LATVIAN SCIENCE TEACHER EXPERIENCE IN LEARNING TEAM FOR IMPROVEMENT OF INQUIRY TEACHING PRACTICE

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Abstract

As of 2006, the new secondary education standards requiring student scientific inquiry have been introduced in Latvia. Student scientific inquiry is a new approach for science teachers in Latvia. Based on the initial research carried out in Latvia on teacher progress in implementation of scientific inquiry, it may be said with confidence that scientific inquiry has entered the learning process. However, results of the teacher survey, as well as lesson observations by experts, show the contradiction between the real situation in the classroom and teacher own perceptions, confirming that teacher analytical and reflection skills must be significantly improved to equip teachers for effective organization of scientific inquiry.

In order to be successful in inquiry teaching, teachers have to be immersed in their performance, take part in discussions, exchange opinions, practice, analyze and reflect on their own and their colleagues' learning. When a teacher, presented with a problematic situation in the classroom, is looking for a solution and developing an understanding of what can be done, it may be useful to test ideas through action research. Action research was chosen as a tool for Teacher Continuous Professional Development (CPD) in order to improve their personal inquiry teaching practices and reflection skills. Teacher learning teams for action research aimed at improving individual inquiry teaching practices and reflection skills were first established in Latvia in 2011.

The research poses a question – how does work in teacher learning teams for action research facilitate improvement of inquiry teaching practices and reflection skills? What are the factors that affect teacher work in the learning team for action research?

This article describes formation of the learning team for the inquiry teaching improvement model as learning in a team. It is based on action research and has a positive impact on science teacher skills to organize student scientific inquiry. The research also looks into the factors that affect learning in a team.

Keywords: science teacher, action research, learning team, inquiry teaching, reflection skills.

1 BACKGROUND

Since 2008, new secondary education standards in science and mathematics have been introduced in Latvia. One of the most significant aspects in the new standards is the requirement for student scientific inquiry in the learning process. To ensure the scientific inquiry approach, it is necessary to instruct teachers in appropriate knowledge and skills, which thus far have not been acquired. At the university and in-service training, teachers traditionally acquired only formal knowledge in the form of information transmission.

The development projects "Curriculum Development and In-service Training of Teachers in Science, Mathematics and Technology" (2005-2008) and "Science and Mathematics" (2008-2011), financed with support from the European Union, have provided training courses available for every science teacher to introduce the new learning standards in Latvia. In these courses teachers mostly acquired the knowledge of what scientific inquiry (SI) was. However, the skills to organize inquiry based learning process were introduced very briefly.

Based on the initial research carried out in Latvia on teacher progress in implementation of scientific inquiry and on student progress mastering inquiry skills, we can say with confidence that scientific inquiry has entered the learning process. However, the results of the survey of teachers and students, centralized examination scores in chemistry, as well as expert lesson observations reveal that teachers still need help with many issues [1, 2]. To succeed in organizing scientific inquiry teachers need to improve appropriate student inquiry organization skills as well as their own analyses and

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reflection skills which can be done through the implementation of the new teacher learning model (learning team).

This article will focus on how teachers can benefit from mutual learning and action research to facilitate their inquiry teaching practice.

2 RATIONALE

Implementation of scientific inquiry in the classroom requires new knowledge and skills. Moreover, teachers must change their beliefs about teaching. Therefore teachers should experiment with new ideas in the classroom as well as analyze and reflect about their performance in changing situations.

Reflection can be in action and on action [3]. Effective Teacher Continuous Professional Development (CPD) needs to enable teachers to reflect on and learn about the new practices and how it can evolve or be modified from the existing classroom practice [4].

Scientists believe that teacher reflective thinking and activity must be strongly linked with the following teacher spheres of activity:

- personal sphere (views, attitude, previous experience)
- practical sphere (teacher authentic work in the classroom)
- external sphere (student achievable outcomes and content)
- outcomes sphere (goal and effect) [5].

One way of trying out new ideas in practice is action research, t.i., teaching and learning as a means of increasing knowledge or improving the curriculum. Action research is deliberate, solution-oriented investigation that is group or personally owned and conducted. It is characterized by spiraling cycles of problem identification, systematic data collection, reflection, analysis, data-driven action and, finally, problem redefinition [6]. The key idea of the research of personal professional performance is:

- I, the teacher, am the central person in the research of my activity.
- I ask a question about a real problem and hope to find a solution.
- I start from where I am.
- I try to achieve improvement of the situation [7].

