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Observation, not only perception but also cognition

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Abstract
According to the Swedish curriculum for primary school it is important in science subjects to develop skills to observe, to describe the observations and to put them into a theoretical framework already starting year 1–3.
Thus, it may be important for the teacher not only to be accustomed to the methods of observing but also to be an expert on using these observations in order to design teaching situations where these skills may be developed.
Here we present a study where 25 pre-service primary school teacher students at the beginning of a 20 weeks course established a relation to a study site focused on ecological questions. The task during the first week of that course was to observe and describe two habitats in the field and suggest what abiotic and biotic factors that had shaped the variation focussing at competition as an important ecological factor. In order to connect those ecological aspects with evolutionary aspects, specimen of the common species in the two habitats were collected and brought to the lab where the students constructed phenetic trees based on morphology but also on ecologically relevant properties like roots/no roots, expecting the set-up to awake evolutionary reflection. A main goal with this week was to give the students tools to investigate nature – to observe and describe patterns and to explain them by observing abiotic and biotic variation and evolutionary features and limitations.
Later during the course we created other, often not obviously similar, situations where the students had the opportunity to use the experiences of this first training week. We used open questions for reflections and examinations in order to get written material to assess the development of the skills.
We found notable personal development in most students and a greater awareness about the importance of personal cognitive activities in order to create better understanding and ability to use achieved knowledge in different situations.

1. Introduction
"The sciences have their origins in man's curiosity and our need to know more about ourselves and the surrounding world" according to the Swedish curriculum for primary school [1] which also stresses the importance for students to develop skills to carry out systematic studies. This includes ability to observe, to describe the observations and to put them into a theoretical framework. This is important within all science subjects and is mentioned in the syllabuses for biology, chemistry, and physics [2]. Thus, it is important for the teacher not only to be accustomed to different methods of observing and recording and to make analyses of the data recorded, but also to be an expert on using these skills in order to design and assess teaching situations where these skills may be developed among the students.

1.1 Teacher training
Also for us as teachers training pre-service teacher students in science different skills of observation are important not only when doing science but also in more didactic and pedagogic teaching situations. The individual variation in the perceptions and cognitive processes among humans and these combined with differences in the ability to extract and identify patterns make it even more important for personal development of any teacher within this. Learning or retained memory is affected by the associations to earlier experiences. Thus, the level of processing observations to knowledge and skills depends on differences in earlier experiences together with differences in processing the obtained information on a higher level [3].

1.2 Science for teacher students
During a 20 weeks course with 25 pre-service primary school teacher students we had the opportunity to develop, design and also to assess the results of both students and ourselves. At the beginning of the course the students had to establish a personal relation to a study site with some biological

variation. The studies on the site where focused on ecological questions. The main task during the first week of that course was to observe and describe and compare two different habitats in the study site and to suggest which abiotic and biotic factors that may have had shaped the biological variation in focusing at competition as an important ecological factor. In order to establish relations between these ecological aspects with evolutionary aspects, specimen of common species in the two habitats were collected and brought to the lab. Here, the students observed and described the specimens and constructed phenetic trees based observations mainly on morphology, but also on ecologically relevant properties like roots/no roots, variation in branching, surface structures, etc. The studies were supposed to stimulate evolutionary reflection. A main goal with that week was to give the students tools to investigate and understand nature – to observe and describe patterns and to explain them by observing abiotic and biotic variation and evolutionary features and limitations.

Later during the course we created other, often not obviously similar, situations where the students had the opportunity to use the experiences of this first training week. This was made also during included courses in chemistry, physics, and technology and included one week long excursion to Southern Sweden, visits to museums, Internet lectures etc.

After six weeks the students wrote a reflection, 2–3 pages long o their experiences during the first third of the whole course. The contents of these reflections were analysed and formatively assessed. The quality or depth in their reflections was made by using the 4 R's of Doll, *recursion*, *relations*, *richness* and *rigor* [4]. These factors were analysed in order to find possible influences on the results on the examination in physical theory two months later.

2. Objectives

Here we wanted to study the personal development of the students and assess if it could be related to the training to observe. We also wanted to investigate if the visualisation of the personal development also gave a greater awareness about the importance of personal cognitive activities in order to better understand and promote the ability to use achieved knowledge in different situations. Further, we also were interested in the correlation between the students' use of the 4R's of Doll in their written reflections and results on the final examination in biology one month later.

3. Material and methods

We used open questions in the instructions for reflections and examinations in order to get personal written material from the students in order to assess the development of their skills. The reflection should include a personal suggestion of the student of a specific task within evolutionary theory which later was included in the examination in biology.

The reflections were analysed in order to find descriptions of personal and group development, references to ecological studies and other types of observations. In evolutionary representations, especially in phylogeny, and in determination keys trees often are used as representations. Thus, we looked for tree-analogies in the texts of the students.

The results of these analyses were compared with the results of the final examination in biology focused on evolution one month later.

To evaluate the effect of showing personal development and using tree models we made a classification tree. The students are divided into groups that are further subdivided according to the explanatory variable that explains most of the variation in each division. When a group is separated out it is no longer part of the subsequent analysis. The most important variables are highest up in the tree and the score limit given is for going to the left branch in the tree.

