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We Know they Love Computers, but do they Learn Science? Using Information Technology for Teaching about a Socio-scientific Controversy.

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ABSTRACT

In this paper we focus on students' learning gains with respect to their understanding of biology and ecological management from the use of a teaching program combining online and offline activities to teach about the socio-scientific controversial issue of wolves in Norway. Gender differences in response to the program and students' attitudes towards wolves are also investigated. The web-based part of the teaching program consists of an online knowledge base designed to promote discourse and argumentation while working at the computers and in an offline classroom debate. The participants were two Norwegian classes of students age 14-15, who followed the teaching program. A pretest-posttest design with a follow-up four months later was chosen to measure student learning gains. Our results show positive achievement from pretest to posttest and even after four months students continue to demonstrate high levels of retention. Girls have significantly higher scores on posttest and follow-up compared to boys. Our results also show that 2/3 of the students changed their attitudes towards wolves during work with this teaching program.

INTRODUCTION

Modern western societies are becoming more and more complex; due to exponential growth in many fields that has lead to both positive and negative impacts on the natural world and humans. Students will increasingly need skills for dealing with controversial issues as they prepare to participate in the democratic process. Science educators seem to agree that relevant, real-life contexts are important when teaching for scientific literacy. Knowledge about how students deal with scientific issues in real-life contexts is of relevance when designing curricula and teaching models aimed at science for citizenship (Jenkins, 1994; Driver, Leach, Millar, & Scott, 1996; Millar & Osborne, 1998; Aikenhead, 2000; Driver, Newton, & Osborne, 2000; Kolstø, 2001). According to Lemke (2001) it is a falsification of the nature of science to teach concepts outside of their social, economic, historical, and technological context. Concepts taught in this way are relatively useless in life, however well they may seem to be understood on a test. Students and teachers need to understand how science and

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science education are always a part of larger communities and their cultures, including the sense in which they take sides in social and cultural conflicts that extend far beyond the classroom (ibid).

The Norwegian people do not agree on the issues surrounding the presence of wolves in the landscape. The wolf was nearly extinct in Norway 30 years ago, and is now making a slow reappearance. The Norwegian government is obliged to protect endangered species such as wolves according to the Bern convention. Organisations engaged in protecting the environment and many in the general public support the government in this view. On the other side of this conflict are people living in wolf areas and powerful sheep farmers practicing free-range methods who see the re-introduction of wolves as a threat to their economic and personal wellbeing. The government has invested huge sums in research on efforts to protect sheep from predators, though losses are still reported. Through the use of dramatic pictures and reports of sheep killed by wolves, the media has had a tendency to present only one side of this controversy. A survey of attitudes towards wolves in four counties in south-eastern Norway shows that about 50% of the sample express varying degrees of fear of wolves (Bjerke & Kaltenborn, 2000). One of the intensions of the teaching program about wolves is to provide information that supports a more nuanced view on this matter.

Through the use of the Internet, it is easier to provide authentic data for students allowing them to make connections between basic knowledge and contexts in which that information might be used. Simulations and animations that make the unobservable observable are easily created. Scientific concepts are presented in new dimensions with the potential to make what often are difficult ideas in science more accessible to students. Information technology can make it easier to help students access, evaluate and make use of information that connects science to society and decision making processes. In this study we evaluate the use of a web-based teaching unit created for teaching about biology and a socio-scientific controversy in grades 8-10 in Norway. The teaching program is based on the controversial issue of whether or not we should have wolves in the Norwegian wilderness. By introducing students to a socio-scientific issue like the wolf controversy, we are placing science into an authentic context. The overall aims in this teaching unit are to let the students learn:

- *About the biology of wolves and their place in an ecosystem.*
- *About the concept of ecological management.*
- *About different viewpoints in a socio-scientific controversy in the Norwegian society.*
- *How to work together in groups to develop understanding of a socio-scientific issue.*
- *To participate in an actual debate about wolves in Norway, allowing the opportunity to construct and evaluate arguments on either side of the issue.*

The wolf program is developed within the Viten[3] platform; a pedagogical toolbox designed to integrate the use of information technology in the science curriculum. The Viten project is a Norwegian version of the WISE project[4] developed at the University of California, Berkeley. In this paper we will focus on evaluating the success of the Viten wolf program in meeting the first three of the overall aims: teaching students about the biology of wolves and the concept of ecological management and to introduce students to a controversial issue in the Norwegian society. We intend to answer the following research questions:

1. *What learning gains were achieved related to the biology of wolves, ecological management and the controversial issue of wolves in Norway?*
2. *To what extent did this learning influence the students view on wolves?*
3. *Were there any differences in the responses of girls and boys?*

THEORETICAL BACKGROUND

In recent years there has been a shift of focus away from viewing learning in terms only of cognitive processes in the individual, towards a view of learning as involving social contexts. A socio-cultural view of learning with a basis in the Vygotskian (1978) ideas about human development has emerged (Solomon, 1994; Scott, 1998; Säljö, 1999). Language is seen as central to the development of knowledge, and the mastering of communicative and intellectual tools is central to the learning process. The process of internalisation (Vygotsky, 1978), where the learner reorganizes and reconstructs talk and activities from the social arena, does not involve direct transfer of the discourse from the social to the internal plane. There has to be a step involving personal interpretation where the individual comes to a personal understanding of ideas encountered at the social plane (Leontiev, 1981; von Glaserfield, 1999; Leach & Scott, 2003). In this respect Vygotskian theory shares common ground with constructivist perspectives in recognizing that the learner cannot be a passive recipient of knowledge and instruction (Mortimer & Scott, 2000). The Viten wolf program provides the students with opportunities to discuss various tasks and activities on the social plane through work in dyads, small groups and in classroom debates. In this paper we investigate the effectiveness of these processes by evaluating the learning outcome of the individual students.

Learning has traditionally been associated with remembering information, but a more current question is: What is the best way of transforming information from a wide variety of sources into knowledge within the group or individual? There is a significant difference between information and knowledge as stated by Salomon (2000); information may be transferred, while knowledge must be constructed as a web of meaningful connections. All information found within Viten programs and links from the

[3] The website http://**viten.no** is a Learning Management Content System (LMCS), launched in February 2002 and located in Norway.

[4] http://wise.berkeley.edu

programs to other sources on the Internet, are selected by the program developers. However tasks and activities within the program are constructed in such a way that students have to make their own selection from the information provided when they construct their answers and transform information found within the program into knowledge.

Students cannot learn science on their own without guidance from other persons or tools. Vygotsky (1978) introduced the term zone of proximal development (ZPD), which may be understood as the distance between what an individual can manage on its own, without help from others, and what the individual can manage with support from other and more competent persons. Focus has centred mainly on the importance of the teacher's role in scaffolding students in the learning process. But this kind of support does not necessarily have to come from a person. Books and tools like information technology may also play important roles as scaffolds for students in the ZPD. The Viten teaching programs are designed both to serve as scaffolds giving students various kinds of feedback and challenges in their learning process (Mork, in prep), but also to provide opportunities for the teacher and other students to support individual students in their learning process.

Roschelle et al. (2000), in a review of studies investigating the effectiveness of computers as learning tools, say that technology may enhance how students learn by supporting the following four fundamental characteristics of learning: 1) active engagement, 2) participation in groups, 3) frequent interaction and feedback and finally, 4) connections to real-world contexts. Roschelle et al. further say that if we connect these ideas to learning in the science classroom, we are able to see how information technology may be used to enhance the teaching of science in a way that engages students to be active participants in the learning process. All of the four characteristics put forward by Roschelle et al. are found within the Viten program about wolves: Firstly it is connected to a real world context with the overall objective that students should learn about an existing controversial issue in the Norwegian society. Secondly active engagement is promoted by the way the wolf program is designed. Another overall aim is to let students work in pairs and encourage them to talk science when at the computer or in small groups when preparing and conducting an offline classroom debate. Frequent interaction and feedback are supported through the program itself, but also through teacher comments in student electronic workbooks and through work in dyads and groups.

