Tom Klepaker is Associate Professor at University of Bergen, Norway. He has a long experience in teacher training education. He has been involved in several studies of science education in Norwegian schools, mainly studying the effects of new curricula both in primary and secondary schools. He has had a special focus on the importance of practical activities in science teaching and the gender aspect in science.

Siv Flæsen Almendingen is Associate Professor at Nesna University College, Norway, where she has a long experience in teacher training education. She has taken a special interest in outdoor education. Almendingen has been a member of the research group evaluating the national curriculum (R97) with respect to the science subject. At present she is engaged in a Ph. D. project exploring young students' interests in future occupations related to science.

Johannes Tveita has a life-long experience in teacher training education at Nesna University College where he holds a position as Professor. He has taken part in several studies with developing and testing teaching programmes based on constructivist learning theory. He has also written textbooks applying constructivist theory in teaching electricity and the kinetic particle model. Tveita was project leader of the national project evaluating the national curriculum (R97) with respect to the science subject.

TOM KLEPAKER
University of Bergen, Norway
Tom.Klepaker@bio.uib.no

SIV FLÆSEN ALMENDINGEN
Nesna University College
Norway, sa@hinesna.no

JOHANNES TVEITA
Nesna University College
Norway, jt@hinesna.no

Young Norwegian students' preferences for learning activities and the influence of these activities on the students' attitudes to and performance in science

Abstract
This study focuses on the use and effects of "Student-active teaching practice" in science in Norwegian schools. In a quantitative study we have collected data on teaching activities, student attitudes and student performance in science. We see that the students clearly prefer teaching activities in which they can take part actively. Separating the classes in four groups according to teaching practice, we find that different practice has significant influence on the students' attitude to science and to their science teacher. The student's performance in science does not relate in the same way to teaching practice.

Introduction

School science has, especially in industrialized countries, faced an uphill struggle to catch the interest of young people (Baird & Penna, 1992; Lødding 2004). The number of students that choose higher levels of science in high school and universities is decreasing. At the same time, we see a great enthusiasm and interest in science-related items among pre-adolescents. This shift in interest, which has been noted by several researchers and authors (Aikenhead, 2004; Bailey, 1996; Gilbert, 1996; Nergård, 2003; Osborne, Simon & Collins, 2003; Speering & Rennie, 1996), is especially evident among girls. The situation causes a low recruitment to important functions in our society, and also a low level of science knowledge in the population in general. In USA, tests have been carried out that conclude that 85% or more of the population can be characterized as scientific illiterate (Miller, 1989).

It is therefore of great importance to explore how different ways of teaching science influence the students' interest in the subject. Former studies have shown that teachers, preservice teachers and students disapprove with a teaching practice that is dominated by lecturing and theoretical learning activities (Palmer, 1999; Klepaker, Almendingen & Tveita, 2002; Johnston, 2003). But does this mean that a stronger focus on a teaching practice where the students take more active part influences the students' attitude to and performance in the science subject?

This study was initiated as part of the official evaluation of the curriculum reform that was implemented in Norwegian schools in 1997 (KUF, 1999). In this reform science was given a special focus. In this study we wanted to focus teaching practice, and how the students responded to different teaching practice in science. The study also includes a multiple choice test that enables us to relate differences in teaching practice to student performance.

Methods and samples

The data in this study were collected in spring 2002 by way of a questionnaire to students in seventh grade in Norwegian schools (12-year-old students) and their science teachers. A random sample of 200 classes was drawn from the total population of Norwegian seventh grade classes. We received answers from 167 classes, which give a response rate of 84 percent. All together, more than 2900 students participated.

Both the students and their teacher answered a questionnaire. The teacher's answer gave information on teacher sex, age, education level, years of experience, classroom practice, their attitude to science and how he or she evaluated the teaching practice. The student questionnaire has three parts. The first deals with the students' attitude to science, their science teacher and the science teaching. Here the students are presented to different statements that they respond to on a four-graded scale (strongly disagree, disagree, agree and strongly agree). The second part of the questionnaire presents different teaching activities, and the students are asked to quantify how frequent each activity occurs on a five graded scale (never, rarely, occasionally, often and always). They were also asked to state whether they wanted the activity to occur less frequent, as now or more frequent. The third part is a multiple-choice test to measure the performance of the students in science. The test, which consisted of 35 tasks, was developed based on the TIMSS-study in 1995 (Lie, Kjærnsli & Brekke, 1997) but adjusted to fit the new Norwegian curriculum in science (KUF, 1999). The multiple choice test is described in detail in Almendingen, Klepaker and Tveita (2003). The teacher questionnaire, the student questionnaire and the multiple choice test can be found at http://www.hinesna.no/content/view/1142/605/

