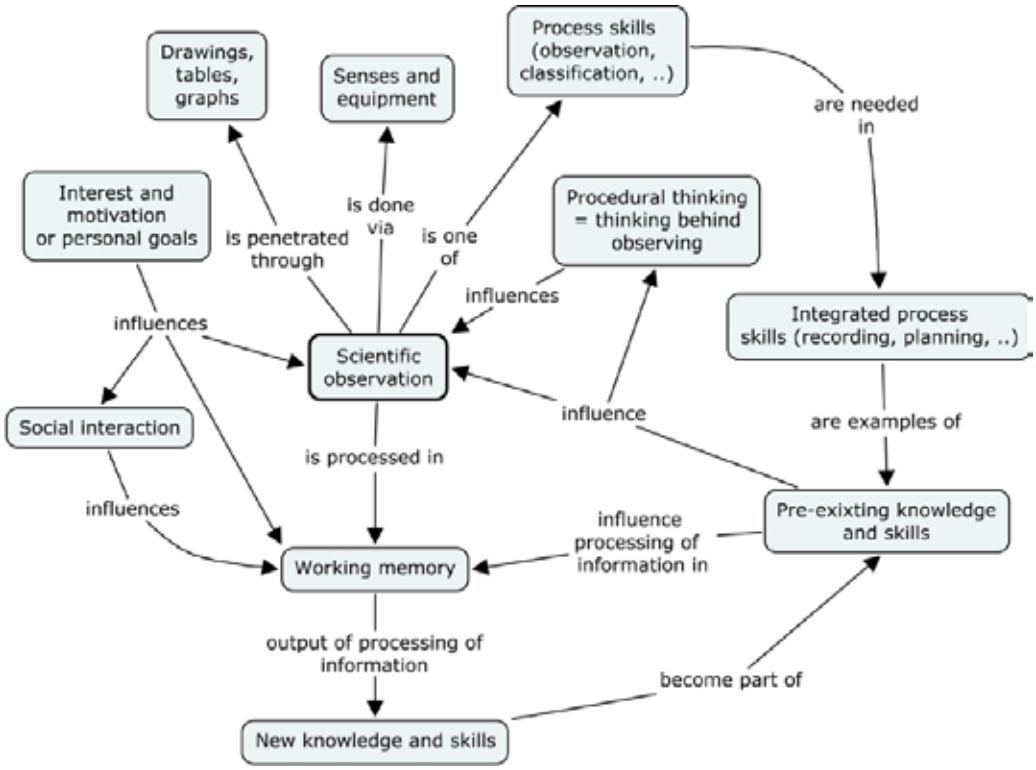

Figure 1. Things connected to scientific observation.

Methods

Subjects

In Finland primary school teachers are educated to teach all subjects except foreign languages in primary school at grades 1-6 (pupils 7 - 12 years old), including mathematics and science. They are educated in eight universities in Finland in master's degree level programmes requiring 300 credit points (cp.). The credits are in accord with the European Credit Transfer System (1 ECTS = 1 cp. = 27 hours work). The primary student teachers belong to a select population; only one in fifteen applicants passes the entrance examination of the primary teacher education programme. The student teachers are mostly female and they are all versatile, talented persons.

The primary school student teachers participating in this study had started their second year in the autumn just prior to the research. During their first year they had undertaken basic pedagogical studies and some didactics studies like in Finnish and mathematics. They had not yet started their training in school. The second year studies, basic courses in biology didactics (3 cp.), chemistry didactics (3 cp.) and physics didactics (3 cp.), focus on the teaching of the basic concepts and models of science. One of the aims within the courses is to help teacher students to understand explanatory models appropriate for school pupils on certain developmental level. Besides that, it is important that students understand that biology, physics and chemistry are experimental sciences with special characteristics as school subjects.

Data gathering

The data was collected during the biology didactic course by asking the primary school student teachers (N = 110) the following questions:

1. What things do you think are connected to making observations?
2. What do you think is the skill of observation?
3. What kind of difficulties do you think you yourself have in making observations?

The aim of the first question (What things do you think are connected to making observations?) is on the one hand to get the students to concentrate on thinking about making observations and on the other hand to find out what features of making observations initially come to their mind and also how many different properties related to making observations they recognize. With questions 2 and 3 we aim to find primary student teachers' conceptions on the skill of observation.

Data analysis

The analysis used is mainly qualitative and it can be best described by inductive content analysis (Patton, 2002). First, student teachers' answers were read through many times. During the reading certain patterns were abstracted. All the team members are teacher educators with the same kind of theoretical background from science education. When different categories started to be formed each category was again read separately and inconsistent answers were taken away and perhaps moved to other categories. Also this procedure was done several times. After this the categories that contained similar ideas were read together. The patterns were not exactly determined so that after several discussions with the team members the final few categories with some subcategories were formed. All responses were carefully categorised together with their frequencies. In the final form the exact classification has been left out and only the full percentages are given.

