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ESTONIAN TEACHERS' READINESS TO PROMOTE INQUIRY SKILLS AMONG STUDENTS

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Abstract. *Researchers in developed countries have reported that the students" skills related to inquiry are poor and the teachers do not adequately teach inquiry skills without the involvement of special interventions. Little is known about inquiry teaching and science teachers" attitudes in post socialist countries, for example the Baltic republics. This study aimed to explore the current situation in Estonian science classes and interpret teachers" development toward inquiry based experimental teaching during an 8-month intervention. The results from this study showed that characteristics exhibited by teachers as a result of their development can be described in 3 categories with only one category showing a readiness to promote inquiry skills and that the changes in students' acquisition of process skills were dependent on teachers' development.*

Key words: *inquiry, process skills, experimental work, teachers" development, authentic teaching*.

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Introduction

"Inquiry" has been a perennial and central term in the rhetoric of past and present science education reforms in the USA and others developed countries. During the second half of the twentieth century, "good science teaching and student learning" has come to be distinctly and increasingly associated with the term "inquiry" (Anderson, 2002; NRC, 2000). An international comparative study (Abd-El-Khalick *et.al*., 2004) documents inquiry as a worldwide phenomenon, where approaches range from fairly straightforward (unproblematic or unproblematized) and somewhat structured laboratory-activities-with-a-twist, to a divergent approach for generating evidence-based answers to open-ended question. Research has shown that teaching science by means of inquiry plays a strong role in enabling students to acquire cognitive knowledge and skills and it increases the interest and positive attitude towards science (Meade, 2002; Chinn & Malhotra, 2002; Chiapetta, 1997).

Little attempt towards promoting inquiry approaches linked to implementation of curricula has been made in Post Soviet countries (Jonane, 2005; Janiuk, 2003). However a few studies have shown that teachers in these countries are not comfortable using inquiry-based teaching and tend to invest too little time to investigative experimental teaching (Keirāns, 2002).

Inquiry teaching

It is possible to describe inquiry issues from different aspects. Abd-El-Khalick *et al*. (2004) emphasise two aspect of inquiry: *inquiry as a means* and *inquiry as an ends*. Inquiry as a means refers to inquiry as an instructional approach, intended to help students develop understanding of science content and processes. Inquiry as an end refers to inquiry as an instructional

outcome to be learned. In this study we link inquiry-based teaching to the first description. According to the USA National Science Education Standards (NRC, 2000) inquiry teaching and learning may involve a number of process skills such as making observations;

- posing questions,
- examining books and other sources of information to see what is already known;
- planning investigations;
- reviewing what is already known in the light of experimental evidence;
- using tools to gather, analyse, and interpret data;
- proposing answers, explanations, and predictions, and
- communicating the results.

The development of students' process skills, which leads to the enhancement of cognitive abilities, seen as important for understanding the real world and formation of attitudes (for example curiosity, interest, objectivity), may be achieved through carrying out inquiry-based experimental work (Meade, 2002).

In the current study, the main emphasis is placed on the development of observation and planning skills. Observation is seen as an important process skill, which provides an opportunity to communicate verbally or in writing. The emphasis is on "meaningful" observation, finding differences and similarities, making comparisons between objects or phenomena and being able to infer based on one's observations.

The importance of planning skills underlies key cognitive developments in science teaching. It allows scientific understanding to be linked to application. Planning provides a basis for consecutive inquiry processes. Research has shown that by using "cookbook recipe" experimental work, students do not develop these skills (Rollnick *et.al*., 2001; Hart *et. al*., 2000).

Experimental work has been considered an indisputable part of the teaching of science subjects in most countries of the world, especially in chemistry (Hofstein, 2004; Rollnick et.al., 2001; Hofstein & Lunetta, 1982). During the last decades the goal, content and nature of experimental work have changed. The goal of experimental work is not only to illustrate the theory, achieve the manipulative skills or gain conceptual knowledge.