According to Jorde (2002; 2003), knowing where to look for information and who to believe is perhaps more important than ever before, since there is no control over information flow. By connecting scientific literacy to computer literacy, we empower students with tools to engage in lifelong learning for responsible decision-making. ICT also provides new possibilities for teaching difficult concepts and ideas. Complex systems may now be simulated, experiments involving expensive equipment may be animated, controversial topics may easier be discussed with experts and

people outside the immediate classroom, and information may be found linking school science to authentic science research. ICT may also make the process of connecting science to the real world easier. Our challenges are to help students' access to reliable resources, and help them with making sense of information and understanding the differences between science and anti-science (ibid).

THE VITEN WOLF UNIT

WISE/Viten is based on a theoretical framework for instruction called Scaffolded Knowledge Integration (SKI), (Linn & Hsi, 2000). This framework has been continuously refined through years of classroom trials, comparing different versions of technology tools, different approaches to guidance, and different designs for curriculum. SKI is the basis for all the WISE/Viten activities and includes four major principles that guide the design of successful inquiry activities and technologies.

The SKI-principles:
- *Making science accessible*
- *Make thinking visible*
- *Learn from each other*
- *Promote autonomous learning*

The development of the Viten programs is informed by a view of learning as a social process, where the use of language is crucial impotance. Viten programs promote student learning at the individual level as well as in a group structure where 2-3 students work together at a computer, and tasks and activities in Viten programs are designed with aims to promote discussions and reflections amongst the students. This is also in line with Roger Säljö's (1999) claim that knowledge development is about learning to argue and that technology may be a resource that contributes to support discussions and argumentation. Results from video recordings of student interactions when working with the wolf program are not addressed in this paper, however many students comment in their logs that they view working in dyads as positive, an impression we also have from classroom observations.

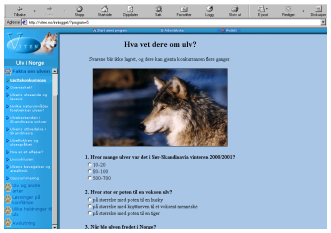
"Wolves in Norway" is a theme well suited for teaching about socio-scientific controversy and science in a context, because it is an authentic ongoing debate in the Norwegian society. It is repeatedly put on stage by the media and it relates to students' everyday life. When teaching about controversy in science lessons, students are usually introduced to two different scientific views and work with evidence for and against these views. When connecting science to issues in society there are other conditions that must also be considered, such as laws, culture, opinions, and so on. In the wolf program the controversy sets a scientific view up against a social-, cultural- and business-related view. The wolf controversy illustrates some of the real challenges connected with science, but it also addresses the nature of science.

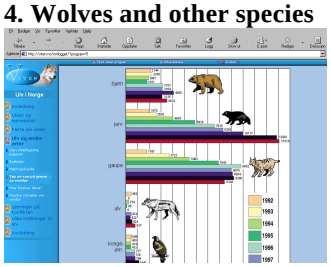
A vital aspect of this teaching program is the combination of online and offline activities. The online part, the knowledge base, is providing the students with information about the current issue; while the offline part, the debate, is the activity where the students are able to use this information in a real life context.

The focus in this study is evaluation of the wolf programs effectiveness in meeting the first three of the overall aims: Learning about the biology of wolves and their place in an ecosystem, learning about the concept of ecological management, and finally, learning about different viewpoints in a socio-scientific controversy in the Norwegian society.

The wolf program contains six main units and a closing activity as described in Table 1. One ambition with the program is to make connections between the biological and political content of this important debate in the Norwegian society. Concretely this is done by building each of the six main units on the previous one. In this way we hope students will be able to see the importance of basic biological knowledge in order to evaluate and argue in socio-scientific controversies. (Erlien, 2001).

Table 1: The wolf-program contains 6 main units and an offline debate as a closing activity.

Units in the program	**Aims**	**Organization**
1. Introduction	▪ Introduce the students to the controversial issue of wolves in Norway. ▪ Map students' preconceptions about the danger of wolves. ▪ Map the students' attitudes towards wolves.	▪ Students work in dyads. ▪ Reading. ▪ Multiple-choice questions. ▪ Written tasks. ▪ View pictures.
2. Wolves and humans	▪ Introduce students to myths and fairytales about wolves to give a historical perspective on attitudes towards wolves. ▪ Introduce students to a research report about the danger of wolves.	▪ Students work in dyads. ▪ Reading. ▪ Written tasks. ▪ View pictures.
3. Facts about wolves 	▪ Learn about the biology of wolves. ▪ Practice interpreting and collecting information from graphical sources.	▪ Students work in dyads. ▪ Quiz. ▪ Reading. ▪ View animations and pictures. ▪ Plotting on a map. ▪ Written tasks. ▪ Interpret graphical sources. ▪ Follow links to web pages outside the Viten wolf program. ▪ Drop and drag activity.

4. Wolves and other species 	▪ Learn about how wolves influence other species. ▪ Learn about the connections in the ecosystem and be prepared to have science-based opinions about ecological management of wolves. ▪ Introduce students to the actual conflict of having wolves in the landscape. ▪ Practice in interpreting and collecting information from graphical sources.	▪ Students work in dyads. ▪ Watch video clip. ▪ Read. ▪ Written tasks. ▪ Follow links to web pages outside the Viten wolf program. ▪ Interpret graphical sources. ▪ View pictures.
5. Solutions to the conflict	▪ Introduce students to multiple ideas for the integration of wolves in the landscape. ▪ Practice interpreting and collecting information from graphical sources.	▪ Students work in dyads. ▪ Interpret graphical sources. ▪ Read. ▪ Written tasks. ▪ View pictures.
6. Attitudes towards wolves	▪ Introduce students to different attitudes towards wolves. ▪ Give students guidelines for how to evaluate arguments in interviews.	▪ Students work in dyads. ▪ Read. ▪ Evaluate argumentation in newspaper articles. ▪ Written tasks.
Closing Activity The closing activity is an offline debate conducted as a role-play where students are assigned different roles in a debate: for or against wolves in Norway. As they have worked through the wolf curriculum, they have had a type of mission to locate information that may be useful in the debate.	▪ Use information from the wolf program in constructing arguments in an offline debate. ▪ Practice evaluating other people's arguments, refute other people's arguments. ▪ Practice how to behave in a debate situation.	▪ Students work in groups of 3-5 students to prepare for the debate. ▪ Debate conducted as a role-play with two opposing groups.

To let the students learn about different viewpoints and attitudes towards wolves is an important overall aim of the wolf program. Since unit 6 deals with this matter we present this unit more in detail. This unit is introduced with a page containing clips of citations from the readers' column in a local Norwegian newspaper. The aim of this page is to introduce the students to different attitudes towards wolves. The next page prepares the students for a task where they are asked to evaluate the use of argumentation regarding wolves in two newspaper articles interviewing people about their views on wolves. The students are asked to view the text critically and evaluate the articles regarding credibility. They are asked to consider who the interviewed persons are, what interests they might have in this matter and which claims and reasons they give. The main objective of this page is to give students guidelines for evaluating arguments in interviews. In addition showing students examples of how other people are using argumentation about wolves is also a preparation for participation in the offline debate about wolves. The next page is a newspaper article where the interview object is arguing against wolves, while the following page is an article presenting the opposite view. Unit 6 closes with a task where students are first asked to present the arguments used by the two interview objects, and then asked with whom they agree most. In unit 6 we try to exploit the technology as a

resource for supporting argumentation as suggested by Säljö (1999). The students are guided in, and provided with the opportunity to practice skills in how to evaluate arguments other than their own, skills that are important for lifelong learning (SKI-principle no 4).

