Wallin, A. (2008)

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In M. Hammann, M. Reiss, C. Boulter & S. D. Tunnicliffe (Eds.), Biology in Context – Learning and teaching for the twenty-first century. Proceedings of the VI Conference of European Researchers in Didactic of Biology (ERIDOB) (pp. 52-63) London – UK: University of London.

ONE YEAR AFTER TEACHING - HOW CONSISTENT ARE STUDENTS IN USING THE SCIENTIFIC THEORY OF BIOLOGICAL EVOLUTION BY NATURAL SELECTION?

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Abstract

A teaching-learning sequence about the theory of biological evolution was developed by linking theoretical reflection, instructional design and classroom research in a cyclic process. Altogether 79 students participated in three trials of this sequence. The students aged 17 – 19 had all chosen the science branch of upper secondary school in Sweden. Before teaching started the students were given a pre-test and, one year later, a post-test. Each students' entire pre- and post-test were categorised into one of four categories. The categories were: consistently scientific; mainly scientific; mainly non-scientific; and consistently non-scientific. In the post-test, 43 % of the students used the scientific theory of evolution consistently throughout the test compared to 6 % in the pre-test. 60 % of the students were categorised as using non-scientific ideas consistently in the pre-test and 5 % in the post-test. 30 students changed their way of reasoning between pre- and post-test in such a profound way that one may speak of conceptual change. The analyses of the students' performance revealed that students who partly used scientific ideas in the pre-test did not demonstrate a more consistent use of scientific ideas in the post-test than students starting with exclusively non-scientific ideas.

1. Introduction

This paper focuses on how consistently students use ideas in their reasoning in written answers to pre- and post-tests. Of interest was to establish whether or not the students had managed to learn the theory of evolution sufficiently well to be able to use it consistently in the post-test, one year after teaching. Can the conceptual change model (CCM) initiated by Posner et al. (1982) be used to understand these students' learning? This model predicts what is needed to change from one conception to another. A student, who used a scientific theory consistently after teaching, but not before, may have undergone such a conceptual change.

1.1 The context of this study

This study is part of a larger project, the overall purpose of which was to study how upper secondary school students (grade 10-12) develop an understanding of evolutionary biology as a result of teaching. The students' reasoning in written tests, interviews, small-groups, and whole class discussions was analysed. In these analyses the students' preconceptions, the conceptual structure of the theory of evolution, and the aims of teaching were kept in mind. This provided insights into those learning and teaching demands that constitute challenges to students as well as to teachers, when beginning to learn, or to teach evolutionary biology. A teaching-learning sequence was developed, implemented and assessed in a cyclic process.

1.2 Learning science

The conceptual change model (Posner et al., 1982) predicts what a learner must experience to change from one conception to another. He/she must experience dissatisfaction with their existing conception, and any new conception must be intelligible, plausible and fruitful. Caravita and Halldén (1994) discuss CCM in relation to different scientific contents, among others the theory of evolution. By analysing students' written essays from a couple of different studies they found students who had acquired a large number of facts but failed to apply the theory in a scientific way. In spite of being rather critical to CCM they express its usefulness in certain areas of science, for example the theory of evolution.

The focus in our project is on the students' learning of the theory of biological evolution by natural selection. In this respect the conceptual change model for learning may be interesting, despite the criticism it has been exposed to. It has for example been criticized for actually talking about exchange of concepts, which several studies have shown that the students do not do (Caravita & Halldén, 1994; Helldén & Solomon, 2004; Solomon, 1983; 1984; Pintrich, Marx and Boyle, 1993; Pintrich, 1999; Duit & Treagust, 2003). In spite of this criticism Duit and Treagust (2003) do not advocate rejecting the CCM model but contribute to its development, since they argue that *conceptual change approaches have proven superior to more traditionally-oriented approaches in a number of studies* (p. 674).

1.3 Ideas about evolution

When Darwin published his pioneer work: *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* in 1859, he initiated a change of paradigms in the science of biology. This theory can be explained without using complicated terms. In short one can say that evolution is a consequence of a populations' existing variation in heritable characters meeting the environment. Thus, natural selection favours individuals with advantageous characteristics in that given environment. These individuals produce more offspring who in turn constitute a greater proportion in the next generation of the population.