Results

Question 1: Things connected to making observations

The four categories found from the students' answers are given in Table I together with the percentage of the responses. The categories are listed according to the decreasing number of responses. The contents of these categories are then explained and some answers are given as examples.

Table I. Distribution of the student teachers' answers in question 1: What things do you think are connected to making observations? (N = 110).

Categories	Proportion of answers (%)
A. Observations are made about entities, details, and changes.	72
object, phenomenon, event, change	47
environment, nature, world	27
thing, target	27
B. Observations are made using senses and apparatus.	64
senses	86
apparatus	14
C. Observations are influenced by observers'	49
experiences and knowledge	43
interest and attention	57
D. Observations are recorded, processed, and reported.	40
recording and reporting	19
processing of information	81

The mean of the number of categories per student teacher was 2.2. A quarter of the student teachers' answers contained material from three categories, and also a quarter wrote only about one subject i.e. mainly about the target of the observation or that the observations are made with senses. About 10% of the student teachers' answers contained material from all the four categories.

Observations are made about entities, details, and changes

Altogether about 70% of the student teachers mentioned some object in making observations. About half of them wrote about properties, phenomena, events but only a couple mentioned changes. One quarter of them spoke about making observations of the environment, nature, or the world. Another quarter referred to the object very vaguely talking about the thing, the object or about a stimulus.

> Observing is watching and examining things and phenomena. Exploring different properties of the object is surely the main point in making observations. In this way one can exclude impossible alternatives or map the object from general features to details.

> I think that watching events in the surrounding nature is connected to making observations. Details are raised from the entity. One will learn new thing by making observations.

Observations are made using senses and apparatus

About two-thirds of the student teachers wrote that observations are made using senses. Only about 5% of the student teachers mentioned that also equipment like the microscope and telescope can be used in making observations.

> Human beings observe the world with all their senses. When observing they look, listen, smell, and sometimes taste and touch.

Observations are influenced by observers' characteristics

Almost a third of all the student teachers saw that interest and concentration are important in making observations. Half of these student teachers mentioned interest, motivation or curiosity whereas the other half spoke mainly about concentration, attention, carefulness and also empathy.

> To make observations the following skills are needed: patience, concentration, working memory and creativity to look from the right place.

A fifth of all the students commented on the effect of earlier experiences and knowledge on observing and on observations. These comments varied from simple statements to deeper analyses.

> A pupil's own world view as well as his/her constructions related to knowledge, skills and values is central in making observations. A pupil's own internal models will direct his/her observations. On the other hand, observations will on their part revise his/her internal models. In teaching it would be important to start from pupils' own observations and analyze and apply them meaningfully in everyday practice.

A little less than a fifth of these students wrote about both the emotional properties and the necessity to have knowledge about the target.

> Observer's earlier knowledge is connected to making observations. Observations may rest on earlier knowledge or deviate from it. In making observations one has to be interested in the things around oneself or be interested both directly and purposefully in the object under observation.

Observations are recorded, processed, and reported

A third of all the students wrote about the processing of the information that could be obtained from observations. The information was processed using the basic skills like identifying similarities and differences, classifying, interpreting and making conclusions. Here the word information is used instead of knowledge as usually the students' real understanding as to the nature of science could not be inferred on the basis of the answers. In most of these answers the terms interpretation and conclusions were mentioned. Only a small number of student teachers mentioned recording and reporting.

> Observations are directed to the properties of a thing or a phenomenon, or its behaviour, the environment and its effect on the thing/phenomenon. The observer can make notes and draw conclusions on the basis of his/her observations and make his/her own conception on the thing/phenomenon in question.
>
> A more complete picture and conception can be formed from the observations like constructing a jigsaw puzzle. This gives a firm basis for going deeper into the matter and for the formation of concepts.

Only two student teachers spoke about making investigations. However, the basic process skills like describing observations with words, classifying, finding similarities, differences and patterns could be found from the answers.

> In making observations one has to watch the different properties of the object and notice the differences and similarities compared to other objects. One has to know how to perceive entities and small details. Also the skill to classify the things that one sees belongs to making observations.

Question 2: The skill of observation

The following five categories were found from the answers to the second question: What do you think is the skill of observation? The categories are listed according to the decreasing number of responses.

Curiosity and open mind

About 40% of the student teachers wrote that the skill of observation means a curious and unprejudiced mind looking at things from many sides actively but objectively, seeing things "with new eyes". More than a third of them spoke about concentration and attentiveness and some emphasized sensitivity. Because the questionnaire was given to the student teachers in the beginning of the biology didactics course it is understandable that many students connected their answers with nature and plants.