It is essential when planning studies, to pay attention to barriers that occur in carrying out inquiry-based teaching in science classes. These barriers are clustered in two dimensions: the dimension related to teachers when carrying out inquiry (Anderson, 2002) and the dimension related to students (Llewellyn, 2002). The former includes the teacher's lack of pedagogical content knowledge and teacher appreciation of the goals of science education, whereas the latter covers the students' lack of discipline during science class and lack of appreciation of the value of such non-content learning.

The role of the teacher

It has frequently been emphasized that a critical element for carrying out inquiry is the teacher (Millar, 2005; Windschitl, 2004; Meade, 2002). Can all teachers successfully teach using inquiry approaches, or is it only possible for exceptional teachers?

Research shows that teachers must change their knowledge, beliefs and skills to adopt inquiry-based approaches (Bell *et. al*., 2003; Davis (2003). Nevertheless, it is hard for teachers, to start using student-centred approaches, which is one of the characteristics of inquiry teaching and therefore need support for this change (Abd-El-Khalik *et al.,* 2004). Teachers indicate that professional development reduces their anxiety and increases their confidence to use student-centred approaches. Unfortunately, there are more published articles about collective intervention type of professional development with goals to change the teachers and improve their skills (Shedletzky & Zion, 2005; Bell *et.al*., 2003; Davis, 2003) and less about case studies of the change process in action (Hart *et.al*., 2000). Changing a teacher's teaching style is complicated and using new teaching materials alone cannot attain an approach new to teachers: the teachers are likely

to simply adapt these to their current teaching style (Davis, 2003; Posnanski, 2002, Rannikmäe, 2001). In order to achieve an effective change, it is recommended that teachers are actively involved in the process of developing the teaching materials (van Zee *et al*., 2003; Rannikmäe, 1998).

In this study, the aim is to examine factors, which help to decide whether science teachers are ready to undertake inquiry-based experimental work and to plan and execute an intervention program to help teachers to gain ownership in teaching approaches that promote inquiry teaching among the students.

The following research questions were put forward:

1. Are Estonian teachers ready to conduct inquiry-based experimental work with their students?
2. Is it possible to plan and execute an intervention program to help teachers to gain ownership in teaching approaches that promote inquiry teaching?
3. What barriers do the Estonian teachers meet in conducting inquiry teaching in science class?
4. Will teachers' change influence students' achievement of inquiry skills?

Methodology of Research

Participants

To answer the research questions, a small research study was carried out. The participants were 10 chemistry teachers from Tartu and its neighbourhood and their students (age a range15-16) from the 9^{th} grade (N=320). All teachers had recently passed an in-service- program in micro chemical experimentation and were thus expected to be at the same level in using experimental teaching methods. All teachers were chemistry graduates from a University during the Soviet time and had been working as chemistry teachers for more than 10 years. All teachers were highly motivated volunteers.

Plan

The study included 3 interrelated stages carried out during 2001/2002:

1. Describing and mapping the pre-intervention situation by means of teachers' pre-questionnaires and students' pre-tests. Thus determining the teacher's readiness to teach inquiry based experimental work among the students and planning the structure of in-service intervention programme for teachers.
2. Running the eight-month intervention programme for teachers, involving theoretical ideas related to well-founded methods of inquiry-based practical work, trying out the new approaches at school, assessing the outcomes and analysing experiences
3. Describing and mapping the post-intervention situation by means of teachers' post-questionnaires and students' post-tests. Thus determing the teachers' professional development and relating this with students' achievement.

In order to plan a successful teachers' intervention programme, data characterising the present situation in the school was obtained. The first stage of the study thus gave an opportunity to find out the domains where the teachers needed support.