The students were given one hour to fill in the questionnaire. To secure maximum anonymity the students put their questionnaire in an envelope, which they sealed before they handed it to the teacher. Each class was given a code number to identify students from the same class. The answers from the questionnaires were transferred to a data file and processed by SPSS 13.0. To group classes according to teaching methods, a k-Means Cluster Analysis was used. Differences in students' attitudes, experiences and performance between the different groups of classes were tested by One-Way Analysis of Variance and gender differences by Independent Samples t-Test.

The study was initiated by the National Board of Research and was a part of the official evaluation of the national curriculum reform for the compulsory school implemented in 1997.

Results

Students' preferences for different kinds of learning activities

We presented the students to 26 activities and asked them to specify how often each activity occurred in their science lessons and whether they wanted the activity "less than now", "as now" or "more than now". The activities and the students' responses are given in figure 1. The figure shows that we can divide the activities into "popular" (student want more than now) and "less popular" (students want less than now). What we see as common for the "popular" activities is that they involve the students actively and/or involve some practical activity. Activities like excursions, watching film/video, using computers/internet, outdoor education, experiments/hands-on activities, working in groups, project work and the use of drama in science are all activities that a large majority of the students want more of.

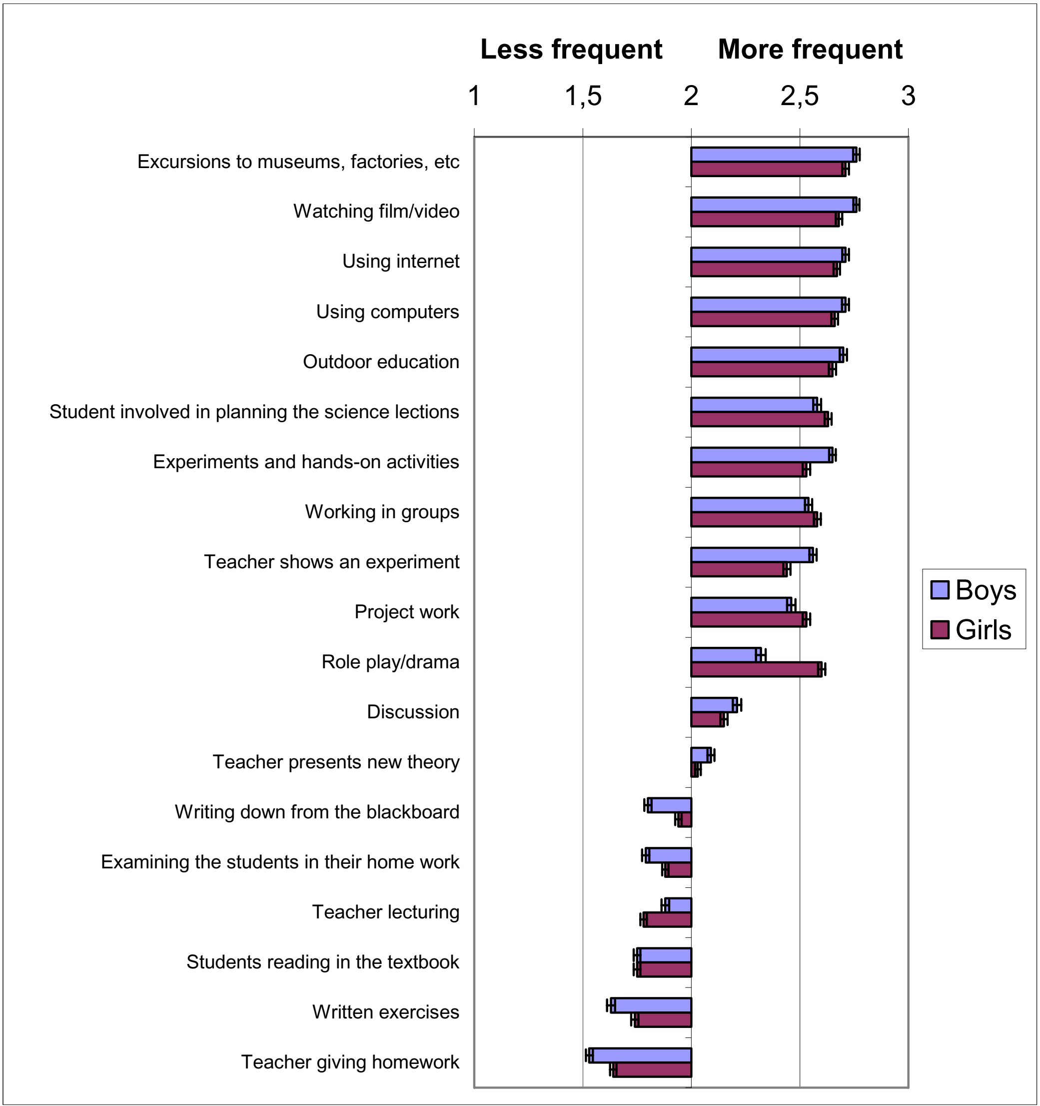

Figure 1. How the student want different teaching practice in science. Mean values for girls and boys with standard error. Columns to the right represent activities the students want more often, columns to the left they want less often.

The “less popular activities” are related to homework, written exercises, reading in the textbook and teacher lecturing. These are activities that are less practical and more governed by the teacher.

Do boys and girls like the same activities? From figure 1 we see that boys and girls agree on which activities are popular and which are less popular. However, there are significant gender differences in the students’ preferences. The single activity where we find the largest difference is “using role play/drama in science”. This is one of the most popular and wanted activities among the girls, while the boys are much more reluctant. Besides this, we see a consistent pattern of difference between boys and girls. For all activities that involves practical activities, like excursions and doing experiments, the boys are more enthusiastic than the girls. Further, the boys tend to be more positive to activities that are common to the whole class, like teacher lecturing, class discussions and teacher demonstrating an experiment. Girls, on the other hand, express a higher preference for working in smaller groups, project work and drama/role play as mentioned above. Another apparent difference is that the girls are less negative to activities that involve writing and to do homework.