METHODS

The data in this study were collected during the winter of 2002. The study includes two 9th grade classes from a culturally mixed school in a city in Norway, both of which implemented the wolf unit. The 59 9th grade students, age 14-15, had previous experience from using WISE, the American version of Viten. A design with individual pretest and posttest (Lund, 1997) and a follow-up four months later was chosen so that student achievement before and after use of the teaching program could be compared. For different reasons, not all students participated in all the tests: pretest (n=42), posttest (n=49) and follow-up (n=41). Thus the final sample of students attending all three tests was 38. The computer-based component of the curriculum lasted four hours during which students worked together in dyads at the computer. For different reasons four students were working alone. All the dyads consisted of either two boys or two girls. Two dyads in each class were video-recorded during the work with the computer-based part of the wolf curriculum. These students were also interviewed individually before and after the teaching sequence. Student pairs' electronic workbooks are also a part of the data material. Students were given one hour to prepare an offline debate, where they were assigned roles either for or against wolves in Norway. During the preparation for this debate students worked in groups of four-six. Finally, one hour was spent on the actual classroom debate. The complete data material also includes video recordings of the offline debate, interviews with the teachers and students logs; however, to address the research questions in this paper only the results from the achievement tests are addressed.

Achievement tests

The paper and pencil pretest and posttest design was implemented with a follow-up test four months after the completion of the wolf curriculum. The follow-up is included in the research design to provide a realistic picture of retention. All tests have both multiple-choice questions and open-ended questions (see appendix), based on the learning goals of the teaching program. 10 multiple-choice questions (see appendix) and 7 open-ended questions are the same in all three tests, so that we could compare the students' preconceptions with information they had found in the teaching program. In addition all the tests contain some questions that are unique for the particular test.

The multiple-choice questions were given code 1 for right answers and code 0 for wrong answers. A coding scheme (see Table 2) was developed for open-ended questions, categorising right answers from code 1-3, where code 3 represented the highest score and wrong answers were given code 0.

According to research question 1, and the goals for the wolf program that are focused upon in this study, the achievement was assessed with respect to students' knowledge about the biology of wolves, ecological management and the wolf controversy in the Norwegian society. All the multiple-choice questions and question 4 and 6 in Table 2 are connected to the biology of wolves. Information about the preferred habitat types (question 4) is important for understanding the biology of wolves, e.g. the predator-prey relations, which is central for understanding the conflict in Norway, and for suggesting strategies for ecological management. The question about why wolves live in packs (question 6) is meant to reflect students' knowledge about the wolves' social behaviour and strategies for hunting and defending territories. To map students' knowledge about ecological management we asked if they knew where wolves are found in Norway today. This geographical information is important to understand why the issue of wolves in Norway is so controversial, providing information about actors in the conflict and is central for suggesting strategies of ecological management (question 7). Here we want to find out whether students are aware of the multiple ideas for integration of wolves into the landscape. Questions 2 and 3 provide information about the students' perception of the stakeholders' views in this conflict, and question 1 helps us assess if more information about whether wolves are dangerous or not made students change their views. The students' responses to question 1 will help us answer research question 2.

***Table 2**: Coding scheme for open-ended questions identical in all tests*[5].

	Questions	***Code 1***	***Code 2***	***Code 3***
1	*Are wolves dangerous or not? What is your opinion?*	*Dangerous/ not dangerous no justification.*	*Dangerous/ not dangerous incomplete justification.*	*Dangerous/ not dangerous. Scientific arguments like: dangerous only when provoked and under certain conditions. Small chance for attacks on humans. Have not killed humans since 1881.*
2	*Which arguments are used by those who want us to have wolves in Norway?*	*1 argument.*	*2-3 arguments.*	*4 or more arguments.*
3	*Which arguments are used by those who do <u>not</u> want us to have wolves in Norway?*	*1 argument.*	*2-3 arguments.*	*4 or more arguments.*
4	*What type of habitat is most preferred by wolves?*	*Imprecise, e.g. wild nature.*	*The woods **or** the mountains (just one of them).*	*The woods and the mountains.*
5	*Where in Norway do we find wolves today?*	*One of the following: Østerdalen, Østfold, the areas by the Swedish border.*	*Two of the following: Østerdalen, Østfold, the areas by the Swedish border.*	*All the following: Østerdalen, Østfold and the areas by the Swedish border.*
6	*Why do wolves usually live in packs?*	*1 argument.*	*2 arguments.*	*3 or more arguments.*

[5] Wrong answers were given 0 points.

7	*Do you have any suggestions for how wolves and people can live together in the same area?*	*1 suggestion.*	*2 suggestions.*	*3 or more suggestions.*

Statistical tests

Statistical tests on gender differences were performed in SPSS 11.0.

RESULTS

Learning gains achieved

To evaluate the effectiveness of the Viten wolf program in reaching its aims, we measured the students learning gains according to the following aims: learning about the biology of wolves, learning about ecological management and learning about the controversial issue of wolves in Norway.

Figure 1 shows an overview of the results from individual students' mean score on pretest, posttest and follow-up. The scores related to each of the categories: biology of wolves, ecological management and the wolf controversy are based on two open-ended questions. Scores related to the biology of wolves are higher than scores in the other categories since they are also based on answers to 10 multiple-choice questions.

Figure 1: *Results from written test scores. N=38. Maximum test score = 31. Data from all the three content parts of the tests are based on two open-ended questions. In addition the part on the biology of wolves also contain answers to 10 multiple-choice questions*

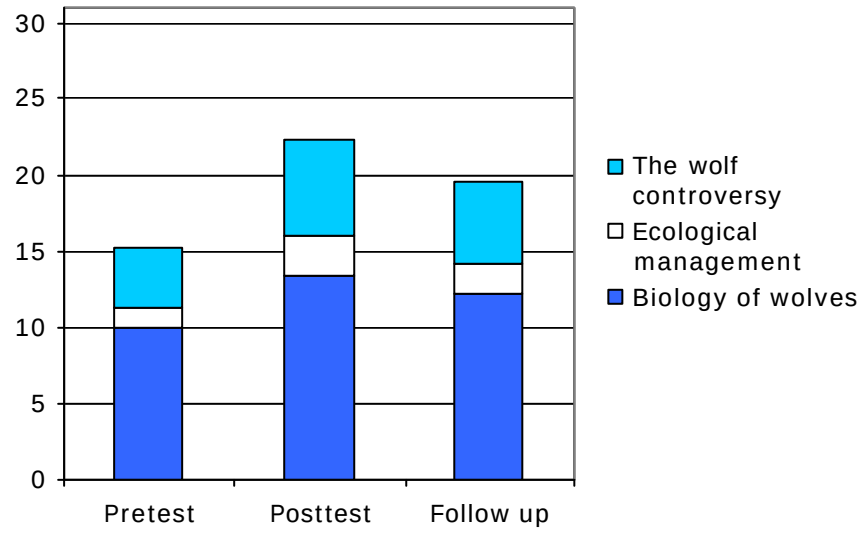


Figure 1 show that student scores were higher on the posttest compared to the pretest, and that even after four months students continued to demonstrate high levels of retention. In order to understand more about students' responses to the tests and the data behind figure 1, we will present some examples of individual student answers to open-ended questions. First we give some brief examples of

answers to questions about the biology of wolves and ecological management. Afterwards we focus more in depth on student answers to questions about the wolf controversy and the view of different stakeholders since an important overall aim of the wolf program is to prepare for an offline debate on the controversial issue of wolves in Norway.

Example related to the biology of wolves

Learning about the biology of wolves is important for understanding why wolves in the Norwegian wilderness are controversial. In one example, the program provides information on how wolves hunt in packs through a simple animation with additional text. Here is an example of how Cecilie answers the question of why wolves usually live in packs.