During the intervention programme, a series of 6 sessions were conducted each highlighting a different aspect of student inquiry. A teachers' pre-intervention questionnaire was administered in the first session and based on outcomes, the content of the sessions was determined. Throughout the sessions, attention was paid to illustrating inquiry-based practical work and the studying of

examples of guidelines for inquiry-based experimental work. The second and third sessions involved discussion and analysis of instructional guidelines composed by researchers and teachers, and their experiences in testing and using these. As homework, teachers were asked to compose their own instructional guidelines for an inquiry based experimental work in 9th grade-chemistry. Subsequently, each teacher was given an additional 10 researcher-composed instructions so that they had sufficient materials to try out in the classroom setting and develop students' process skills. The last two sessions included the analysis and evaluation of the experiences of inquiry based experimental work in chemistry, the instructions given for assessment and validation of teacher results.

Changes in students' achievement, which were taken to reflect teacher professional development, were measured. The collection and analysis of this data formed the third stage of the study.

Instruments

Three types of instruments were used:

A. Questionnaires for the measurement of the teacher's self-evaluation of inquiry teaching skills were applied in the first and second stages of the study. The instrument was selected from the Instrument Package & User's Guide (1997) of the Iowa Chautauqua Program (ICP), adapted and translated into Estonian, and used as the pre- and post-intervention questionnaire, because it was directly related to the collection of information for designing the intervention programme and for the determination of the teachers' readiness to teach inquiry skills. To increase the validity of the translation, two independent interpreters were involved.

B. Semi structured interviews, to validate answers to the questionnaires, were used in the first and second stages of the study.

The interviews used the following divergent questions:

- What do you think about instructional guidelines for inquiry-based experimental work
- What do you think about instructional guidelines for assessment?
- Which problems did you experience in carrying out experimental work?

C. Pre- and post-tests of students were used for the first and third stages of the study to determine change in students' process skills. This change was determined on the basis of 10 chemistry lessons, in which inquiry-based experimental work was undertaken using the instructions composed by the author and chemistry teachers during the in-service training course. The students were assessed according to the instructions for assessment, which were completed by the teachers.

The changes in outcomes were investigated by quantitative research methods. Observation skills were tested in the pre-test by observing a burning candle and in the post-test by observing the dissolving of potassium permanganate crystals. Planning skills were tested, in both pre-test and post-test by asking students to draw experimental equipment for producing and collecting hydrogen in the laboratory.

Results of Research

The pre-intervention situation

The results obtained by administering the questionnaires were used for data analysis. The questionnaire used a 5-point Likert type scale and included 31 questions for teachers to evaluate their work. 8 domains were found:

1. Shared control (involving students in planning inquiry-activities),
2. Teacher-centred (teacher organizing practical activities),
3. Directing students to observe.

4. Directing students to plan experiments to test a hypothesis.
5. Directing students to analyse and interpret the results of experiments.
6. Directing students to evaluate experiments and their own actions.
7. Popularising science through personal actions of students.
8. Popularising science through whole-class actions outside science classes.

Each domain included 3-5 questions. The means for each domain were found. If these exceeded 3 (scale's mean), then the evaluation of teacher's opinions in that domain was considered to be positive. A teachers' positive opinion was taken as a basis for readiness to organize inquiry based experimental work. A mean value below 3 indicated a negative teacher's opinion. The pre-questionnaire data show a *teacher-centred domination* when teachers carried out experimental work (mean of teachers' opinion 4, 4 on a 5 point scale).

Table 1. Comparison of teachers' opinion based on responses to pre-and post-questionnaires.

Mean Domain of teachers' (N=10) opinions	1	2	3	4	5	6	7	8
In pre-questionnaire	2.9	4.4	3.4	2.2	3.1	2.9	1.9	2.1
ST DEV	0.48	0.52	0.52	0.32	0.81	0.69	0.52	0.60
In post-questionnaire	3.2	4.3	3.9	2.8	3.7	3.2	2.1	2.3
ST DEV	0.85	0.99	0.85	1.22	0.85	0.99	0.69	0.73

The data tended to indicate that teachers are not yet willing and ready to carry out inquiry-based experimental work. When asked about undertaking inquiry-based practical work, the teachers referred to their use of 2 of the 8 areas indicated by NRC (2000) only: organizing the observations and analysing and interpreting the results.