To register the teaching practice in science, we presented for the students 26 different activities and asked them how often they occurred in their science lessons. Each student specified the different activities on a five-graded scale (never = 1, rarely = 2, occasionally = 3, often = 4 and always= 5). The mean value was calculated for each class, and this value was used to quantify the frequency of each activity in the different classes. We had a special focus on teaching practice that involved the students actively in practical or theoretical work. The eleven activities listed below were the ones with the highest degree of student involvement and activity. We called these “Student-active teaching practice”:

- Excursions to museums, factories, etc
- Students involved in planning the science lessons
- Outdoor education
- Experiments and hand-on activities
- Students working in groups
- Project work
- Students using computers in science lessons
- Students using internet in science lessons
- Students gathering information from other sources than the textbook
- Drama and role-play in science
- Discussion

The occurrence of these activities varies from class to class. We wanted to group the classes on the overall use of “Student-active teaching practice”. Based on the mean values of each of the teaching activities listed above, we wanted to group the classes according to the level and kind of activities that were used. To do so, we ran a k-Means Cluster Analysis (SPSS 13.0). The analysis was performed with three, four and five clusters. Of these, the four cluster model produced the most

Table 1. The Squared Euklidian distances between the four groups of classes as given by the k-Means Cluster analysis (SPSS 13.0)

	Group 1	**Group 2**	**Group 3**	**Group 4**
Group 1		1.49	1.58	3.05
Group 2	1.49		1.06	1.63
Group 3	1.58	1.06		1.86
Group 4	3.05	1.63	1.86	

meaningful separation of the classes. One of the activities, "Discussion", was removed because it contributed very little to the separation of the groups. Based on the mean values of the remaining ten activities, the differences between the four clusters of classes could be identified. The clusters were named Group 1-4. The characteristics of each group are described below:

Group 1
This is the largest group. It consists of 63 classes (37.7 percent). The classes in this group are characterized by a low level of all activities we define as "Student-active teaching practice".

Group 2
This group consists of 40 classes (24.0 percent). It has a low level of "Student-active teaching practice", but higher than group 1. The group is characterized by a low level of experiments and hands-on activities, but somewhat more frequent use of project work, computers and internet.