Action research is a way enabling a teacher through his/her personal practical experience, formed through planning, implementing, observing and reflecting, to improve his/her skills of learning leadership, reflection and considering his/her performance in the classroom [8]. Fig.1 and Fig.2 shows performance of a teacher-researcher.

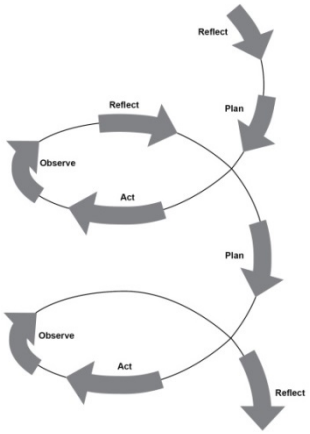

Fig.1. Action research model [6].

Fig.2. Research cycle of teacher professional performance.

Reasons for performing action research fall into the following categories: to promote personal and professional growth, to improve practice, to enhance student learning, and to advance the teaching profession [9], to solve a problem or improve a situation [10].

Action research is based on the following assumptions:

- teachers address problems (research questions) crucial for themselves;
- teacher efficiency grows when they research and evaluate their own performance and then decide what changes are needed;
- teachers help each other through collaboration;
- collaboration among colleagues facilitates professional growth [11].

In order to make changes happen in the classroom, the teacher has to be immersed in his/her performance, take part in discussions, exchange opinions, practice, analyze and reflect on their own and his/her colleagues' learning [12]. In order to facilitate their professional growth, teachers need to be subject to lesson observation and opinion exchange. They need to hear other opinions about their performance. Moreover, teachers must receive quality feedback. Support is crucial for teacher improvement, especially when they are working to implement innovations in the classroom. [13].

Teachers CPD focuses on teacher as learner. Teacher as researcher presents a challenge for CPD experts to develop new teacher learning models based on teacher action research, reflection and collaboration [14].

3 RESEARCH METHODOLOGY

3.1 Research question

The research poses the following questions:

- How does work of teachers in the learning team for action research facilitate improvement of their inquiry teaching practice and reflection?
- What are the factors that affect teacher work in the learning team for action research?

3.2 Participants involved

Two groups of teachers were formed for the purposes of the research:

- **Group A** was formed in study year 2011/2012 with an aim to approbate the developed learning team model. It involved teachers from the innovative experience schools network with previous innovative experience acquired at the National Center of Education;
- **Group B** was formed in study year 2012/2013 with an aim to find how learning in a group affects teachers who had not previously received training in teaching inquiry (in other words, training to find answers to research questions). Description of Group A and B participants is summarized in Table1.

Table1. Description of research participants.

Criteria	**Participants to the research**	
	Group A teachers (N=12)	**Group B teachers** (N=10)
Place of employment	Basic, Secondary school	Basic, Secondary school
Teaches subject	6 Biology, 4 Physics, 2 Chemistry	Chemistry
Grades	Grades 7-12	Grades 8-12
Background	Mg.biol. – 6, Mg.phys. - 4, Mg.chem. - 2	Mg.chem - 9
Teaches second subject	2 teachers	4 teachers
Experience in organizing scientific inquiry before 2011	6 years	None
Experience in analyzing and reflecting on their professional performance, collaborating with others before 2011	6 years	None

Because of the absence of similar experience, learning for the learning team leaders had to be organized in parallel to Group A learning. The training for potential learning team leaders was organized in the spring of 2011 in close cooperation with foreign experts. A group of experts was ready to pilot the new CDP model in summer of 2011. The workshop leaders were acting as learners during the CDP. As a result, research and expert learning methodology was created. The procedure for every workshop was developed by experts and updated before the upcoming workshop during leader meetings held between workshops.

3.3 Data collection and analysis

The efficiency of the learning team performance was analyzed utilizing Dictaphone recordings and transcripts of the sessions, teacher pre and post surveys (teachers evaluated their student scientific inquiry organizing skills as well as group work and action research skills, using the 1-5 level Likert scale). Every teacher followed student improvement by evaluating inquiry tasks during the learning process and by evaluating student inquiry skills at the beginning and end of the school year.