The 8-month teacher intervention programme

The outcomes from an 8-month-teacher intervention programme are shown in the table 2. The data illustrates the actions of the 10 teachers during the sessions. These actions can be grouped as individual (in the table identified as I) and collaborative (C). The collaborative group of actions gave opportunities to shape teachers' ownership of the nature of inquiry during the interaction. In the table, a symbol (+) indicates the teacher took part in the session and undertook the homework. Their absence is marked with the symbol (-). When the teacher composed more than one set of instructions, this is reflected by the symbol "++".

Table 2. The actions by teachers during the intervention programme

Action / Teacher No	1	2	3	4	5	6	7	8	9	10
Participating in the Introductory session (I).	+	+	+	+	+	+	+	+	+	+
Evaluating the inquiry scheme (C).	+	-	+	+	+	-	-	+	+	+
Undertaking an analysis of inquiry teaching (C).	+	-	-	+	+	-	-	+	+	+

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Action \ Teacher No	1	2	3	4	5	6	7	8	9	10
Composing inquiry-based teaching instructions (I).	+	-	++	+	++	-	-	+	-	+
Trying out inquiry-based experimental work (I).	+	+	+	+	+	+	+	+	+	+
Evaluating the outcomes of the experimental work (C).	+	-	+	-	+	-	-	-	+	+
Development of an assessment scheme for inquiry-based experimental work (C).	+	-	-	+	+	-	-	+	-	+
Implementing instructions for assessment (I).	+	-	-	+	+	-	-	-	+	+
Evaluation of the assessment instructions (I).	+	-	+	-	+	-	-	+	-	+
Total number of actions undertaken by teachers.	9	2	7	7	10	2	2	7	6	9
Students' achievement (change in process skills between pre and post test).	**0.26**	**0.20**	**0.36**	**0.25**	**0.37**	**0.16**	**0.18**	**0.24**	**0.27**	**0.32**

The total number and the quality of actions undertaken characterize the development of the teachers during the sessions. Table 2 shows that all teachers took part in the introduction session and tried out the inquiry-based experimental work using instructions handed out during the session. In some sessions, teachers were absent and therefore they had no opportunity to interact with other teachers and to learn about their experiences. Some teachers put much effort in the homework (composing, testing and evaluating the inquiry-based instructions and assessment instructions) while others did not.

The post-intervention situation

The post-intervention questionnaire data show that *the teacher-centred domination* when carrying out experimental work *had not changed* (Table 1).

However, the willingness and readiness of teachers to organize inquiry-based experimental work was more appropriately expressed in four areas: directing students to observe, directing students to analyse and interpret the results, shared control, and evaluating the experience and one's own actions. *Thus the mean opinion of the teachers' has changed,* compared with the responses from the pre-questionnaires.

Teacher interviews

The individual interviews with teachers revealed that:

- The teachers gave a positive evaluation of inquiry approaches
  "*in this way it is more interesting to teach and learn*, *this makes students think and reason"*
  (a similar tendency was noted by 5 additional teachers).
- The teachers found that the new instructions for assessment of inquiry-based experimental work enables a more objective evaluation

"it is easier and more fair to assess this way; *we discussed the presentation of all teams'*

results together and evaluated them collectively"
(mentioned by 4 teachers).