Bishop and Anderson (1990) found in their study that most students see evolution as a process where all individuals of a species change by adapting gradually to the environment. In several studies authors show that pupils and students do not change their ideas to any considerable extent after teaching (e.g. Bishop & Anderson, 1990; Demastes, Settlage & Good, 1995; Halldén, 1988). Ferrari and Chi (1998) write that in spite of natural selection being a relatively simple process, most students have problems grasping it and non-scientific ideas are very evident.

1.4 Consistency in using scientific ideas

Studies show that students have difficulties using scientific ideas consistently in the area of biological evolution (Engel Clough & Driver, 1986; Demastes, Good & Peebles, 1995; Halldén, 1988). For instance, Brumby (1984) finds that two thirds of her 32 university students had difficulties recognizing that different problems discussed in an interview dealt with the same topic, biological evolution or natural selection. Shtulman (2006) studied students' understanding of six evolutionary phenomena and approximately one third uses one idea consistently over all six.

Engel Clough and Wood-Robinson (1985) interviewed pupils about adaptation and they found that in different contexts the pupils use different non-scientific ideas. Engel Clough and Driver (1986) found in their study that scientific responses appear to be used more consistently than non-scientific responses. They also found that the consistency varies between different contents and contexts. Students are also shown to have difficulties using theories and models consistently in other areas of science (Mortimer, 1995; Redfors & Ryder, 2001).

2. Aims and research questions

One aim in this paper is to investigate how consistently the students use scientific and non-scientific ideas in their reasoning answering items in pre- and post-tests. Another aim is to analyse the students' changes in answering between pre- and post-tests, and to discuss this in the light of the conceptual change model. Thus, the questions addressed in this paper are:

1. Do students use scientific and non-scientific ideas consistently in their pre-test and in their one year delayed post-test?
2. Have any students changed their reasoning in such a profound way as predicted by the conceptual change model?

3. Sample and methods

3.1 The teaching-learning sequence

The teaching-learning sequence was designed for a compulsory course in biology in the Natural Science Programme at upper secondary school in Sweden. This course comprised 50 hours of teaching and covers mainly ecology, ethology and evolution (National Agency for Education, 2001). Evolution was strongly emphasised in the course curriculum, and 14 out of the 50 hours were exclusively used for teaching evolution. These 14 hours were divided into 9 lessons. The sequence is described in detail elsewhere (Hagman, Olander & Wallin, 2003; Wallin, 2004).

3.2 Students, teachers and schools

Three experimental groups of altogether 79 students, aged 17 - 19, were taught according to the designed teaching-learning sequence in three successive trials. Two teachers were engaged in the study, both as teachers and as researchers. The students attended schools in and around the city of Göteborg, Sweden. In two of the groups most students were ethnical Swedes, but in the third the majority had another ethnical background. The students themselves had all chosen the Natural Science Programme, and due to the reputation of being highly demanding, they can be described as well-motivated.

3.3 Teaching strategy

One of the most distinguishing features of the teaching-learning sequence in this study was the many structured small group and whole class discussions. Another aim, inspired by the CCM, was to make the students aware of their own and their peers' existing ideas and compare those with the scientific ones. By articulating ideas and examining them critically, some ideas will lose in status, while others will increase in status. The teacher has a central and important role in this teaching-learning sequence. He/she not only has to create a classroom atmosphere that is open and friendly and invites the students to express and discuss various ideas, but also to introduce and support scientific ideas.

To promote learning with long-term understanding, we paid great attention to students' possibilities to repeatedly use the theory of evolution by natural selection and in many different contexts. The students wrote logbook entries and it was obvious that they noticed, appreciated, and often commented on the application of the theory in many different contexts.

3.4 Data collection

The consistency in using ideas was analysed by using the students' written answers to the pre- and post-tests. Seven tasks were identical in both tests, but in the post-test, one for the students' completely new task was added. The tasks were of different kinds (see table 1 and Appendix 1).

Table 1. The problems in the pre- and delayed post-tests. See also Appendix 1.