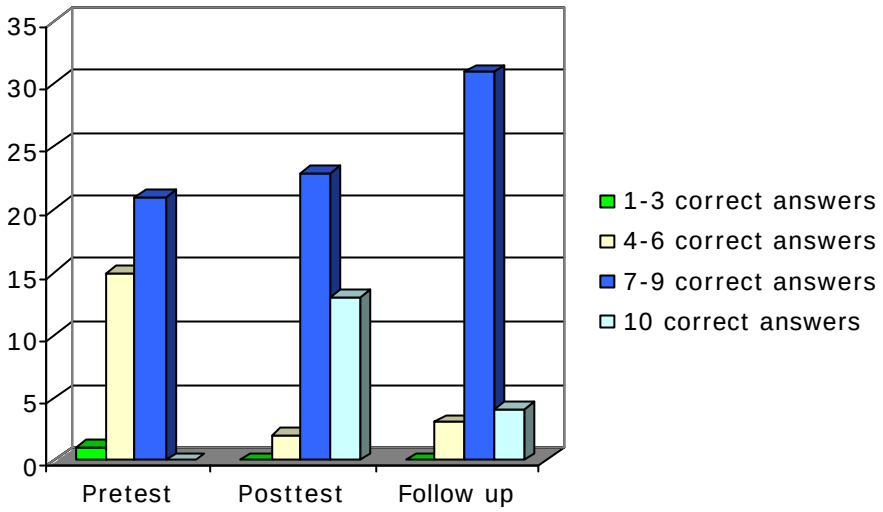
Example 1: Cecilie
Question
English: Why do wolves usually live in packs?
Norwegian: Hvorfor lever ulv vanligvis i flokk?

Pre-test:	***Post-test:***	***Follow-up:***
English		
It is easier to get hold of an animal when there are several wolves I think.	*Wolves mainly live in packs because it makes it easier to attack bigger animals like e.g. deer. Then one can distract the deer, while the others can attack it from behind. If several animals of the same species come into their territory it is easier to chase the intruders away.*	*Easier to defend the territory. Easier to hunt.*
Norwegian:		
Det er lettere å få tak i et dyr når man er flere enn en tror jeg.	*Ulver lever hovedsakelig i flokk for at da er det lettere å angripe større dyr som f.eks hjort. Da kan en distrahere hjorten, mens de andre kan angripe bakfra. Hvis det kommer dyr av samme art i territoriet er det lettere å få jaget inntrengerne ut.*	*Lettere å forsvare territoriet. Lettere å jakte.*

In the pretest Cecilie (example 1) is insecure in her answer about wolves living in packs. Her argument is correct but quite limited. In the posttest she gives a much more elaborated answer demonstrating that she is familiar with wolves hunting tactics and she gives an example of which type of prey this tactic can be suitable for catching. She also mentions the advantage of living in a pack when defending the territory against other wolves. Cecilie uses the same arguments in the follow-up also. However, the quality of the answer is reduced since she is no longer using examples as backing of her argumentation. Cecilie's answers demonstrate a pattern that is representative for many students in this study, showing that in the pretest students give a kind of "common sense" argumentation, i.e. a very general answer that one might expect from persons with no particular interest or knowledge about this issue, while the answer in the posttest is more elaborate and much more specific. In the follow-up the answer is reduced to two very short arguments. This pattern is also reflected in figure 1.

All the multiple-choice questions common on the three tests were related to the biology of wolves. Figure 2 shows that at the pretest about half of the students have 7-9 correct answers. At the posttest and follow-up, the majority of the students had from 7-10 correct answers.

Figure 2: *Student score on multiple-choice questions on the three tests. N = 38. Maximum score is 10.*



Examples related to ecological management

The Norwegian government has suggested several strategies for ecological management as attempts to solve the wolf conflict. These strategies are presented in the Viten wolf program since knowing where we find wolves in Norway today is central to understanding the conflict. The Viten program asks students to mark a map of Norway where they think wolves are found and then provides the correct information on the map in the next step of the program.

In example 2 we see that Svein's answer to this question on the pretest is the name of one of the wolf areas of Norway, Østerdalen. It is not surprising that Svein knows about this area since it is one of those that has been most focused in the media, especially after the government allowed 10 wolves to be killed there during the winter of 2001. In the posttest and follow-up Svein does not mention Østerdalen, but describes 2-3 other important wolf areas in Norway. Here it is interesting to note that Svein does not use the geographical names of these areas, he is just describing where they are on the map, a pattern found in the answers of several students to this particular question. Some students were also drawing maps and marking the wolf areas on the map.

Example 2: Svein
Question
English: Where in Norway do we find wolves today?
Norwegian: Hvor i Norge finnes det ulv i dag?

Pre-test:	***Post-test:***	***Follo- up:***
English		
In the Osterdalen.	*Today there are wolves along the Swedish border in the East and South, just below the Oslo fjord areas and higher towards East.*	*By the Swedish border in East and a bit higher up and a bit further down.*
Norwegian:		
Østerdalen.	*I dag finnes det ulv langs svenskegrensen i Øst/syd, like under Oslofjordområdene og høyere opp mot øst.*	*Ved svenskegrensen i Øst, og litt lengre høyere opp, og litt lengre ned.*

To the question about suggesting strategies for ecological management, Heidi has no answer in the pretest (example 3). However, in the posttest she gives an elaborated answer showing that she is familiar with strategies like fencing in livestock, using shepherds and limiting the living areas for wolves. What is most interesting in Heidi's posttest answer is that she reflects upon which of the strategies that is most preferable. In her follow-up Heidi provides three suggestions for what farmers can do. Two of these suggestions are actually different from those she used in the posttest. In the follow-up she suggests the use of shepherd dogs and limiting the grazing areas of sheep, but she does not suggest using shepherds and restricting the living areas of wolves as she did in the posttest.

Example 3: Heidi
Question
English: Do you have any suggestions to how wolves and humans can live together in the same area?
Norwegian: Har du noen forslag til hvordan ulv og mennesker kan leve sammen i det samme omraadet?

Pre-test:	***Post-test:***	***Follw-up:***
English		
No answer.	*In the same place? Then I suppose one have to set up fences to protect their livestock. There has actually been suggested limiting the living areas of wolves. I think that would function better. I don't understand why wolves and people have to live "on top of" each other. I don't see wolves as any threat to humans, so it must be if one has sheep and other animals. But one can use fences and shepherds and that kind of things.*	*There are more things the sheep farmers can do that they haven't tried yet. E.g. shepherd dogs, limit the grazing areas, electric fence and so on. Maybe this might work.*
Norwegian:		
Ikke besvart.	*På samme sted? Da må man vel sette opp gjerder for å beskytte husdyrene sine. Det har jo blitt lagt fram forslag om å begrense ulvens leveområde. Jeg tror nok heller at det vil fungere. Jeg skjønner ikke hvorfor ulv og mennesker må leve omtrent "oppå" hverandre. Jeg ser ikke på ulven som noen trussel mot mennesker, så det må vel være hvis man har sauer og andre dyr. Men man kan benytte gjerder og gjeterhunder og slike ting.*	*Det finnes flere ting sauebøndene kan gjøre som de ennå ikke har prøvd. Eks er gjeterhund, begrenset beiteområde, elektrisk gjerde osv. Kanskje dette kan fungere.*

Examples related to the wolf controversy

The recent increase in the wolf population in Norway has led to a relatively intense debate about the management of the species. One of the overall aims of the wolf program is to prepare the students to participate in an offline debate about the wolf controversy in Norway. Research on offline debates about the wolf controversy is reported in Mork and Jorde (2003). However, in this paper we focus on the aim that students should learn about different viewpoints in a socio-scientific controversy in the Norwegian society. It is therefore of particular interest to investigate student answers to questions about the views of the stakeholders in this conflict. Here we present examples of two students' arguments for wolves, and two students' arguments against wolves.