The group leaders made notes after every session. The feedback from participants, observers and group leaders was recorded and discussed. Teachers presented their work, took part in the focus group discussions and in the final survey during the final conference.

3.4 Learning team model for improvement of inquiry teaching

The learning team model for improvement of inquiry teaching was developed in order to find answers to research questions. The learning team model was based on the following criteria:

- to improve inquiry based learning in chemistry,
- to develop chemistry teacher skills to organize student scientific inquiry,
- to facilitate reflexive thinking of chemistry teachers,
- to provide teachers with feedback about their scientific inquiry practice;
- to form a community of chemistry teachers that share their knowledge, experience, and difficulties, and collaborate to resolve a methodological problem encountered in the organization of scientific inquiry.

Fig.3 shows the key structural elements that are at the basis of learning in a group model.

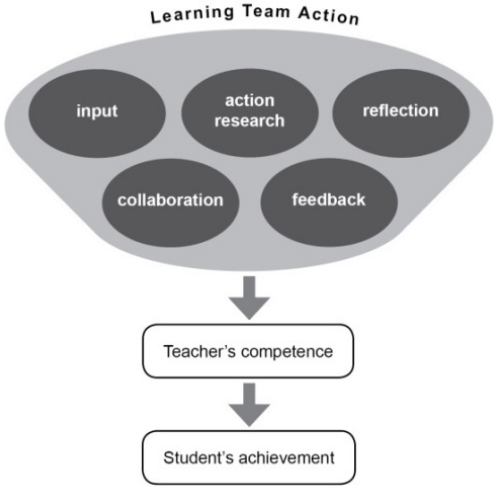

Fig.3. Structural elements of learning team for improvement model of inquiry teaching.

The structure of the learning team model is not linear. As seen in Figure 4, the activity cycle of the learning group and teacher professional performance research develop as a spiral.

The plan of the learning team work consists of monthly working sessions during the school year. Groups A and B have 9 sessions in total. Action research is done in the classroom between sessions and the final conference. Digital communication with the group leader between sessions is available.

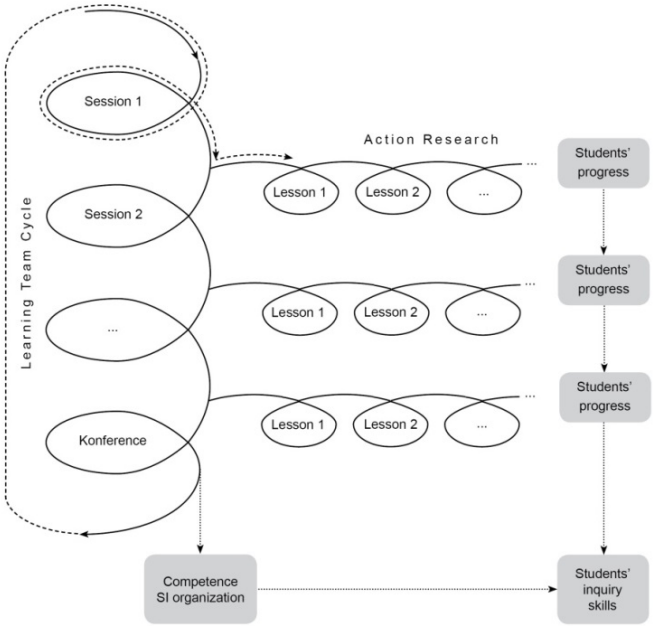

Fig.4. Structure of learning team for improvement model of inquiry.

Every session includes a structured procedure:

- Individual reflection (2 minutes for everybody, no questions or comments)
- Group reflection and discussion about the work done between workshops
- Focused input from the group leader according to teacher needs
- Planning of next steps
- Reflection about the day
- Independent action research – follow up (Fig.5).

Duration of the group session was planned for about 4 hours. However, as there was a greater demand for input regarding organization of student inquiry, Group B teachers worked 5 hours. (see session step "input" questions below). Consequently, Group A teacher program was 36 hours; Group B – 45 hours.