Theme of the problem	Kind of task	Name of the problem	Pre-test	Delayed post-test
Variation	Multiple choice	The origin of variation	X	X
	Multiple choice	Existing variation	X	X
	Likert type with open motivation	The origin of variation	X	X
Heritage	Likert type with open motivation	Heritage	X	X
Natural selection	Multiple choice	Changes in a population	X	X
	Likert type with open motivation	Changes in a population	X	X
Theory of evolution	Open-ended	The *cheetah* problem	X	X
	Multiple choice with open motivation	The *lice* problem		X

The students' responses to open-ended problems were categorized using a system with eight qualitatively different levels. In this categorization the five principles from Ferrari and Chi (1998) were used: Variation; Survival; Reproduction; Heredity and Accumulation. Answers categorized as levels 1 – 4 were labelled non-scientific and answers categorized as levels 5 – 8 were labelled scientific (see table 2). In the multiple choice problems one or occasionally two alternatives were correct and labelled scientific. Both pre- and post-tests contain three different tasks using a Likert-scale (see table 1). The student answers were categorized by taking into consideration the results from the Likert-scale as well as the opened-ended motivation. These answers were categorized into eight different levels similar to the open-ended problems, and levels 1 – 4 were labelled non-scientific and 5 – 8 scientific. Also the new problem in the post-test (the lice problem, see table 1; Appendix 1) was categorized in the same way.

Table 2. The labels and levels of the responses to open-ended problems in pre- and post-tests

Principles /ideas	Label	Level
Variation Survival Reproduction Heredity Accumulation	Scientific	8
Variation Survival + 2 additional principles	Scientific	7
Variation Survival + 1 additional principle	Scientific	6
Variation Survival	Scientific	5
Alternative ideas + scientific terms	Non-scientific	4
Alternative ideas	Non-scientific	3
Do not know/irrelevant	Non-scientific	2
No answer	Non-scientific	1

Responses to the open-ended *cheetah* problem (table 1; Appendix 1) were chosen in order to illustrate the different levels in table 2. The following six quotations are selected because these students have written relatively short responses containing the basic characteristics for each level:

Sara: *They have developed, because they need to run faster in order to catch prey and to escape dangers. (Level 3)*

Lisa: *Some learned to run faster. These were favoured by natural selection and their offspring passed on. (Level 4)*

Adam: *Natural selection. Through mutations faster cheetahs were created. Compared to their mates they run a bit faster and for that reason they managed to catch more prey. (Level 5)*

David: *Offspring which could run faster had greater chance to survive and to pass on their "fast genes". The character was favoured by natural selection. (Level 6)*

Johan: *The fastest cheetahs can more easily manage to get food, for the slower this is harder due to their somewhat weaker running capacity. The fastest survive and get more offspring, which can pass on their genes. (Level 7)*

Karl: *The fastest cheetahs born got most food during their lives, and had the largest survival. As this contributed to their larger production of offspring during their life time, this "fast" gene passed on, and a larger and larger proportion of the population became fast runners. (Level 8)*

3.5 Intercoder reliability

The reliability of categorizing the students’ answers into scientific or non-scientific was tested. The data base contained 333 answers to the open-ended *cheetah* problem, 158 of them (two times 79) from the students reported in this paper. The author of this paper categorized the same answers twice, approximately one week apart (see table 3: the same person). Then, another well-informed person categorized the same answers. During these categorizations the answers were randomly arranged, both according to types of test (pre- or post-test) and groups of students (experimental or others). The reliability for categorisation of answers into scientific and non-scientific answers was high (see table 3).

Table 3. Intercoder reliability in categorisation of answers to the open-ended *cheetah* problem (n=333), into two different categories: answers with non-scientific and scientific ideas respectively.

Ideas	**Reliability** the same person	**Reliability** two different persons
Non-scientific or scientific	98 %	99 %

3.6 Constructing categories of consistence

All answers to the items in the pre- and post-tests were categorized as scientific or non-scientific as stated in table 2. A non-scientific answer was labelled A (Alternative) and a scientific answer S (Scientific). Each student’s (n=79) results in pre-and post-test were plotted (see figure 1 for three examples of plots).

In these plots you can read if a student’s answer is categorized as non-scientific (A) or scientific (S). If an answer is categorized as non-scientific (A) it will appear low in the plot, close to the X-axis, and if an answer is categorized as scientific (S) it will appear at the top of the plot. The entire pre-test is represented by a band and the post-test by another band directly after each other. If all answers in a test are categorized as non-scientific (AA) the band will appear low in the plot, and if all answers are categorized as scientific (SS) the band will appear at the top of the plot. Students who are not consistent are represented by bands alternating between the low non-scientific and the high scientific level in the plots (AS and SA).