- Difficulties with applying inquiry-based experimental work are described as follows:
  the functional literacy of students is poor:
  "the students read only the first row of instruction and start to work"
  (a similar tendency was noted by 3 additional teachers);
- Perceived overloaded curriculum:
  "I do not have enough time to spend two lessons during the semester on inquiry-based experimental work"
  (a similar tendency was noted by 5 teachers)
- Large number of students in chemistry class
  "*it is not possible, to carry out chemistry experimental work with 30-36 students"*
  (mentioned by 6 teachers).
- The reasons for not using inquiry-based experimental work are that in the examinations, knowledge and process skills, which have been gained through conducting experiments, are not tested
  "*I teach the chemistry needed for exams because teacher effectiveness is evaluated based on students' achievements, i.e. students' results in tests or exams"*
  (a similar tendency was noted by 5 additional teachers)
- The lack of resources
  "*I don't have a chemistry class not to mention reagents"*
  *(*mentioned *by* 2 teachers).
  The data from the pre- and post-questionnaires were validated by these interviews.

Teacher development during the intervention programme

A. Categorising the characteristics exhibited by the teachers

The categorising was based on

a) interaction during the sessions, distinguishing between passive interaction related to sessions attended and active interaction related to sessions by participating in discussions;
b) actions connected with composing and evaluating instructions for inquiry-based experimental work and assessment;
c) the using of new methods in chemistry classes and analysing these results.

Table 3. Summarising the categorising of the teachers' development.

Category	Characteristic	Influence on students' achievement
A (characteristics shown by teachers 1, 5, 10)	a) participated actively in discussions during the sessions, analysed their own and others' opinions and evaluated work done by themselves, b) composed the instructions for experimental work and assessment, tested, modified and discussed the instructions and gave feedback, c) showed readiness to organize inquiry-based experimental work during the intervention programme, d) teacher-centralism decreased,	Development of students' process skills was statistically significant
B (characteristics shown by teachers 3, 4, 8, 9)	a) took part passively in discussions during the sessions, did not give their own opinions during the sessions, seldom presented observation notes on their inquiry-based study in their classroom,	Students' process skills developed, but they were not statistically significant

Category	Characteristic	Influence on students' achievement
	b) composed a few instructions for inquiry-based experimental work, but preferred to test instructions of others and did not give feedback, used assessment instructions composed by others, c) showed partial readiness in at least 6-8 domains, which varied depending on the teacher, d) teacher-centralism did not decrease	
C (characteristics shown by teachers 2, 6, 7)	a) interaction between the teachers was missing, such teachers interacted mostly with the organizer of the sessions, b) did not compose instructions for inquiry-based experimental work, but used instructions composed and tested by others, c) did not show readiness to organize inquiry-based experimental work, d) teacher-centralism did not decrease,	Development of students' process skills was significant only in one domain (planning skill)

B. Grouping the teachers

The development of teachers was based of their willingness and readiness to organize inquiry-based experimental work. The teachers who's opinions in the 5-8 domains, (based on the post-questionnaire), was summarised by a mean higher than 3 and who's total number of actions during the intervention programme was over 2 (table 1), were considered to be ready to undertake inquiry-based experimental work. There were 7 such teachers and these formed the *group of "inquiry-based ready"* teachers.

The *"not-ready" group* was formed by 3 teachers who were considered not to have achieved the readiness for organizing inquiry-based experimental work (opinion in most domains led to a mean rating below 3 and the number of actions did not exceed two (table 1). As category B was also taken as being indicative of teacher readiness (at least partially), the readiness group was formed from categories A and B, and the non-readiness group formed category C.

Willingness and readiness to organize inquiry-based experimental work was shown by the teachers who wished to change (group "ready to introduce inquiry-based experiment work").

Unfortunately, the data from the questionnaires showed the predominance of *teacher-centred approaches* in carrying out experimental work. Teacher-centred approaches in science classrooms indicate that the teachers feel that this is the most appropriate way for them to use their expertise when guiding student learning – they trust the transmission mode of teaching too much. On the basis of the interviews carried out with the teachers, explanations for the preference of the teacher-centred domination were:

- large number of students in chemistry class (mentioned by 6 teachers),
- the perceived large content of the curriculum and little time available for experimental work (mentioned by 5 teachers) and
- the lack of coverage of process skills in the examinations (mentioned by 5 teachers).