Questions reviewed in the "Input" step of the session:

- What research of personal professional performance means.
- What is inquiry based learning and why it is needed in chemistry lessons.
- What is the difference between traditional laboratory tests and inquiry based laboratory tests.
- Kinds of inquiry based activity.
- Scientific inquiry: problem to be researched, hypothesis, variables, course of activity, equipment and substances, observations and recording, analyses, evaluation and conclusions.
- How to compile student scientific inquiry form.
- Kinds of scientific inquiry tasks.
- How to evaluate research tasks.
- What evidence based learning process is.
- Importance and organization of providing student self-evaluation of their scientific inquiry skills and feedback.
- Scientific inquiry for developing student cognitive skills.
- Development of reading skills in the context of scientific inquiry.

- Use of questions; facilitation of scientific inquiry.

Teacher learning team model for improvement of inquiry teaching is shown in Fig.5.

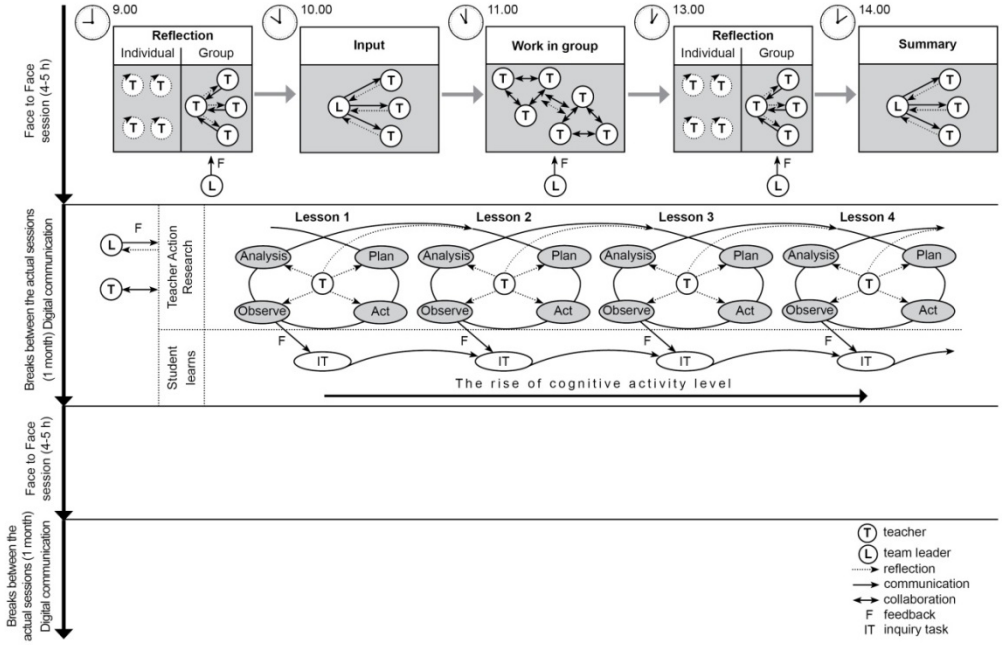

Fig.5. Teacher learning team model for improvement of inquiry teaching.

Every participant formulated an individual inquiry based question. The table 2 shows student scientific inquiry skills that were chosen to improve by teachers. The task samples for students and action research instruments were prepared, regularly discussed and updated.

Table 2. Student scientific inquiry skills that needed improvement chosen by Group B teachers.

Student scientific inquiry skills	Initiating and defining inquiry problem or hypothesis	Experiment planning	Observation and recording outcomes	Data analyses, evaluation, conclusions
Teachers	A, B, C, D	E, F	G	L, M, N

Training in the learning team was held in an informal environment, one session lasted 4 – 5 hours. During breaks between the actual sessions, active communication took place both between the learning team leader and members, and among the members themselves.

4 RESULTS AND DISCUSSION

Approbation of the teacher learning team model for improvement of inquiry teaching with participation of Group A teachers was organized in 2011, and it was successful. Teachers improved their scientific inquiry teaching skills by applying action research. During approbation the group leader acquired experience of leading a learning group and achieving the planned outcomes. The program content for the learning team was updated, for example, allowing Group B teachers to receive more input and allocating additional time to discuss the essence of the research, as well as through teacher collaboration in developing inquiry tasks.

Further on we will observe how Group B teacher learning team for action research facilitated improvement of their inquiry teaching practice and reflection through analysis of teacher skills to organize student scientific inquiry, skills to analyze and reflect on their personal performance (survey results) and student progress in scientific inquiry (teacher report on student progress).