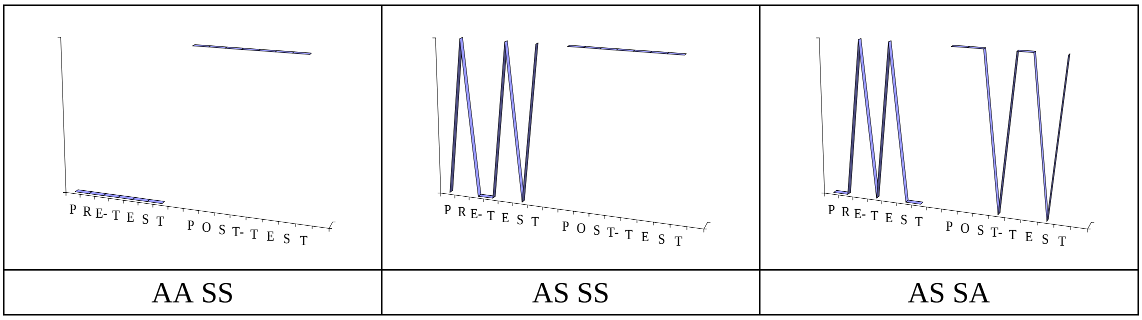


Figure 1. Examples of three students’ plots, which show the pre- and post-tests content of scientific or non-scientific answers. The first plot shows a student who in the pre-test gave consistently non-scientific answers (AA) and in the post-test gave consistently scientific answers (SS). The second and the third plots show students who in the pre-test were categorized to AS i.e. mainly non-scientific, and in their post-test were categorized to SS and SA respectively, i.e. consistently scientific and mainly scientific. Each letter in the words pre-test and post-test on the X-axis represent the students’ answer to one problem in the test.

Each student’s entire pre- and post-test were categorised into one and only one of four categories:

- AA: The student uses non-scientific ideas consistently throughout the test. In a test no more than two multiple choice problems or one Likert-problem are categorized as scientific. The open-ended problems are never answered with scientific ideas.
- AS: Mainly non-scientific ideas. At least one multiple choice and one Likert-problem must be answered scientifically. The open-ended problems are seldom answered with scientific ideas.
- SA: Mainly scientific ideas. At least four problems of multiple choice or Likert-type must be answered with scientific ideas. The open-ended problems are seldom answered with non-scientific ideas.
- SS: The student uses scientific ideas consistently throughout the test. In the test no more than one multiple choice problem is categorized as non-scientific. The open-ended problems are always answered with scientific ideas.

These plots (figure 1) were used to show all answers to both pre- and post-test of each student in one picture. These pictures, one for each student, were printed out, grouped, and regrouped, repeatedly until the result was stable. I was interested in investigating how many students solved their pre- and post-tests consistently across the range of problems.

4. Results

4.1 The different categories of consistency

The results from the three experimental groups of students are grouped together in table 4, as they do not differ significantly (Chi2-test; 2*4 table; ns). However, the students' performance on pre- and post-tests are significantly differently distributed over the categories of consistency (Chi2-test; 2*4 table; p<< 0,001), see table 4.

Table 4. The number of students in the four different categories of consistency (n=79)

Test	AA	AS	SA	SS
Pre-test	47	17	10	5
Post-test	4	17	24	34

In this study 47 students (59 %) answer the pre-test consistently non-scientifically and 5 students (6 %) consistently scientifically. Altogether 52 students (66 %) are consistent in the pre-test. In the post-test, the corresponding percentages are 5 %, 43 % and 48 %. In other words the students are less consistent in the post-test, from 66 % to 48 %, but more students are scientifically consistent.

Figure 2 presents the distribution in more detail. The squares in the diagonal from the lower left AA AA, via AS AS and SA SA, to the upper right square SS SS, represent students who have been categorized to the same category of consistence both in pre- and post-tests. There are altogether 18 students (23 %), whose post-tests have the same category of consistency as their pre-test. It is still possible for these students to have developed their knowledge of the theory of evolution; if their answer to one or more tasks enters a higher scientific level within the scientific ones (levels 5 – 8). The majority, 14 out of the 18, actually did increase their scientific level of the post-test compared to the pre-test. However, this change does not influence the category of consistency.