It is not surprising, therefore, that teachers decide which experiments students undertake in the science class and prescribe the other students' actions. Most teachers rarely allow student involvement in activities such as planning and carrying out experiments. This result agrees with statements about the need for teachers' intervention to achieve student-centred teaching (Abd-El-Khalick *et al*., 2004).

Research has shown that teachers' development is effectively enhanced by means of collective actions (Bell *et.al*., 2003; Davis, 2003) or individual actions (Hart *et.al*., 2000). This study points out that both – collaborative and individual action - are needed (table 2). As emphasized by Rannikmäe (1998),

it is also very important that the teachers not only use, but also compose the instructions used in class. This is supported by the categories of descriptors of teachers in this study (tables 3, 4 and 5).

The investigation of Estonian teachers shows that changing a teacher's teaching style is a complex matter. Rannikmäe (2001) found that during another 8-month-interaction programme, teachers were willing to use new materials, but still continued teaching in traditional ways. This tendency has been evident also in this research. All teachers used instructions, which guided students to design experiments, but only a few teachers (from category A), valued students active learning. While teachers changed in the intervention programme, teachers, especially those from categories B and C, still did not appreciate the importance of directing students to evaluate their experiment results and their own work. Despite data by Israeli researchers (Mamlok, 1998), which showed teacher-centeredness decreased as a result of the intervention process, this research showed that teacher-centeredness remained high after the intervention (it decreased for the teachers estimated to have achieved readiness, but this was not statistically significant). The results of the intervention programme are similar to those of Rannikmäe (2001) who demonstrated that not all teachers internalise proposed teaching approaches during an intervention programme. In this study, the descriptors of the highest category were only exhibited by one third of the teachers. Furthermore, it is advantageous to measure the long-term impact. This is because research by Rannikmäe (2001), related to ownership of teaching approaches in the STL-domain, demonstrated that, in the course of time, some teachers who had reached the ownership stage, returned to a lower level.

C. Students' results

The acquisition of observation skills

The results of the students' pre-test demonstrated the poor process skills of students: meaningful observations were made on the burning of the candle by only ~5% of students. The results of the students' pre-test were similar to those reported by Sandall (2001) where the stumbling block was also the teaching of meaningful observation skills.

The results of this analysis are shown in tables 4 and 5. The maximum value was taken to be 1.

Table 4. Comparison of mean scores of student meaningful observations with the different teacher categories.

Category of characteristics associated with teachers	Student mean of observations in the pre-test	Student mean of observations in the post-test	Difference in means (Change)
A	0.22	0.33	+0.11**
B	0.19	0.23	+0.06
C	0.20	0.22	+0.02

The data in table 4 shows that the change of students' meaningful observation mean scores was most marked for category A teachers. Because of the reciprocal interaction, the conclusion can be drawn that these two variables are dependent on each other. The change in meaningful observation skill level of students, of category A teachers, was statistically significant.

The data relating the change of mean score for meaningful observation skills of students and the teachers in categories B and C were inconclusive. The change of mean score was not significant.

The acquisition of planning skills

Table 5 illustrates a comparison of the mean scores for students taking the pre- and post- planning test with the different teacher categories. The maximum score for both the pre- and post- test was 5

Table 5. Comparison of the mean scores for students' planning skills with the different teacher categories.

Category of characteristics associated with teachers	Mean of writing procedures logically in the pre-test	Mean of writing procedures logically in the post-test	Change
A	1.22	1.84	+0.62**
B	1.30	1.62	+0.32
C	0.82	1.40	+0.58**

The data in table 5 show that the planning skills of students, taught by teachers of the group "ready" (category A and B teachers), are at a relatively high level in the pre-intervention situation. The difference in the changes of their students' results supports the notion that teachers' willingness to change is likely to be very important for improving students' process skills, (table 3). The most surprising result from this table is the big change in the mean of students' planning skills for students related to teachers exhibiting characteristics associated with category C. Students of category C teachers, as a group, were the weakest in planning skills both at the beginning and at the end of the study. And responses from category C teachers in the questionnaires and interviews indicate that all used teacher-centred approaches and did not use inquiry approaches in their lessons. It is unlikely that the achieved change in students' skills is caused by the altered attitudes and teaching methods of the teacher and it seems to be caused by the teacher promoting the concept of planning through didactic approaches and perhaps by the use of materials shared in the sessions.