Example 4: Trude
Question
English: *Why do some people want to have wolves in Norway? (pretest) Which arguments are used by people who want wolves in Norway? (posttests)*
Norwegian: Hvorfor ønsker noen at vi skal ha ulv i Norge? (pretest) Hvilke argumenter for ulv brukes av de som er tilhengere av ulv i Norge? (posttest)

Pre-test:	***Post-test:***	***Follow-up:***
English		
Wolves have been in Norway for a long time and it would be a pity if we drive them to extinction.	*Wolverines kill many more sheep than the wolves. Very few people have been killed in Scandinavia the last centuries. 100 000 sheep are killed every year of other reasons than predators.*	*Predators keep the deer and moose population down. Not as dangerous as we think. Other predators, even golden eagle kill more sheep than wolves do.*
Norwegian:		
Ulven har lenge vært i Norge og det ville være dumt om vi utryddet den.	*Jerven tar mange flere sauer enn ulver. Veldig få mennesker er blitt drept i Skandinavia de siste århundrene. 100 000 sauer blir hvert år drept av andre årsaker enn rovdyr*	*Rovdyr holder hjortedyrbestanden nede. Ikke så farlig som vi vil ha det til. Andre rovdyr, t.o.m kongeørn tar flere sauer enn ulven gjør.*

Example 4 shows that in the pretest Trude's arguments for wolves are types of "common sense" arguments, i.e. they are very general and a type of argumentation one could expect from someone not very involved in this matter. This type of argumentation is similar to that of other students in this study. In the posttest Trude is using statistical information based on a research report about the danger of wolves as found in the wolf program. Her argumentation in the posttest focuses on the idea that the damage caused by wolves is not as bad as one might think. Trude claims that other predators kill more sheep than wolves and that wolves are not dangerous to people. It is also interesting to note that Trude, in contrast to most other students, points to the important fact that every year about 100 000 of the 130 000 grazing sheep that die or disappear, die from other reasons than predators. In her follow-up Trude uses the more general argument that predators keep the deer and moose population down, and thereby shows that she is familiar with ecological principles like relations between predators and prey. When saying that wolves are not as dangerous as people think, she backs up her argument with facts about other predators doing more damage to sheep than wolves. The qualitative difference in Trudes' answers on the different tests is that in contrast to the pretest she is more specific, and uses more scientific concepts and statistical information in her argumentation in the two last tests.

Example 5: Heidi
Question
English: *Why do some people want to have wolves in Norway? (pretest) Which arguments are used by people who want wolves in Norway? (posttests)*
Norwegian: Hvorfor ønsker noen at vi skal ha ulv i Norge? (pretest) Hvilke argumenter for ulv brukes av de som er tilhengere av ulv i Norge? (posttest)

Pre-test:	***Post-test:***	***Follow-up:***
English		
Wolves are facinating animals and wolves are a natural part of the	*Wolves have not killed (humans in Norway) for over a hundred years. Wolves are natural parts of the ecosystem in the woods*	*The wolves have not killed (humans in Norway) for more than 200 years. Are natural parts of the ecosystem in the*

ecosystem in the woods. For those who are not bothered by wolves there is no reason to drive them to exticntion	*and mountains. Norway is part of an agreement (don't remember the name) that commits us to taking care of the animals. It is wrong to drive the wolves to extinction only because they have killed some sheep. It is not wolves that have killed most sheep in Norway.*	*nature. We are members of the Bern convention. It is wrong to drive a species to extinction. Wolverines kill more sheep than wolves.*
Norwegian: *Ulv er jo et fascinerende dyr og ulven er en naturlig del av økosystemet i skogen. For dem som ikke plages av ulv er det vel ingen grunn til at den skal utryddes.*	*Ulven har ikke drept (mennesker i Norge) på over hundre år. Ulven er en naturlig del av økosystemet i skog og fjell. Norge er med i en avtale (husker ikke navnet) som forplikter oss til å ta vare på dyrene. Det er galt å utrydde ulven i Norge bare fordi den har drept noen sauer. Det er ikke ulven som har drept flest sauer i Norge.*	*Har ikke drept (mennesker in Norway) på 200 år. Er en naturlig del av økosystemet i naturen. Vi er medlem av Bernkonvensjonen. Det er galt å utrydde en art. Jerven dreper mer sau enn ulven.*

Heidi's argumentation in the pretest is based on feelings and she focuses on the values of the wolves as a species and that they are a natural part of the ecosystem. In the posttest she repeats the argumentation of wolves as a part of nature, and like Trude, Heidi is also basing her argumentation on statistical data from the research report about the danger of wolves. What makes Heidi's posttest interesting is that she refers to the Bern convention. She can't remember the name of it, but it is obvious that she is familiar with the content because she says that it commits us to taking care of animals. However, in the follow-up four months later Heidi actually uses the name of the Bern convention and she is still demonstrating that she is familiar with the content when she says that it is wrong to drive a species to extinction. The qualitative difference in Heidi's answers in the tests is that even though the very general argumentation in the pretest is repeated in the two other tests, Heidi supplements it with arguments based on statistical information and an argument that refers to an international agreement.

Trude's and Heidi's answers in the tests are representative for answers given by the other students in this study. Their answers also reflect the main arguments used by stakeholders arguing for wolves:

- *Wolves are not as dangerous as people think because:*
  - *Wolves have not killed humans in Norway the last 200 years.*
  - *Wolves kill fewer sheep than other predators.*
- *About 75% of sheep that die while grazing die for other reasons than predators.*
- *Wolves are natural parts of the ecosystem.*
- *Norway has signed the Bern convention committing us to preventing the extinction of species.*
- *Predators are important to control prey populations like moose and deer.*

Let us now look into two examples of the kind of arguments students think people use when arguing against wolves.

Example 6: Karl
Question
English: Why are some people against having wolves in Norway? (pretest) Which arguments do people use who are against wolves in Norway? (posttests)
Norwegian: Hvorfor er noen motstandere av at vi skal ha ulv i Norge? (pretest) Hvilke argumenter mot ulv brukes av de som er motstandere av ulv i Norge? (posttest)

Pre-test:	***Post-test:***	***Follow-up:***
English		
Because their sheep are killed, and wolves often seem scary.	*People are afraid of wolves. It costs a lot of money to keep them away. Wolves kill more sheep per wolf than other predators. Wolves are on the top of the food chain. Wolves are dangerous to humans. Wolves can be moved to Sweden.*	*Wolves kill sheep, they are a threat to humans and animals, and they are on the top of the food chain. Farmers and others loose millions on loss of their livestock, and by fencing in livestock.*
Norwegian:		
Fordi sauene/dyrene dems blir drept, og ulven kan opptre skremmende.	*Folk er redde for ulv. Det koster penger å holde den borte. Ulven dreper mer sau per ulv enn andre dyr. Den er på toppen av næringskjeden. Den er farlig for mennesker. Den kan flyttes til Sverige.*	*De dreper sau, er en trussel for mennesker og dyr, de er på toppen av næringskjeden. Bonden og andre taper millioner av kroner på inngjerding og tapte dyr.*

Karl's arguments in the pretest are based on feelings, a typical trait for many student answers in the pretest. In his posttest he claims that people are afraid of wolves, and that wolves are dangerous to humans, but these claims are not supported by statistical evidence. What is most interesting in Karls' posttest answer is that he is obviously aware of the fact that other predators kill more sheep than wolves. However, as Karl correctly points out: individual wolves kill more sheep on average than individuals of other predator species like wolverines and bears. To get to this information, Karl must have been using a combination of information sources in the wolf program. A graphical representation in the wolf program provides information about the number of sheep killed by the different predator species every year. To get information on the population size of other predators than wolves it is necessary to follow links to web pages outside the Viten wolf program. Another interesting feature of Karl's answer is the claim that wolves are on the top of the food chain. He doesn't support this claim with backings in the posttest, but several students used this information when arguing in the offline debate: since wolves are on the top of the food chain, it doesn't influence other species very much if they are driven to extinction. This argumentation suggests some misunderstanding about population dynamics: the students only refer up trophic levels (stating that no animals depend upon wolves for food), rather than considering the effect of wolves on population size at lower trophic levels. Karl also brings in the economic dimension of this controversy when arguing that it is expensive to protect people and livestock against the wolves. In the follow-up four months later Karl repeats most of the arguments from the posttest; however, he elaborates the argumentation about economic losses due to wolves by the concrete example of fencing. Fencing in livestock is a strategy suggested for ecological management, but as Karl claims; it increases the costs for farmers and is thereby an argument against wolves. There is certainly a qualitative difference in Karl's argumentation between the tests. From a pretest answer based on feelings, his argumentation in the posttest demonstrates that he has done a

good job combining and interpreting information from different sources provided in the program, thereby putting forth argumentation that is not easily accessible. In contrast to the pretest, Karl uses terms like predators and food chain in the posttest and the follow-up.