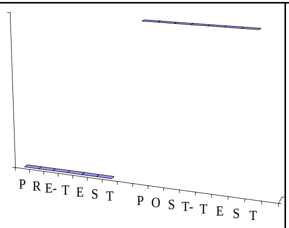
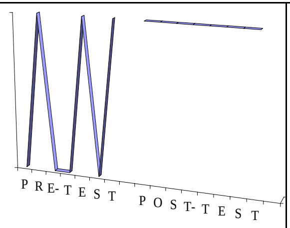
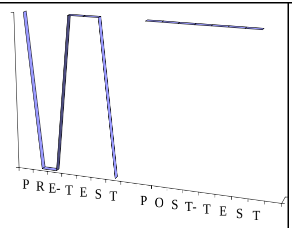
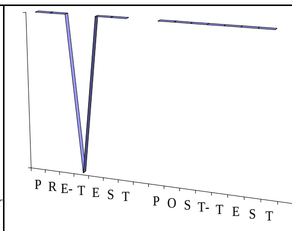
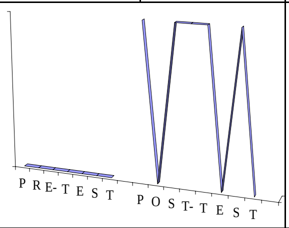
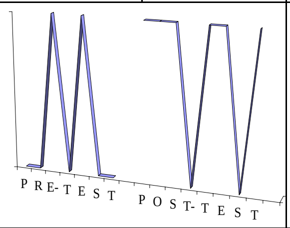
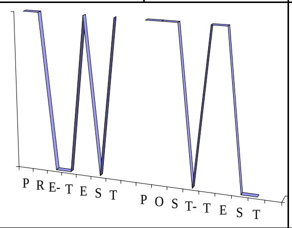
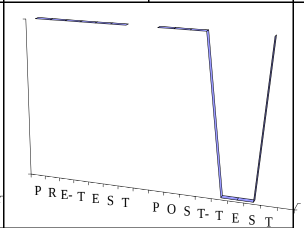
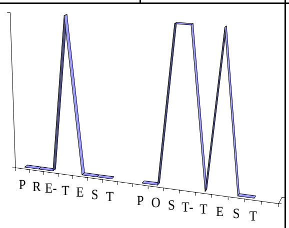
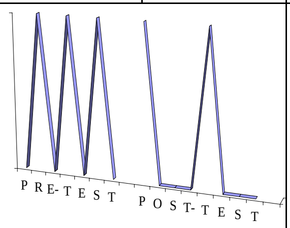
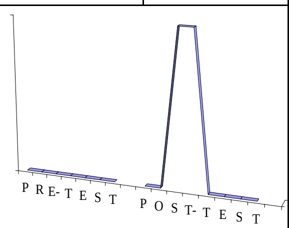
	AA		AS		SA		SS		Post-test
SS									SS
	AA SS	20	AS SS	3	SA SS	7	SS SS	4	34
SA									SA
	AA SA	13	AS SA	7	SA SA	3	SS SA	1	24
AS									AS
	AA AS	10	AS AS	7	SA AS	0	SS AS	0	17
AA									AA
	AA AA	4	AS AA	0	SA AA	0	SS AA	0	4
Pre-test	AA	47	AS	17	SA	10	SS	5	79

Figure 2. The changes in consistence between pre- and post-test. Below every plot is first the abbreviation for the category of pre- and post-test taken together, and the number of students in the category (n=79). SS= consistently scientific; SA= mainly scientific; AS= mainly non-scientific; AA= consistently non-scientific

One student ended up in a lower consistency category in the post-test, from SS in pre-test to SA in the post-test. This student appears below the diagonal in figure 2, and is the only student in this study who does not perform better in the post-test compared to the pre-test. Of the total 16 combinations of possible results eleven combinations are represented by any students' performance on pre- and post-test. No student in the study ended up in the five remaining squares below the diagonal, see figure 2. The remaining 60 students (76 %) reached a higher scientific consistency category in their post-tests. They are to be found above the diagonal in figure 2 in squares AA SS, AS SS, SA SS, AA SA, AS SA, and AA AS.