Group 3
This group consists of 46 classes (27.5 percent). The classes in this group have a relatively high level of "Student-active teaching practice". They are characterized by a frequent use of activities that we can call traditional in science, like experiments, outdoor education and other excursions. The use of computers and internet, on the other hand, is low, even lower than in group 2.

Group 4
This is the smallest group, consisting of 18 classes (10.8 percent). Like group 3, we find a relatively high level of "Student-active teaching practice", but this is not caused by the same activities. Group 4 classes are characterized by a high level of project work, use of computers and internet. It is also here we find the most frequent use of drama and role play in science.

The separation of the four groups of classes represented by the squared Euklidian distance is given in table 1. It shows that Group 4 is the most distant group, especially from group 1. The greatest contribution to this difference is the use of computers and internet. Group 1 also differs from the three others by a generally low level of "Student-active teaching practice".

Student attitude to science
Do different teaching practices affect the students' attitude to and interest in science? We presented the students for eight different statements that relate to different aspects of their attitude to and interest in science. These statements are presented in table 2. From the eight statement variables, we calculated a collective variable (sci-att) as the mean of the eight variables. This collective variable is a more broad-banded expression of the students' attitude to science. We have tested the reliability of the collective variable by calculating Cronbach's alpha. The test produces an alpha value of 0.85, which shows that the collective variable has a satisfying reliability.

To examine the attitude of the students in the four different groups of "Student-active teaching practice", we calculated the mean within each group. We also calculated separate means for girls and boys in each group to be able to spot any gender differences. The results are shown in figure 2. There are three evident results we can read from this figure. First, we see that students from all four groups express a positive attitude to science (sci-att > 2.5). Second, we see a gender difference, the boys in all groups express a more positive attitude. And third, we see that the attitude to science differs between the four groups of classes. Group 1 is the group where the students express the lowest attitude to science. Group 2 is intermediate, while the two groups of highest levels of "Student-active teaching practice" (groups 3 and 4) have the students who express the most positive attitude to science. We see this pattern both for boys and girls, and the difference between group 1 and 2 compared to groups 3 and 4 is approximately 1/3 standard deviation. The relation between teaching activity and student attitude is highly significant (Anova, d.f. $= 3$, $F = 14.64$, $p < 0.0001$).

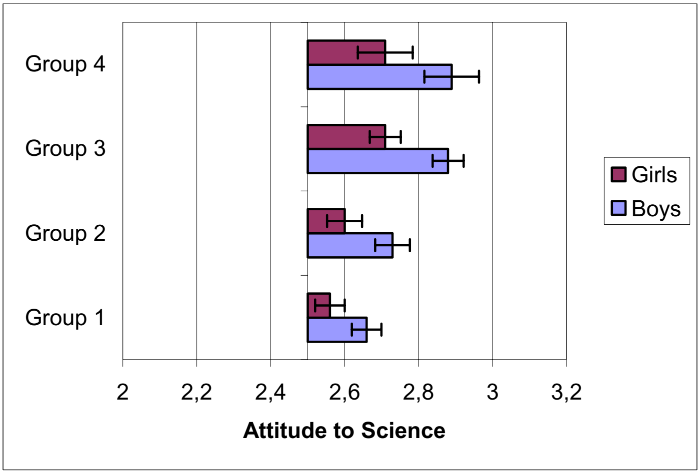

Figure 2. The score of the students for the collective "attitude to science" variable. Mean value for each teaching practice group with standard error. Columns to the right represent positive attitude.

Table 2. The mean and standard error for students' answers to statements about science. The p-values represent a test of variance testing the homogeneity between the groups of classes with different levels of practical science teaching methods.

Statement:	**Practical science groups**								**Anova**
	Group 1		**Group 2**		**Group 3**		**Group 4**		
	M	**s.e**	**M**	**s.e**	**M**	**s.e**	**M**	**S.e**	**p-value**
I like science	2.76	0.02	2.86	0.03	3.00	0.03	2.94	0.04	>0.001
I like to learn about science	2.89	0.03	3.00	0.03	3.11	0.03	3.08	0.04	>0.001
Science is important to everyone	3.08	0.03	3.08	0.04	3.27	0.03	3.25	0.05	>0.001
I want more science lections	1.99	0.03	2.01	0.04	2.12	0.04	2.27	0.06	>0.001
What we learn I science will be useful	3.07	0.03	3.12	0.03	3.29	0.03	3.18	0.05	>0.001
I like to watch science programs on tv	2.51	0.03	2.54	0.04	2.59	0.04	2.61	0.06	=0.234
Science is boring	2.31	0.03	2.22	0.04	2.08	0.03	2.10	0.05	>0.001
I would like to have a job where I can use science	1.90	0.03	1,96	0.04	1.99	0.03	2.15	0.06	>0.001