Example 7: Camilla
Question
English: Why are some people against having wolves in Norway? (pretest) Which arguments do people use who are against wolves in Norway? (posttests)
Norwegian: Hvorfor er noen motstandere av at vi skal ha ulv i Norge? (pretest) Hvilke argumenter mot ulv brukes av de som er motstandere av ulv i Norge? (posttest)

Pre-test:	***Post-test:***	***Follow-up:***
English		
Because they think that they are dangerous or threatening for e.g. their flock of sheep.	*They kill the farmers' sheep, the farmers economy will weaken. Wolves <u>have</u> killed humans, it <u>can</u> happen again and it is terrible that people living close to wolf areas have to live in fear now. We can do something about it.*	*Wolves have killed (humans) and can do it again. The wolf population is increasing. Wolves eat the farmers sheep.*
Norwegian:		
Fordi de mener de er farlige eller er truende for for eksempel saueflokken deres.	*De tar sauene til bøndene, bøndene får verre økonomi. Ulven <u>har</u> drept mennesker, det <u>kan</u> skje igjen, og det er forferdelig at de som bor i nærheten av ulv skal leve i frykt nå. Vi kan gjøre noe med det.*	*Ulven har drept (menesker) og kan gjøre det igjen. Ulvebestanden vokser stadig. Ulver spiser sauer til bøndene.*

Camilla's argumentation in the pretest is based on feelings. In the posttest her argumentation is still dominated by feelings, but she uses a more elaborated argumentation, since she now is familiar with information about the fact that wolves actually have killed humans in Norway. In the follow-up Camilla repeats the argumentation about danger and fear, but she also introduces a new argument against wolves: the wolf population is increasing - a problem for farmers since wolves kill their sheep. Camillas argumentation in the tests is dressed in an emotional language, and this also reflects some of the argumentation held by stakeholders against wolves. Camilla's and Karl's answers on the tests sum up the most important arguments used against wolves:

- *Wolves kill sheep and cause economic loss to farmers*
- *Wolves have killed people and can do it again*
- *Wolves kill more sheep per individual wolf than other predators*
- *Wolves are on the top of the food chain, therefore the influence on other species is minimal if wolves are driven to extinction*
- *People in wolf areas are living in fear*
- *The wolf population is increasing*

As we can see, there is a difference in the types of arguments used for and against wolves. The arguments used for wolves seem to be based on the biological value of the wolves and the commitment to the Bern convention to protect endangered species. In addition many arguments for wolves are counter-arguments to those against wolves. On the other hand, arguments against wolves seem to be based on the danger of wolves to humans and livestock, and the economic consequences of having wolves in the Norwegian wilderness.

To what extent did working with the wolf program influence the students view on wolves?

The wolf conflict in Norway is regularly put on stage by the media. However, the media often tends to present views of just one side in the conflict, something that might influence public opinion. Results from a survey on attitudes toward wolves in four counties in South-eastern Norway shows that about 50% of the sample express various degrees of fear for wolves (Bjerke & Kaltenborn, 2000). One of the intentions with the Viten wolf program is to provide a more balanced view of this conflict. To evaluate whether the wolf program has influenced the way students think about this issue, we asked the students about their opinion as to whether wolves are dangerous or not. 12 of the 38 students did not change their view from pretest to follow-up. Three of these 12 students thought that wolves are dangerous, while the 9 other students thought that wolves can be dangerous under specific circumstances. Einar is an example of a student that did not change his view on the danger of wolves. As shown in example 8, his answers on the three tests are almost identical.

Example 8: Einar

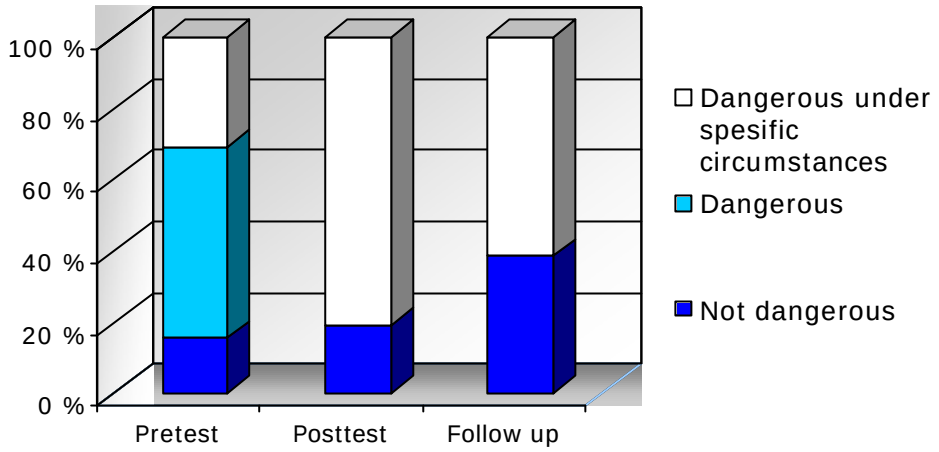
Question

English: Much has been written about wolves lately. Are wolves dangerous or not? What is your opinion?
Norwegian: Det har vært skrevet mye om ulv i det siste. Er ulven farlig eller ikke? Hva er din mening?

Pre-test:	***Post-test:***	***Follow-up:***
English		
Wolves can be dangerous when they are in a pack and haven't eaten for many days/weeks. I'm not afraid of the wolves	*Wolves are not dangerous. Wolves are actually shy to humans, but they can attack people if they are in a pack and haven't eaten for several weeks/days.*	*Wolves are not dangerous to humans. They can be dangerous if you tease them.*
Norwegian:		
Ulven kan være farlig når de går i flokk og ikke har spist på mange dager/uker. Jeg er ikke redd ulven.	*Ulven er ikke farlig. Ulven er egentlig sky for mennesker, men den kan gå til angrep på mennesker hvis ulven går i flokk og ikke har spist på flere uker/dager.*	*Ulv er ikke farlig for mennesker. Den kan være farlig hvis du terger den.*

On the other hand, 26 of the 38 students did change their opinion as to whether the wolves are dangerous from pretest to follow-up. As shown in figure 3, all the students who claimed that wolves are dangerous in the pretest have actually changed their answers in the posttest and follow-up, where most of them are claiming that wolves are dangerous under specific circumstances. Another interesting feature is that the number of students thinking that wolves are not dangerous increased from posttest to the follow-up.

Figure 3: *How students changed their opinion regarding the danger of wolves from pretest to follow-up. N=26.*



The following example shows how Maria changed her answer during the different stages of the teaching sequence.

Example 9: Maria
Question
English: Much has been written about wolves lately. Are wolves dangerous or not? What is your opinion?
Norwegian: Det har vært skrevet mye om ulv i det siste. Er ulven farlig eller ikke? Hva er din mening?

Pre-test:	***Post-test:***	***Follow-up:***
English *Wolves are dangerous to humans and to sheep. I think of wolves as a little bit dangerous, perhaps. Everything you see on the news and so on. But I think it is wrong that people kill them. They are nice when they are tame.*	*I mean that wolves are not dangerous!! At least not to humans. It is unusual for wolves to attack people. The most serious incidents are adaptation, rabies, (but rabies do not exist in Norway any more), provocation and environments with little or no regular prey. There have not been any people killed by wolves in Norway for more than 200 years. Of course people get scared if they meet a wolf, but wolves are more afraid of us!!*	*Wolves are not dangerous. Wolverines kill more sheep than wolves, so why do wolves always gets the blame?!?! Many people are afraid of wolves, but they have not killed a single human in Norway for the last 100 years.*
Norwegian: *Ulv er farlig for mennesker og for sau. Jeg forbinder ulv som litt farlig, kanskje. Alt det man har sett på nyhetene osv… Men jeg synes at det er galt at folk dreper dem. De er snille når de har blitt tammet opp.*	*Jeg mener ulv ikke er farlig!! Hvertfall ikke for mennesker, det er uvanlig at ulv angriper mennesker, De største hendelsene er tilvenning, rabies (men det finnes ikke lenger rabies i Norge), provokasjon og miljø med liten eller ingen naturlige byttedyr. Det er 200 år siden noen har blitt drept av ulv i Norge. Det er klart at man blir redd hvis man møter en ulv, men det er ulven som er redd oss!!*	*Ulven er ikke farlig. Jerven har drept flere sauer enn ulv, hvorfor er det ulver som får mest skylden da?!?! Det er mange som er redde for ulv, men de har ikke tatt et eneste menneskeliv i Norge de siste 100 år.*