Self-evaluation of their personal professional performance of learning Group B teachers at the beginning and end of the learning period showed teacher awareness of the improvement of all skills necessary for effective organization of student scientific inquiry (see Table 3).

Table 3. Teacher gains from learning team (B group, 2012/2013).

	My gain from learning in a team is	**Average result on a 5 level Likert scale**		
		Before pre	After post	Improvement Δ
1	Understanding of student scientific inquiry	3.4	4.7	1.3
2	Skill to develop exercises of a research nature	2.6	4.3	1.7
3	Skill to manage student scientific inquiry	3.2	4.6	1.4
4	Skill to observe student inquiry skills	3.4	4.6	1.2
5	Skill to organize feedback about the student inquiry	2.9	4.3	1.4
6	Confidence in organizing student scientific inquiry	3.5	4.6	1.1
7	Skill to analyze personal performance	3.2	4.7	1.5
8	Skill to reflect about team work	3.4	4.9	1.5
9	Skill to obtain proof indicative of result improvements	2.3	4.3	2.0
10	Skill to collaborate in a team	3.4	4.9	1.5

Data about self-evaluation of improvement of teacher professional performance (see Table) show that the learning team teachers apply action research to facilitate improvement of their: inquiry teaching skills – improvement fluctuates between 1,2 and 1,7 (positions 1-5 position); analysis and reflection skills – improvement of 1,5 (positions 7-8).

According to teacher self-evaluation, the most significant challenges from participation in the learning group were the following:

- skills to acquire evidence for improvement of outcomes (improvement by 2,0). This may be because this was a new thing that no teacher in Latvia had ever done before;
- teacher skills to develop inquiry tasks (improvement by 1,7). This may be because teachers use tasks compiled by other authors in the classroom. However, participating in the learning team encouraged them to collaborate with other colleagues and jointly develop their own tasks (which is related to the skill of solving problems of methodological character). Consequently, teachers acquired new experience and assurance in this field.

It is interesting to note that upon joining the learning group, teacher self-evaluation about their sense of security in organizing student scientific inquiry was 3,5. Moreover, teacher evaluation of their personal skills of organizing student scientific inquiry, analyzing and reflecting was below 3,5. This created a certain controversy which may be explained with the fact that at the beginning, a number of teachers faced a status quo of: “I don’t know that I don’t know”.

A group leader wrote: *I am glad they understand there is much to learn for them, a lot of things to improve; there was an obvious demonstration of reflection when they shared about their research; they are a team - they communicate and consult each other... they are ready to continue...*

Student progress in scientific inquiry is one of the aspects that demonstrates improvement of teacher inquiry teaching practice. Every session began with teacher reflection on the teacher’s and his/her students’ progress between the sessions. Dictaphone transcripts revealed that in every session teachers pointed to a tendency toward student progress in scientific inquiry. At the beginning of the school year teachers evaluated different kinds of tasks which they used to develop student scientific inquiry skills, thus following the dynamics of every student’s progress. A test was organized at the beginning and end of every school year where students had to solve a specifically developed inquiry based task. The outcomes were compared at the beginning of the year, with a determination made whether students had insufficient or sufficient scientific inquiry skills. By the end of the year, scientific inquiry skills had reached an optimal level* as defined (see Table 4). However, comparison of

outcomes is insufficient to make a valid conclusion about improvement of student scientific inquiry skills. Detailed analyses of every task would be needed, showing what is measured by the teacher's developed task, what is the scope, etc. However, that is not the focus of this research.

Table 4. Improvement of student scientific inquiry skills as a result of teacher personal professional performance research.

Teacher	A	B	C	D	E	F	G	L	M	N
Number of students	21	21	24	24	18	18	24	6	23	21
Average performance at the beginning %	33	45	46	29	44	31	27	33	30	40
Level of acquisition at the beginning	i	s	s	i	s	i	i	i	i	s
Average performance at the end %	74	79	73	67	72	67	69	72	70	78
Level of acquisition at the end	o	o	o	o	o	o	o	o	o	o
Improvement %	41	34	27	38	28	36	42	39	40	38

*Insufficient level (n) - performance 0 to 39%. Sufficient level (p) – performance 40% to 64%. Optimal level (o) - performance 65% to 84%.

Post survey of teachers provided feedback on their performance in the learning team during the learning group sessions and focus group discussion. They shared student scientific inquiry progress and pointed to the changes in learning, in both students and themselves.