The difference between the low activity groups (groups 1 and 2) and the high activity groups (groups 3 and 4) is found for most of the single attitude variables (table 2). Only for the statement "I like to watch science programs on TV" we cannot find a significant difference between the groups. When we compare the two high activity groups, we see that the attitude to science differs slightly. The students in classes belonging to group 3 tend to be somewhat more positive to the statement "I like science" and "What we learn in science will become useful". The group 4 students are more positive to the statements "I want more science lessons" and "I would like to have a job where I can use science".

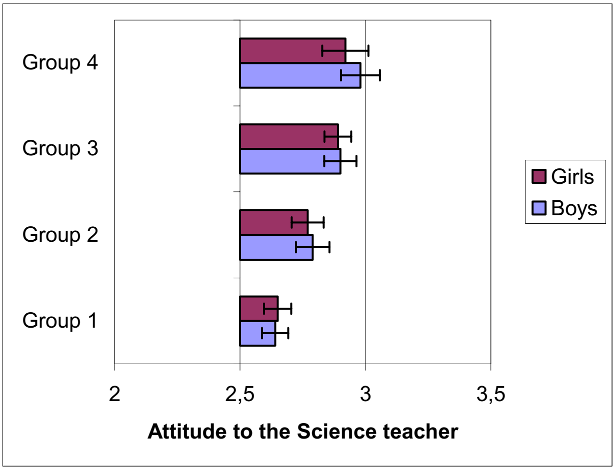

Figure 3. The score of the students' collective "attitude to science teacher" variable. Mean value for each teaching practice group with standard error. Columns to the right represent positive attitude.

Table 3. The mean and standard error for students' answers to statements about science their science teacher. The p-values represent a variance test testing the homogeneity between the groups of classes with different levels of practical science teaching methods.

Statement:	Practical science groups								Anova
	Group 1		Group 2		Group 3		Group 4		
	M	s.e	M	s.e	M	s.e	M	S.e	p-value
The teacher makes the science teaching interesting	2.36	0.03	2.51	0.04	2.65	0.03	2.77	0.05	>0.001
The teacher is only using examples that we can read about in the text book	2.38	0.03	2.30	0.04	2.19	0.04	2.17	0.05	>0.001
The teacher explains things in a way that is easy to understand	2.82	0.03	3.00	0.04	3.13	0.03	3.19	0.05	>0.001
I learn much science by listening to the teacher	2.80	0.03	2.88	0.04	2.94	0.03	2.99	0.05	>0.005

Students' attitude to their science teacher

The teacher plays an important role both when it comes to the way the teaching is organized and choice of teaching methods. Does the difference in "Student-active teaching practice" affect the way the students look upon their teacher?

We presented the students for four statements that were related to how they apprehended their science teacher (table 3). From the scores of these statements we calculated a collective variable ("teach-att") expressing the students' attitude to their teacher. The "teach-att" variable has a Cronbach's alpha = 0.70, which expresses a satisfying reliability of the collective variable.

Figure 3 shows a comparison of the mean values of "teach-att" in the four groups of classes. We see that in general the students express a positive attitude to their science teachers in most classes (mean value of "teach-att" > 2.5). We also see that boys and girls have a similar view of their science teacher. But we see that the students in the two groups with high levels of "Student-active teaching practice" express a higher attitude to their teacher than the students in the two groups of low levels of "Student-active teaching practice". This is the case both when it comes to how interesting they find the subject, how well they understand what the teacher is teaching and how much they think they learn from the teacher (table 3).

There is also a difference between the two groups of classes with high level of practical teaching methods. In group 4, the group with more use of project work, computers, internet and drama, the students expresses a higher attitude to the teacher than the students in group 3.

"Student-active teaching practice" and performance

We presented the students for a multiple-choice test to assess their performance in science. The test consists of 35 questions, which are chosen to cover a broad range of topics in science. Further, the included questions aim at addressing both theoretical knowledge and everyday experiences.