3.1 Statistical methods

We used the statistical package R 2.15.2 [5] and within the R environment the package effects [6] to make plots of predictions from linear models. The classification tree was made using the R-package rpart [7]. Linear models were constructed for each of the assessment scores using the summed Doll´s R score as explanatory variable.

4. Results

Some students showed notable personal development (6 out of 23) and almost all students (22) showed great awareness about the importance of personal cognitive activities and how these create understanding and ability to use achieved knowledge in different situations.

Many students showed examples of *recursion* (14 out of 23) while the other R's where only used by a small number of students (Table 1).

Type of R	Number of students (N=23)
Recursion	14
Relations	7
Richness	2
Rigor	2

Table 1. Number of students using any of the 4R's of Doll [8].

The probability to achieve high marks on the final examination increased for students with notable personal development (Figure 1).

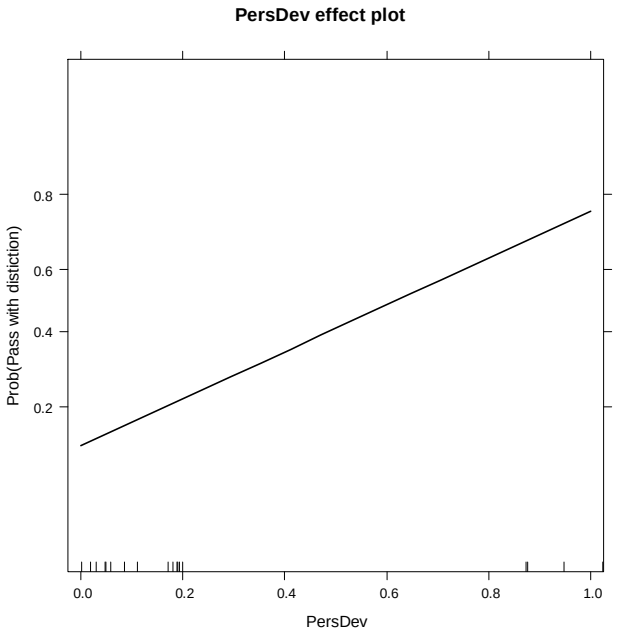

Figure 1. The probability to achieve high marks (VG) on the final increases for students showing personal development, p=0.008048 **.

Students showing low degree of personal development and with fairly low use of a tree model concept passed the examination but not with high marks. Students showing high degree of personal development had better results on the final examination (Figure 2).

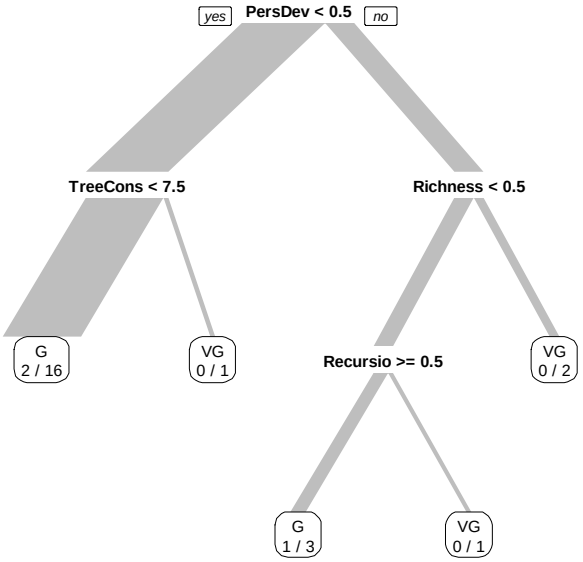

Figure 2. Predictions of results of the examination in biology based on reflections made one month earlier. The left branch shows the result if the explanatory factor is expressed. Here the first division show lower results in the assessment to the left (G=passed, VG= higher mark) and low degree of personal development. The numbers 2/16 means that 16 students are represented but two of them has other results than the main group.

5. Discussion

We found personal development among the students and a great awareness about the importance of cognitive activities to create understanding and ability to use achieved knowledge. Probably some students didn't explicitly expressed their personal development. Of course, it would be possible to analyse the texts in order to identify traces of personal development but here we have chosen to only include clear statements. This was made in order to include only directly expressed opinions of personal development.

The quality or depth in their descriptions was made using the 4 R's of Doll, recursion, relations, richness and rigor. Recursion was the most commonly used method of Doll's 4R's. Recursion is a skill which can be regarded as a type of reflection. Regularly used this reflective interaction with the environment produces a sense of consciousness about the personal relation to the environment [9]. The importance of relations is mentioned by seven students, all of these refer to the importance of participating in other people's experiences, reflections and feelings. Two students use both richness and rigor. They expressed thought on high meta-cognitive levels using many experiences often in combination, thus also showing recursion in their reflections.

Almost all students expresses their own learning out of the variation of the exercises during the course, with base in the training of observation during the first week. They also show good understanding of why we use so many different situations and methods. One students claims that he during this six week have practised more different methods than during the first two previous years of his studies. These exercises have taught hem more than all the previous examinations.

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