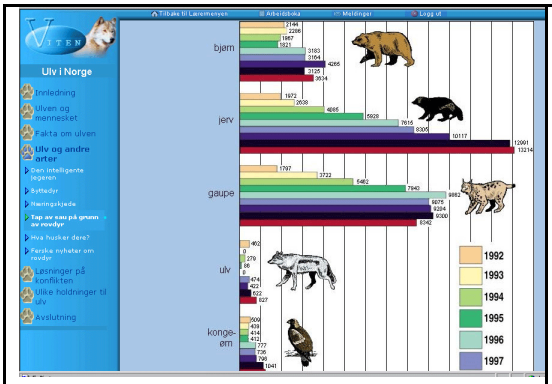
In the pretest she thinks that wolves are dangerous to sheep and humans, and indirectly she bases this view on what has been said about the issue in the media. In the posttest Maria has changed her opinion towards the danger of wolves. She starts by claiming that wolves are not dangerous, but from the rest of her answer it is clear that she modifies this claim by pointing to specific circumstances where wolves are dangerous to humans. Therefore we have classified this answer as dangerous under specific

circumstances. Her answer in the posttest is also much more elaborate compared to the pretest and her argumentation is based on information presented in a research report on the danger of wolves. In her follow-up she says that wolves are not dangerous; and in contrast to the posttest, she doesn't provide information of situations where wolves actually can be dangerous to humans. We thereby classified her answers as not dangerous. Like Maria, most students who changed their answers from claiming that wolves are dangerous to dangerous under specific circumstances refer to information found on a page with a research report about the danger of wolves, see Table 3. When Maria in the follow-up argues that wolves are not dangerous she is backing her claim with information that other predators kill more sheep than wolves. Hence Maria's argumentation can be traced back to a page with statistical information about the loss of sheep to predators, see Table 4.

Table 3: *Page with a research report about the danger of wolves.*

	Aims for the page ▪ *This summary of a research report is meant to give students factual information of how dangerous wolves really are to humans.* ▪ *Promote discussion about this issue in the student dyad.*	***SKI principle 1 and 3*** ▪ *Scientific research about the danger of wolves is made accessible to the students.* ▪ *Students can learn from each other by discussing the given information.*

Table 4*: Page with statistical information about the loss of sheep due to predators.*

	***Aims for the page*** ▪ *Students should learn to read and interpret information from graphical sources.* ▪ *Students should learn factual knowledge about the relationship between the sheep and the predators.* ▪ *Promote discussion about this issue in the student dyads.* ▪ *Students should be able to use information from this page when arguing in the debate.*	***SKI-principle 3 and 4*** ▪ *Students can learn from each other by discussing the given information.* ▪ *Practice in using information from graphical sources promotes autonomous learning.*

Differences in the responses of girls and boys?

Under classroom observations during the teaching sequence our impression was that girls spent more time on most activities than boys. A recently developed feature of the Viten platform made it possible to document the amount of time that each dyad spends on individual pages within the wolf program. We found gender differences in mean time spent on the computer-based part of the program, with girls spending more time than boys, see Table 5. The number of girls spending more than 180 minutes on the wolf program is significantly higher than the number of boys ($P<0.001$), one-sample t-test. Our

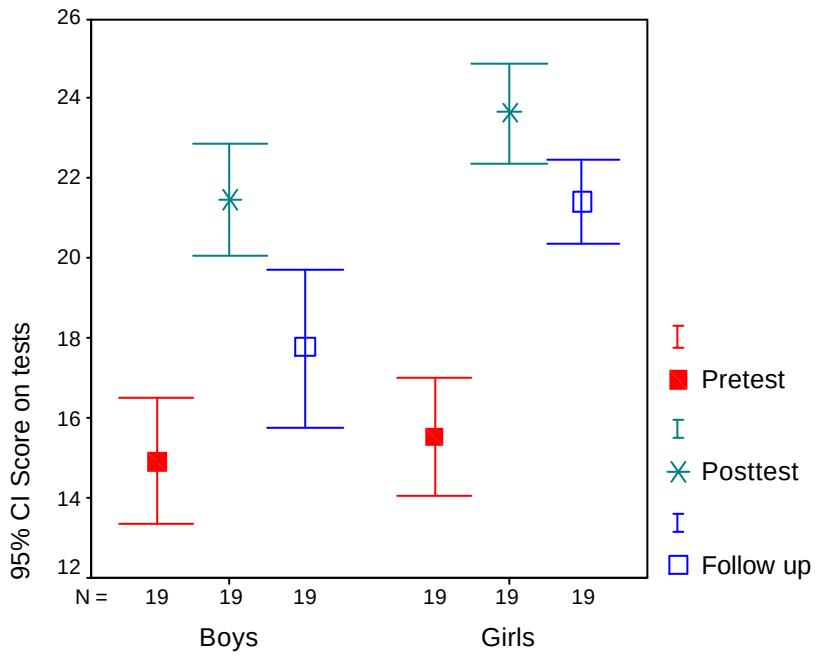
observations and teacher interviews support this data. Teachers commented that girls worked more systematically and discussed more as compared to boys.

Table 5: *Gender differences in time spent on the wolf program.*

Time spent using the wolf program	***Total***	***Boys***	***Girls***
Number of students spending less than 90 minutes	*2*	*1*	*1*
Number of students spending between 90-180 minutes	*42*	*26*	*16*
Number of students spending more than 180 minutes	*12*	*0*	*12*

Finding this gender difference in time spent on the computer-based part of the program we were curious to investigate whether this influenced the students' achievements on tests. As indicated in figure 5, there are no significant differences between gender in scores on the pretest. However, girls have a statistically significant higher score than boys on the posttest (p=0.022), t-test for independent samples. There is also a statistically significant difference in favour of the girls in score on the follow-up test (p=0.002), t-test for independent samples. These findings indicate that students spending more time on the different activities in the wolf program absorb more of the content and also have a higher degree of retention.

Figure 5: *Gender differences in score on achievement tests.*



DISCUSSION

In this study, we set out to evaluate the effectiveness of the Viten wolf program in meeting the aims of teaching about the biology of wolves, about ecological management and the controversial issue of wolves in Norway. In addition, we also wanted to find out whether the teaching sequence influenced students' views on wolves, and whether there were any gender differences in the responses to the program.

Learning gains achieved

As expected, the students scored significantly higher on the posttest compared to the pretest. It is interesting to notice that even after four months, students continued to demonstrate high levels of retention. Not surprisingly, the results also showed that most students lost some of their arguments during the period from the posttest to the follow-up test. The extent to which this happened varied, of course, between the individual students. However, the follow-up tests and student logs have convinced us that the students became genuinely involved in this conflict and retained information about the different aspects of it even weeks after completion.

Of the questions common in the three tests, all of the 10 multiple-choice questions were about the biology of wolves. A majority of the students had 7-10 correct answers on multiple-choice questions at the follow-up, even though one might think that details (see appendix) could be quickly forgotten.

In taking a closer look at the answers to open-ended questions, we found a general pattern amongst the students to give more elaborated answers in the posttest. Typical answers in the posttest were recognized as suggestions or claims backed up by examples or reasoning. Overall the posttest answers were more specified, and the students used concepts like predator, population and the Bern convention, in contrast to the pretest answers that were found more general and based on feelings. Another general feature in students' answers was that they lost some of the examples and reasoning between posttest and the follow-up.