The data indicates that the development of students' planning skills is enhanced by teacher evolution. Teachers who wished to change and are willing to work for attaining the highest level of competency in carrying out inquiry teaching (by including experimental work) were able to significantly develop students' planning skills. Table 5 illustrates this conclusion.

The pre- and post-test data from students show also that there is a need for analyses of the actual classroom environment to decide how didactical approaches, besides inquiry intervention, used by teacher influence students' change. Nevertheless, the study illustrates that there is an association between teacher readiness to undertake inquiry teaching and student gains in acquiring process skills.

Conclusions

The following conclusions can be drawn from the study:

- Without intervention, Estonian teachers are generally not ready to conduct inquiry-based practical work.
- It is possible to change teachers through a theoretically justified intervention, which gives ownership of the nature of inquiry. During such an intervention teachers' opinions can change and the competency to carry out inquiry-based practical work can increase.
- It is possible to determine objective and subjective barriers, which influence inquiry teaching in the science class. Teachers preferred to emphasise the objective factors such as: overloaded curriculum, large number of students in chemistry class and the fact that, in examinations, the knowledge and skills which have been gained through experimental work are not tested.
- Students' achievement is sensitive to teacher development. Development of students' process skills depended on the teachers' evolution towards inquiry approaches in the teaching of experimental work. Only teachers who wished to change and were willing to work for attaining the highest level of competency were able to significantly develop students' process skills.

- An important step towards improvement of students' process skills is the development and publishing of instructional materials for inquiry-based experimental work and assessment.

As the teachers' professional competency developed through teacher-teacher interaction, it is recommended to create conditions to promote science teachers collaborative seminars at schools for the analysis of best practice in science teaching.

The practical importance of this study is the composing of inquiry-based experimental work and instructions by teachers to assess students during the intervention process. It has been important to work out the instructions for assessment that evaluates inquiry-based experimental work as a process.

A limitation of the study is related to the sampling of teachers. Therefore the outcomes are applicable among the teachers having educational background and teaching experiences similar to the teachers in the sample, high motivation to learn about new trends in science education.

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Резюме

ГОТОВНОСТЬ ЭСТОНСКИХ ПРЕПОДАВАТЕЛЕЙ РАЗВИВАТЬ ИССЛЕДОВАТЕЛЬСКИЕ НАВЫКИ УЧАЩИХСЯ

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Исследовательский подход в естествознании отражен в государственных учебных программах многих стран. В то же время исследования, проведённые учеными этих стран, показывают, что при применении такого подхода возникают некоторые проблемы.

В данной статье проанализирована ситуация в школах Эстонии как с точки зрения преподавателей так и с точки зрения учащихся. Для изменения положения был проведен восьмимесячный курс обучения преподавателей, в процессе которого отслеживался уровень профессиональной компетентности учителей. Происшедшие изменения уровня профессиональной компетентности преподавателей сопоставлялись с уровнем исследовательских навыков учащихся в контексте экспериментальных исследовательских работ по химии.

Результаты исследований показали, что развитие уровня профессиональной компетенции преподавателей возможно описать по 3 категориям. Только преподаватели высшей категории были готовы организовать экспериментальные исследовательские работы по химии. Только у тех преподавателей, которые были готовы к организации эксперементальных исследовательских работ и желали измениться сами, уровень исследовательских навыков обучаемых учащихся претерпел значительные статистически значимые изменения.

Ключевые слова: исследование, исследовательские навыки учащихся, экспериментальные работы по химии, уровень профессиональной компетентности преподавателей.

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