> To my mind curiosity, ability to work hard and opportunity are connected to the skill of making observations. In the classroom a pupil may not be eager to go into the nature but when s/he sees that the teacher and other pupils are interested in looking at what there is in the forest s/he also will become interested and will start to work harder.

Essential things details and entities

Also about 40% of the student teachers' answers were classified in this category. In half of them it was stated that the skill of observation means to pay attention to essential things. A third of them spoke about noticing details or characteristic features whereas every sixth spoke about perceiving entity.

> To notice essential things, those that differentiate the object under observation from other things.
> To find details and special features.
> To react to the changes in the environment and connect single things into an entity.

Thinking processes

About 20% of the student teachers wrote about skills to produce causal relations.

> The skill to observe includes also the development of thinking processes needed to treat observations.
> When a person can make observations s/he can also direct his attention and analyze at least on some level information received through the senses.

Watching the nature and the environment

Nearly 15% of the student teachers described the skill to observe as a skill to notice things around oneself or in the nature.

> The skill of observation means to make observations and watch the surrounding world and its different parts.
> The skill to make observations includes recognition and classification of different types of organism.

Investigations

About 10% of the student teachers related the skill of observations with making investigations.

> The skill to make observations is a skill to investigate, analyse and report, to keep eyes and ears open, and understand similarities, differences and the many- sidedness of some things.

The majority of the student teachers' answers were classified only in one category. Only 25% of the answers contained material from two categories. Less than 10% of the student teachers' answers could not be classified to these categories. In most of these answers the student teachers spoke only about senses. Also some answers contained material outside the categories. A fifth of the student teachers mentioned the importance of senses. Some of the student teachers pointed out that the skill of observation develops when it is used and trained.

Question 3: Student teachers' own difficulties

The following four categories were found from the answers to the third question: What kind of difficulties do you think you might have in making observations? The categories are listed according to the decreasing number of responses.

Lack of knowledge

Nearly half of the student teachers stated that their difficulties in making observations were due to not having enough background knowledge about the matter to be observed. About a third of these students expressed that they were not able to pay attention to the right, essential things. We have interpreted this that they did not have enough knowledge to know what is essential and therefore included these answers to this category. A fifth of them referred to their scarce knowledge especially in science.

> My difficulty to make observations is due to almost nonexistent knowledge about the background.
>
> I have almost no basic knowledge about different species. I know very little about both plants and animals. I can make observations only about their appearances but I do not have conceptions to which I could connect my esthetical observations.

Lack of concentration

A third of the student teachers thought that their difficulties to make observations were caused by lack of concentration, impatience or carelessness. Behind all these factors may be a lack of interest as also some of the students emphasized.

> Lack of concentration may cause difficulties in making observations because one has to observe intensively the situation.
>
> Lack of interest, being inattentive may make observing more difficult.

Own conceptions and habits

A fifth of the student teachers figured that they were "set in their own ways" so that in observing familiar things they do not really observe the object but look for things that they are used to paying attention to. Many of them answered the question from a general point of view and not necessarily from the science point of view. In slightly more than a third of the answers in this subcategory the students wrote about preconceptions and stated that a person's own preconceptions can direct observations so that to change one's conceptions may be difficult.

> If one is too experienced and always acts as before it may happen that s/he only carries on as before and never makes any observations from her/his surroundings. One day s/he then will notice that "a new house has been built here", even though the house has been there for a long time.
>
> Not enough critical thinking. I accept too easily as facts that have been told to me and do not question them. Therefore I do not observe, ponder and analyse things enough.

Lack of practise

About a sixth of the student teachers stressed that one has to become accustomed to making observations, have practice in observing. Some students wrote that their difficulties are related to their uncertainty about their own skills. There were, however, a few students who stated that they have no difficulties whatsoever in making observations.

> One has to get used to making observations so that one can describe the thing with the right words.

Less than 10% of the student teachers' answers could not be classified to these categories. These students spoke about recognition of species or lack of time or colour blindness. About a fifth of the answers contained material from two of the categories, the other answers contained material from only one category.

Discussion and conclusions

Our main aim in this study was to find out what primary student teachers understand by making observations. As it can be seen from Table I less than 30% of the student teachers, at least spontaneously, seem to connect earlier experiences and knowledge with observations. Furthermore, when the student teachers described the skill of observation in their answers to question 2, only 20% of them mentioned thinking processes. The students, who wrote about the information based on observations and how it could be processed, did have the view that making observations is a holistic event in which all parts are simultaneously activated and there is continuous feedback between them. For the majority of the primary student teachers making observations seems thus to mean in the first place just noticing things. They may therefore not pay enough attention to the essential role of observations in construction and verification of scientific models. They may not spontaneously start wondering and questioning what is behind the observations, and how to explain them. However, all practical work in science involves interactions of procedural and conceptual understanding (Gott & Duggan 1994). The development of procedural understanding, on the one hand, and, conceptual understanding, on the other, can be likened to a double helix, both developing in linked spirals (see Johnston 2005, pp. 30-31). It seems to be important to find out what difficulties the primary student teachers have for example in forming questions in regards to showing a phenomenon to pupils.