On the basis of our results we make the claim that students score higher on the achievement tests after completion of the Viten wolf program, and even after four months students continue to demonstrate high levels of retention. There is a qualitative difference in the students' answers to open-ended questions before and after the work with the Viten wolf program: the posttest answers are more specific, contains examples, claims are often backed up by reasoning, and the students use biological concepts like predator, prey, population and rabies in contrast to the more general pretest answers that are often dressed in an emotional language.

When we asked students about where in Norway one finds wolves today, we were struck by many student answers that did not recall the areas by their names. Many students explained where on the map one could find these areas, with some students even drawing a map to locate the wolf areas. As curriculum designers this tells us that visualisations are important since the activity provided in the program concentrated on map locations. At the same time, however, we are also aware that our map should provide the names of geographical areas so that this information might also be included in student responses.

Students were asked to suggest strategies for ecological management, and we were surprised to learn how little our student population actually knew about the wolf controversy and ecological management before starting the program since it is so visible in the Norwegian media. A general feature in responses to questions related to these issues was limited or lacking answers on the pretest, with more elaborated answers on the posttest. Since one of the overall objectives for the Viten wolf program is to allow students to participate in an offline debate about the wolf controversy, we were interested in to what extent the students were able to identify the views of the stakeholders in this conflict or use information from the program to construct argumentation for or against wolves. When developing the wolf program, the Viten team was very conscious of providing an approximately equal number of arguments for and against wolves in the program. However, many of the arguments introduced in the program can be used both for and against wolves: e.g. the information about the small size of the Scandinavian wolf population. Such an argument is used for the protection of wolves as an endangered species and backed up by the fact that Norway is committed to the Bern convention. In contrast this piece of information is also used as argumentation against wolves since it shows that the wolf population is slowly increasing. However, there are differences in the types of arguments suggested for and against wolves. The arguments used for wolves seem to be based on the biological value of the wolves and the commitment to the Bern convention to protect endangered species. In addition many arguments for wolves are counter-arguments to arguments against wolves. On the other hand, arguments against wolves seem to be based on the danger of wolves to humans and livestock and the economic consequences of having wolves in the Norwegian wilderness.

Not surprisingly the type of arguments suggested for and against wolves reflects arguments used by the stakeholders in the actual wolf debate in the Norwegian society.

We have also seen examples that students are able to interpret and combine different information sources to construct argumentation that is otherwise not easily accessible in the wolf program.

How did working with the wolf program influence students view on wolves?

Due to the fact that wolves historically have posed a threat to human safety it is easy to understand why we have a "cultural fear" of wolves, which is reinforced through stories and mythology. Recent surveys in Norway indicate that fear of wolves is still widespread among people even though the wolf population has been extremely small during recent decades and nobody has been killed or injured for 200 years. Only 10% of Norwegians accept that wolves should live within 5 km of their home, 48% answer that they are "slightly afraid of wolves". However it is important to remember that there is a clear majority of Norwegians in favour of wolves existing in the country (Linnell & Bjerke, 2002).

The attitude that people in general have towards wolves is also influenced by their confidence in different sources of knowledge (scientific knowledge versus lay knowledge). Those with confidence in scientific knowledge are likely to be more positive towards wolves; however large parts of rural communities have low confidence in this source of knowledge. There has been a conflict between lay knowledge and scientific knowledge with regards to the danger wolves pose to human safety (Linnell & Bjerke, 2002). One intention with the Viten wolf program was to provide information that supports a balanced view of the wolf conflict in Norway. Finding out to which extent the wolf program had influenced the students' ways of thinking about wolves was therefore of particular interest in this study.

Two thirds of the students actually did change their opinion towards the danger of wolves after working with the Viten wolf program. Half of these students thought that wolves were dangerous at the pretest. At the posttest and follow-up these students had modified their answers and claimed that wolves are dangerous under specific circumstances.

So, what is it that made these students change their view on the danger of wolves? By looking in detail at the individual student answers, we find some common traits in their argumentation. It seems that most of these students have constructed their new argumentation on the basis of two particular pages in the Viten wolf program, see Table 3 and 4. One of these pages is a research report on the danger of wolves. In this report researchers have identified four factors that are associated with wolf attacks on humans: rabies, habituation, provocation and extreme socio-economic environments. A summary of incidents where wolves have attacked humans is also provided in this report. All or parts of this information are frequently used in the students' argumentation about the danger of wolves. The other page often referred to by students contains statistical information about the loss of sheep to predators. The graphical information provided on this page is shocking to most Norwegian students. It seems that the media only write about wolves killing sheep and therefore the general public is quite unaware of other predators in the Norwegian wilderness. Even golden eagles have killed more sheep than wolves

have, in the last decade. On this page, one can also find information about the fact that 75% of sheep that die while grazing die for other reasons than predators.

Another interesting feature of students' views on wolves is that the number of students thinking that wolves are not dangerous increased from the posttest to the follow-up. This can be due to several reasons e.g. that the students have forgotten under which circumstances wolves could be dangerous. Another possibility is that students have continued paying attention to this issue and changed their mind due to new evidence.

Our results show that the Viten wolf program did change the ways students are thinking about the danger of wolves. It seems that two particular pages with research-based scientific information had the strongest influenced on the students' opinions regarding this issue. Our results are also in line with recent surveys on peoples' attitudes towards wolves in Norway reporting that people with confidence in scientific knowledge are likely to be more positive towards wolves than others (Bjerke, Skogen, & Kaltenborn, 2002).

Were there any gender differences in response?

The girls in this study spend more time working with the online part of the wolf program than the boys. The girls also have significantly higher scores on posttest and follow-up compared with the boys in this study. These findings indicate that students spending more time on the different activities in the wolf program absorb more of the content and also have a higher degree of retention. It is interesting to view these findings in light of the results of Program for International Student Assessment (PISA) which reports large gender differences in reading competences in favour of girls in Norway (Lie, Kjærnsli, Roe, & Turmo, 2001). If it is so that girls are better readers, spend more time on the activities in the program and have higher scores on the achievement tests, then we have something to learn from this information. It would be interesting to follow-up these results more systematically in a study with a larger sample.

Our impression from classroom observations and students' individual logs does not suggest a gender difference in motivation and engagement for working with the wolf program. Both girls and boys seemed very motivated and engaged during this teaching sequence. Several students have commented in their logs that they enjoyed learning about the wolf controversy, and that they thought the work gave them useful information. Two students had the following comments in their logs:

"It has been fun to become engaged in the wolf debate and form my own opinion. Now that I know more facts about wolves, I can also contribute and come with arguments if the wolf controversy is discussed"

"I hope we are going to have more projects on the computer. It makes learning more fun, and we will probably be needing ICT skills later in life."

CONCLUSION

From student logs and their engagement when working with this teaching program, we know that the students love using the computers for learning. We are surfing on a wave of new methods that fits very well into youth culture. But are they learning science?

On the basis of our results we make the claim that students score higher on the achievement tests after completion of the Viten wolf program, and also demonstrate high levels of retention after four months. There is a qualitative difference in the students' answers to open-ended questions before and after the work with the Viten wolf program and we have also seen examples that students by interpreting and combining different information sources are able to construct argumentation that is not easily accessible in the wolf program.

Our results show that the Viten wolf program did influence the ways students are thinking about the danger of wolves, with 2/3 of the students changing their opinion about the danger of wolves.

This study further shows that there are statistically significant gender differences in time spent on the online part of the wolf program, and we suggest that these differences seem to influence students' achievement on the posttest and also on the follow-up after four months.

We are just starting to understand the effects of learning environments such as Viten. The wolf program provides a mixture of information and activities, allowing student dyads to make their own selections of information and construct their own texts in the electronic workbooks. As curriculum developers in this new medium, we are integrating our knowledge of science together with information technology and pedagogy. The challenges are many, and not all easy to solve. However, when we are able to show positive learning gains, together with enthusiastic students eager to learn science, we feel as though we are on the right track. Given what we have experienced from this study the next step on our research will involve a focus on construction and evaluation of arguments. We are working on a paper evaluating student argumentation in the offline part of the wolf program, the classroom debate. We are also preparing a revision of the wolf program, where we focus even stronger on construction and evaluation of argumentation.

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