Looking at the overall results of the test, we see that the boys are scoring slightly better than the girls. Boys give correct answers to 48.5 percent of the questions, compared to 46.6 percent for girls. The difference is statistically significant (independent samples t-test, $p < 0.001$).

Do performance in science relate to "Student-active teaching practice"? When we compare the four different groups of classes, we see only small differences in performance and these are far from statistically significant. If we look at the girls only, we still cannot observe any difference in performance between the girls in the four groups of classes (figure 4). For the boys, we can see a tendency to a slight increase in mean score when we move from group 1 to group 3, but this is not statistically significant. But the boys in classes belonging to group 4 differ from the others. They have a score of correct answers of 45.7 percent, which is significantly lower than the rest of the boys (independent sample t-test, $p < 0.016$). This is the only group where the boys have a lower mean score than the girls have. To sum up, our results indicate that girls are less affected by the teaching methods in science than the boys, and that teaching methods associated with group 4, such as project work, use of computers, drama and role play might have an counteracting effect on boys' learning in science.

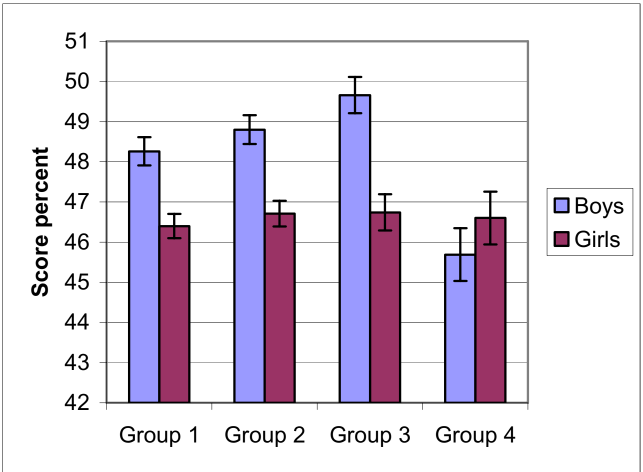

Figure 4. Mean score (in percent) with standard error in the multiple-choice test for boys and girls in the four groups of teaching practice.

Discussion

The use of "Student-active teaching methods" in science has been focused for a long time (e.g. McRobbie, Giddings & Fraser, 1990; Osborne & Collins, 2001). Questions have been raised on the learning outcome of practical teaching methods (Jenkins, 1999; White, 1996). Further, the methods of practical work in science have been debated and undergone a significant change. Traditionally, activities in school science have been dominated by laboratory activities that allowed the students little self-direction in their work. They have followed detailed work descriptions from start to finish which allowed very little room for student's initiative. However, modern science teaching puts emphasis on a higher degree of freedom in student experiments and hands-on activities. The students themselves are given more responsibility to how they should carry out an experiment or investigation in the best way. Further, the range of methods has broadened considerably. New methods to science, like project work, the use of computers and internet and dramatizing in science have provided new opportunities to integrate student activities with the theory of science.

The present study shows that the students themselves want more activities in their science lessons. This is a clear wish from both boys and girls, but the boys express this even stronger than the girls. The gender difference can be explained by the traditional activities in science attracts the boys' interest more than the girls' (Krogh & Thomsen, 2005; Whyte, 1986). Boys tend to be attracted to spectacular phenomena and surprising reactions, while girls are more interested in topics related to human body, pet animals and unexplainable and mystic phenomena (Schreiner, 2006).

It is interesting to see that when we turn to methods that have been more untraditional, at least in Norwegian science education, like project work and drama, the girls are more positive than the boys. This is especially evident when we look at drama as an activity in science teaching. This is one of the most preferred activities among the girls, while the boys are much more reluctant. However, a study by Tveita (1993) has shown that this may be due to lack of experience of drama as a method. Prior to the study, dramatizing the kinetic particle model, girls expressed a more positive attitude to drama. But after the students had finished the drama project, the boys had become equally positive. We also see from our study (Almendingen, Klepaker & Tveita, 2003) that the use of drama in science is low in Norwegian schools.