4.2 The changes in categories of consistency between pre- and post-tests

A profound way of changing ideas between pre- and post-test is a student who uses non-scientific ideas consistently in his/her pre-test (AA) and one year later uses scientific ideas consistently (SS) or vice versa. 20 students changed from consistently non-scientific to consistently scientific, category AA SS in figure 2. Also the ten students who partly used scientific ideas in the pre-test and ended up in the consistently scientific category (AS SS and SA SS) in the post-test have changed their reasoning in a profound way. Altogether 30 students changed their way of reasoning between pre- and post-test in such a profound way that one may speak of conceptual change.

In the pre-test 47 students use non-scientific ideas consistently throughout the test (AA; table 4; figure 2). Of these 20 or 43 % (AA SS) are among the students who use scientific ideas consistently in their post-test. Among the 32 students who at least partly use scientific ideas in the pre-test 14 students or 44 % (AS SS, SA SS or SS SS) use scientific ideas consistently in their post-test. Thus, for the students in this study, it does not seem as if they benefit from having at least partly understood the theory of evolution before teaching, for being able to use scientific ideas consistently in the post-test.

5. Discussion

5.1 How consistent are the students in using the scientific theory of evolution?

In this study 34 students or 43 % are consistent in using scientific ideas throughout the entire post-test, and 4 students (5 %) use non-scientific ideas consistently. Whether the scientific use of ideas is a relatively high proportion or not, is difficult to say, and comparisons with other studies must be made very carefully. For example Shtulman (2006) investigated students from high schools and colleges together with three individuals with doctoral degrees in biology. 31 % of his participants used either scientific or non-scientific ideas consistently over all six evolutionary phenomena (30 items). Redfors and Ryder (2001) analyse their university students' consistency over three different tasks about interaction between electromagnetic radiation and matter and 47 % use one model consistently, either a scientific or a non-scientific one. The scientific model was used by 19 % of the students consistently. Ardac and Akaygun (2005) show that 75 % of the students used a particular model of molecules consistently after instruction with dynamic visuals on an individual basis compared to slightly less than 50 % after instruction with dynamic or static visuals on whole class basis. These studies indicate that the level of consistency may depend on many variables, e.g., content area and teaching approach.

Maybe some reasons for the students in this study reaching higher consistency levels compared to for example Redfors and Ryder (2001), can be found in the design and performance of the teaching-learning sequence. Redfors and Ryder write:

> *… teaching using exemplary phenomena is an important first step as students begin to understand the key elements of a model. However, we suggest that such teaching needs to be followed by using the model to explain an extended range of phenomena. The intention of such teaching would be to enable students to recognise the relationship between the model and different phenomena. In this way the teacher is able to draw out the distinctions between the model and the phenomena to be explained, and therefore the limitations of the model.*

One of the most distinguishing features of the teaching-learning sequence described in this paper was the students' possibility to use and communicate the theory of evolution by natural selection in a variety of contexts.

5.2 The conceptual change model

Among the students, whose pre-test was categorized as consistently non-scientific, 20 students' post-test responses were categorized as consistently scientific. Ten students who answered with partly scientific ideas in the pre-test used scientific ideas consistently a year later. Among these 30 students one could possibly find students who have undergone conceptual change according to CCM (Posner et al. 1982). The post-test was performed one year after teaching and this supports the idea that they had successfully undergone a conceptual change. Another supporting factor is that the students experienced the theory of evolution in so many different contexts that they had the possibility to undergo conceptual change. This factor could also provide an explanation for the findings that the advantage of knowing about the theory before teaching started, in this study became negligible.

The post-test of 40 students was categorized as AS or SA. These students use both non-scientific and scientific ideas when they answer evolutionary problems and they do not seem to have changed their reasoning radically, but can be examples of what Pedersen and Halldén (1994) describe as assimilation to established framework. Or in terms of Aikenhead (1996) these students' life-world culture did not agree with the subculture of science. The data collection did not allow any deeper analyses of these students relating for example to their life-world culture.

Also the eight students who answered their pre-test consistently and ended up in the same consistency category in their post-test can be said to have assimilated an established framework, scientific or non-scientific. The four who assimilated their already existing scientifically framework succeeded better in the post-test compared to the pre-test through enhancing their scientific level within level 5 - 8 (see table 2).