In answering question 1 only about 5% of the student teachers mentioned that also equipment like microscopes and telescopes can be used in making observations writing mainly that observations are made using the senses. This proportion can be compared to 20% of the similar mentions of the upper secondary science students who answered the similar questionnaire (Ravanko, Hakkarainen & Ahtee, 2009). Norris (1985) has argued that the misconception about human sense perception playing a dominant role in scientific observation is due to the historical development of science. So it is time to change this conception because the use of the microscope and telescope open up completely new worlds in science for children. In preschool and at the beginning of primary school sensory observations have obviously a central role whereas later more emphasis should gradually be placed on pupils' skills to use different equipment. This raises another research question about how ready and confident prospective primary teachers are in using different equipment in their teaching, or is the use of equipment one reason why prospective class teachers may avoid science teaching (Appleton, 2003).

The student teachers used terms like motivation, interest and also empathy to describe the factors which arouse and maintain behaviour towards attention and concentration within an individual making observations. Howes (2008) has pointed out that students are good observers typically only if the phenomenon is intriguing or important to them. Young children's science learning is based mainly on intrinsic motivation such as curiosity. Hidi, Renninger and Krapp (2004) point out that interest caused from intrinsic motivation is optimal for learning science. Moreover, interest can develop progressively (Hidi & Renninger, 2006) and it can be self-regulated by pupils (Sansone & Smith, 2000; Sansone, Wieb & Morgan, 1999). However, having started school education, the curriculum replaces children's natural curiosity directed learning.

From the science point of view it is important to understand that observations are not only categorical announcements about the objects and phenomena. In the first place they are the observer's report about what the objects and phenomena seem to be from his/her point of view. Therefore at school pupils have to present their observations by telling about them, or give them in the form of tables and graphs. Only a couple of the student teachers mentioned reporting about observations. However, it is easy to omit mentioning things that to your mind are not relevant from the perspective of the questionnaire. Therefore, it could be interesting to study further primary student teachers' views about the importance of reporting one's observations.

The student teachers mentioned observing details, entities or nature but only a couple of the student teachers mentioned changes. The purpose in making observations is to collect data from different targets. There is a difference depending on whether the target is an object, a phenomenon or the whole surrounding (Gott, Duggan & Roberts, 2008). Observations start from looking at similarities and differences and progress to making full investigations. To recognize the features of an object or a phenomenon demands paying attention to details but at the same time one has to recognize the whole entity where the object is or the phenomenon happens. At the same time when a target is being observed the observer also starts to analyse the data and compare it with pre-existing knowledge. Therefore, observation enables the observer to identify patterns or causal relationships, or to check ideas. According to the variation theory (Marton & Booth, 1997) every object or phenomenon has its own critical features that distinguish it from other objects or phenomena. In order to be able to create proper explanations one has to observe how the critical features vary in a certain phenomenon. Different people will discern a phenomenon in different ways depending on their own experiences and awareness (Marton & Booth, 1997). They will observe different features as well as discern the whole in its context and distinguish the parts from the whole (Marton, Runesson & Tsui, 2004). People differ according to what they know and what they are interested in and therefore they will pay attention to different things. People will become aware of and form a conception about the target they are observing when they connect to a certain feature the meaning that is activated simultaneously on the basis of their earlier knowledge and experience. They start to give explanations to the phenomenon (Marton & Booth, 1997; Marton & Tsui, 2004; Runesson, 2006).

When the student teachers tell about their own difficulties in making observations, the majority of the teacher students speak about lack of interest, own habits and lack of practice. This is in accordance with the study by Johnston and Ahtee (2006) in which it was found that Finnish students come to primary teacher training programmes with a negative attitude and apprehension about physics teaching.

Scientific observation is a complex process. It forms part of a whole investigation, and its meaning is closely related to the purpose of the investigation. Furthermore, conceptual framework cannot be isolated from observation as it guides the selection and interpretation of the observations to be made. When disciplinary knowledge guides perception of observed phenomena the teacher has to help students understand how to detect significant features during their observations and how to compare these against other observed examples to understand similarities and differences across behaviours (Driver, 1983; Hodson, 1986). This means that normally tacit, expert strategies should be made explicit also to student teachers (cf. Smith & Reiser, 2005).

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