The students express less enthusiasm for activities where they play a passive role and where the focus is on theory only. Especially the boys are negative to activities that involve writing. This may be due to difference in reading and writing abilities between boys and girls (Spence, 1995; Swiatek, 2000). Girls on the other hand, seems to be more reluctant to large group activities, they prefer to work in smaller groups. Studies have shown that the boys receive more attention from the teacher in large group activities, and tend to dominate such activities (Kahle, Paarker, Rennie & Riley, 1993; Kelly, 1988).

From this study we observe two main lines of "Student-active teaching practice" in science education in Norwegian schools. The first emphasize the "traditional" activities like excursions, outdoor education, experiments and other kinds of hands-on activities. The second line include more "modern" activities like project work, computers/internet and to some extent, drama. Both lines can be said to partly fulfil the aims in the curriculum which say that the teaching must be designed to invite a broad range of activities (KUF, 1999). However, the majority of the classes experience a science teaching where the use of practical methods, both "traditional" and "modern" are low.

The curriculum stated that the students should develop knowledge about, skills in, and attitudes to all aspects of the subject (KUF, 1999). We see that developing positive attitudes to science was not only regarded as a means to improve the students' knowledge and performance in the subject, but was a major aim itself. Then it is important to use teaching methods that affect the students' attitude in a positive way. This study confirms what have been found in other studies, that involving the student actively and use practical learning methods significantly improves the students' attitude to science. This is the case for both boys and girls. It is interesting to see that the attitude does not differ much between the classes with focus on "traditional" activities and "modern" activities. This may indicate that the improved attitude is related more to variation in methods and less lecturing, rather than any specific practical activity.

Is the kind of learning activities in science important for the students' perceptions of their teacher? We see that it is an evident difference between the low and high activity classes. The students state that teachers who allow more practical activities make science more interesting and the students also feel that they learn more from these teachers. This result is similar to what Palmer (1999) found among Australian students when he asked them to describe their "best" science teachers. The attribute that was most frequently put forward was hands-on activities. Eichinger (1997) received similar answers from US college students. The teachers themselves also state that practical activities are what the students like most in science. Further, in a previous study we found that the difference between teachers who are satisfied with their science teaching and those who are not are mainly the amount of practical activities and the ability to apply a variety of teaching methods (Klepaker, Almendingen & Tveita, 2002). This is consistent with the present results; how content the teacher is with his teaching is closely related to the feedback he gets from his students.

A common objection from teachers to practical learning activities has been that they are time consuming and that the learning output has been questioned. The students may have fun, but they do not learn anything from it. In this study, with an interesting exception for the boys in the classes with high level of "modern" activities, we have not found any significant difference in performance between classes with different levels of student-active teaching. In other studies, like Wenglinsky (2000), it has been found that students who conduct frequent hands-on activities perform better in national tests.

The low score of the boys in the "modern" activity group is puzzling, but we suggest two possible explanations. First, these classes use computers frequently. It may be that especially the boys become more fascinated by the tools and methods (i.e. computers and soft ware) than the content (science). They become good in handling the computers, but learn less science. The other explanation is based on the obvious fact that a multiple choice test cannot measure all aspects of science knowledge and definitely not all skills the students may have acquired. On the contrary, the students that are most used to solving written tasks using the textbook may have an advantage in this kind of tests. The result could have been different, and in favour of the students that have experienced an activity based science if we had tested practical skills, ability to reason over outcome of experiments or ability to seek, process and mediate information.

References

Aikenhead, G., S. (2004). The Humanistic and Cultural Aspects of Science & Technology Education. *Proceedings of 11th IOSTE Symposium*, Lublin, Poland

Almendingen, S., Klepaker, T. & Tveita, J. (2003). *Tenke det, ønske det, ville det med, men gjøre det...? En evaluering av natur- og miljøfag etter Reform 97.* Nesna:, skriftserien til Høgskolen i Nesna, nr 52.

Bailey, M. S. (1996). Shortchanging girls and boys: Gender equity in education. *Educational Leadership 53*, 75-80.

Baird, J. R., & Penna, C. (1992). Survey Research. In J. R. Baird (Ed.),*Shared adventure: A view of quality teaching and learning* (Second Report of the Teaching and Learning Science in Schools Project) (185–274). Victoria: Monash University.

Eichinger, J. (1997). Successful students' conceptions of secondary school science. *School Science and Mathematics, 97*(3), 122-131.

Gilbert, C. M. (1996). Attributional patterns and perceptions of math and science among fifth-grade through seventh-grade girls and boys. *Sex Roles, 35*, 489-507.