5.3 Some educational implications of the results

In spite of the fact that the students in this study were well-motivated and were taught by experienced teachers, not all of them could use the theory of evolution consistently in the post-test. Many students showed by their logbooks that they needed many lessons to be able to use the theory. No more than 43 % of our students, used the theory of evolution consistently in their post-tests. Compared to other studies, however, this is a high proportion. If we really want our students to understand and be able to use scientific theories they need time to practice and more problems in different contexts to solve than students experience today in Sweden.

I think the conceptual change model is a useful tool when thinking about students' learning in science. It is a necessity to understand that it is not easy for a student to undergo conceptual change. For example a new concept has to fit into the individual's present conceptual ecology. For many (most) of our students, science does not easily fit in and to change ones conceptual ecology is hard work.

6. Acknowledgement

First I want to thank all the 79 students who so willingly answered the questions, both in interviews and in written tests. I would also like to thank the two teachers who were engaged in the study, both as teachers and as researchers, Mats Hagman and Clas Olander. I also want to express my gratitude to two anonymous referees for many good comments, which I think enhanced the quality of my paper.

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Appendix 1

Variation: The origin of variation

Throughout time living organisms have developed a variety of different traits. What is the origin of this enormous variation?

1. The traits arose when they where needed.
2. Random changes in the gene pool of the organisms.
3. Living organisms strive to develop.
4. Great variation is needed in order to get balance in nature.

Variation: Existing variation (Bishop & Anderson, 1990; Jensen & Finley, 1995)

A number of mosquito populations are today resistant to DDT (a chemical used to kill insects), so that DDT treatment now is less effective than it used to be. Biologists believe that the DDT resistance evolved because:

1. Individual mosquitoes developed resistance to DDT after being exposed to it.
2. The mosquito populations needed to be resistant to DDT in order to survive.
3. A few mosquitoes were probably resistant to DDT before it was ever used
4. The mosquito populations became resistant by chance.

Variation: The origin of variation (Bishop & Anderson, 1990; Jensen & Finley, 1995)

a) The trait of webbed feet in ducks appeared in their ancestors because:

they lived in water and needed webbed feet to swim. 1 2 3 4 5 of a chance mutation.

b) Why did you choose this answer?

Heritage (Bishop & Anderson, 1990; Jensen & Finley, 1995)

a) While ducks were evolving webbed feet, with each generation most ducks:

had about the same amount of webbing on their feet as their parents. 1 2 3 4 5 had a tiny bit more webbing on their feet than their parents.

b) Why did you choose this answer?

Natural selection: Changes in a population

Which one of the following alternatives does best explain changes in a population with time?

1. Some individuals are better at reproducing than others.
2. Some individuals starve to death, while others survive by moving to new places.
3. Organs and structures that are needed evolve.
4. Individuals can adapt to survive.

Natural selection: Changes in a population (Bishop & Anderson, 1990; Jensen & Finley, 1995)

a) The population of ducks evolved webbed feet because:

the most successful ducks adapted to their to their aquatic environment. 1 2 3 4 5 the less successful ducks died without offspring.

b) Why did you choose this answer?

Theory of evolution: The cheetah problem (Bishop & Anderson, 1990)

Cheetahs are able to run fast, around 100 km/h when chasing prey. How would a biologist explain how the ability to run fast evolved in cheetahs, assuming their ancestors could only run 30 km/h?

Theory of evolution: The lice problem (after Jiménez Aleixandre, 1994)

The following question was given in a biology test: 15 % of school children were infected by head lice during the winter. The exact cause of the recent epidemic is not known, given that hygiene has improved, but everything seems to point to the fact that insecticides no longer seem to have any effect on lice. How do you think a biologist would explain the fact that insecticides affected lice some years ago, and not now? The answers from two students:

Student A: Because being an animal that gives birth so many times, only the strongest stay alive; those not affected by the insecticide and their offspring are attacking now.

Student B: Against the higher quantity of insecticides, the lice seek survival, and get used to them; this is what in biology is known as *adaptation*, until in the end it doesn't affect them; that is, they became *resistant* to the insecticide, and the new generations will inherit this and will be more resistant over time, because, following Mendel's laws, new generations evolve until they are more perfect than the former.

a) Choose the answer what best agree with the theory of evolution! Answer A or Answer B?

b) Why did you choose this answer?