Jenkins, E. W. (1999) Practical Work in School Science – some questions to be answered. In Leach, J. & Paulsen, A.C. (Eds.) *Practical Work in Science Education. Recent Research Studies.* (17-32). Fredriksberg: Roskilde University Press

Johnston, J., D. (2003). Active Learning and Preservice Teachers Attitudinal Change. Paper presented at the annual meting of the MSERA, Biloxi, November 6, 2003.

Kahle, J. B., Paarker, L. H., Rennie, L. J. and Riley, D. (1993). Gender Differences in Science Education: Building a Model. *Educational Psychologist, 28*(4), 379-404.

Kelly, A. (1988). Gender differences in teacher-pupil interactions: a meta-analytical review. *Research in Education 39*, 1-23.

Klepaker, T., Almendingen, S. & Tveita, J. (2002). Satisfied or dissatisfied with their science teaching? What distinguishes between teachers who evaluate their teaching positively from those who evaluate it negatively? *Proceedings of 10th IOSTE Symposium*, Foz do Iguacu, Parana, Brasil.

Lie S, Kjærnsli, M. & Brekke, G. (1997). *Hva i all verden skjer i realfagene? Internasjonalt lys på trettenåringers kunnskaper, holdninger og undervisning i norsk skole.* Oslo: ILS, Universitetet i Oslo.

Krogh, L., B. & Thomsen, P., V. (2005). Studying students' attitudes towards science from a cultural perspective but with a quantitative methodology: Border crossing into the physics classroom. *International Journal of Science Education, 27*(3), 281-302

KUF (1999). The Curriculum for the 10-year compulsory school in Norway.

Lødding, B. (2004). Hvor ble realistene av? Om valg av studieretning og prestasjoner i videregående opplæring blant elever med gode karakterer i realfag fra ungdomsskolen. *NIFU skriftserie 11*/2004.

Miller, J. D. (1989). *Scientific literacy.* Paper presented at the Annual Meeting of the American Association for the Advancement of Science. San Fransisco, CA.

McRobbie, C. J., Giddings, G. J., & Fraser, B. J. (1990). Research into the environment of science laboratory classes in Australian schools. *Research in Science Education, 20*, 200-209.

Nergård, T. (2003). "Jenter liker ikke naturfag, i hvertfall ikke fysikk og kjemi." I D. Jorde, & B. Bungum (Red.) *Naturfagdidaktikk. Perspektiver, forskning, utvikling.* Oslo: Gyldendal Akademisk.

Osborne, J. & Collins, S. (2001). Pupil's views of the role and value of the science curriculum: a focus-group study. *International Journal of Science Education*, *23*(5), 441-467.

Osborne, J., Simon, S. & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049-1079.

Palmer, D. (1999). Students' perception of high quality science teaching. *Australian Science Teachers Journal, 45*(3), 41-44.

Schreiner, C. (2006). *Exploring a ROSE-garden: Norwegian youth's orientations towards science – seen as signs of late modern identities*. Thesis submitted for the degree of Doctor Scientarium. Faculty of Education. University of Oslo.

Spence, D. J. (1995). *Explicit Science Reading Instruction in Grade 7: Metacognitive Awareness, Metacognitive Self-Management and Science Reading Comprehension.* Annual Meeting of the National Association for Research in Science Teaching.

Speering, W. & Rennie, L. (1996) Students' perceptions about science: The impact of transition from primary to secondary school. *Research in Science Education, 26*(3), 283-298

Swiatek, M. A., Lupkowski-Shoplik, A. and O'Donoghue, C. C. (2000). Gender differences in Above-Level EXPLORE Scores of Gifted Third through Sixth Graders. *Journal of Educational Psychology, 92*(4), 18-23.

Tveita, J. (1993). *Helping Middle School Students to learn the Kinetic Particle Model.* J. D. Novak (Ed.) Proceedings from the Third International seminar on Misconceptions and Educational Strategies in Science and Mathematics. Cornell University, Ithaca.

Wenglinsky, H. (2000). *How Teaching Matters. Bringing the Classroom Back Into Discussion of Teacher Quality.* Educational Testing Service.
White, R. T. (1996) The link between the laboratory and learning. *International Journal of Science Education 18*(7) 761-774
Whyte, J. (1986). *Girls into science and technology*. London: Routledge & Kegan Paul.