5 SOME EXAMPLES FROM TEACHER FEEDBACK

Teacher sense of security organizing student scientific inquiry

- *In the beginning, I was very inexperienced, because I am not teaching at upper-secondary school and I do not encounter research much. Now I can afford more, next year I am planning to continue with other students. I was not certain about my values. Now I feel good, I have no doubt.*

Teacher thinking process, approach to learning, personal gains

- *My thinking was activated, there were many instances that I had never considered more deeply.*
- *That is a good experience. I am a practical person by nature. I can implement a ready-made idea. Now I have to generate and analyze ideas myself.*
- *My approach to teaching-learning changed.*
- *I can tell that I was not inexperienced, but I also learned doing many things for the first time...I have been observing students for 30 years, but for the first time I noticed how the students were working.*

Teacher positive attitude to learning group

- *I am attending the learning team in order to get inspiration, and I got it.*
- *We were discussing a lot in the learning team, listening to every opinion...that was great! For the first time I focused on that.*
- *I did not believe that data input and processing would help me in understanding my class better – who is motivated, who has problems ...In surveys children say that the checklist helps them a lot, and I find it very useful for me, too.*
- *I loved what we did in our team; during our last session children even thanked me.*
- *I feel the support from colleagues to my ideas.*

Teachers on student positive attitude and outcome improvement

- *Student attitude toward the subject has changed – all are working, making efforts, also actively attending consultations after classes.*
- *All students returned their papers with completed analysis and conclusions sections. The conclusions section was thicker. The paper itself becomes more valuable.*

- *Students are waiting for more exercises to come!*
- *The progress is smoother now! It is obvious that students are collaborating. I am glad that the students who were always whining, who once did not understand and did not like the work, now are happy to work, and they like it!*

Factors, found by teachers most helpful in the research of their professional performance and with the greatest impact on the outcome are shown in Table 5. Most teachers mentioned their own individual performance at school, collaboration with the learning team colleagues and the group leader, but mostly – a possibility to think during sessions and discuss important issues.

Table 5. Chemistry teachers on impact of different factors on research of professional performance participating in the learning team.

Most helpful factors in research of my performance	Percent of teachers evaluating the statement with 4 and 5 according to 5 level Likert scale
Support and ideas by other group participants	90
Group leader	96
My individual performance at school	98
Additional literature of interest on the topic	45
Possibility to exercise thinking during session and discuss important issues	100
Electronic communication with the group leader	65

Team leader reflections showed that the largest challenge for them was that at the beginning their situation turned out to be completely different from their expectations. Team leaders found a problem with formulating good research questions - they were too general or too specific. Teachers are used to acting as empty vessels and are waiting to be filled. Therefore, teachers encountered difficulty trying to formulate even the shortest research questions. It was not easy to follow the rules, to have a common understanding of what inquiry teaching is and what are the instruments to obtain evidence about their practice etc.

The teachers highly valued the role of the team leader in workshops. Team leaders were the ones who created a positive atmosphere, kept the discussion focused, worked as coaches and supported individual teachers. The teachers mentioned the following individual gains: sharing with colleagues and learning to reduce their self-centeredness.

Group B teacher team leader's role turned out to be unusual because the leader was the sole expert of scientific inquiry issues on the team and had already had successful experience in leading a learning team and action research. This may be the reason for the team leader to sometime take the initiative and guide the team towards problem solving.

6 CONCLUSIONS

1 The teacher learning team model, which is based on teacher action research, is a successful teacher professional development form for improvement of teaching inquiry. However, the challenge for this CPD activity was that both the session leader and teachers were learners at the same time.

2 Teachers work on action research in the learning team facilitates improvement of their inquiry teaching practice:
   - The following teacher skills were improved:
     - skills to organize student scientific inquiry;
     - skills to analyze their personal performance;
     - skills to reflect on their personal performance;
     - skills to collaborate with colleagues from the group.

- A tendency towards student progress improvement and positive attitude to inquiry was observed.

3 Teachers gave positive feedback about their participation in the learning team. They noted personal gains related to organization of student scientific inquiry, as well as changes in their thinking and approach to the learning process. Work in the learning team encouraged positive emotions, assurance and sense of security about their performance toward improvement of inquiry based learning.

4 Research of professional performance, while participating in the learning team, is reinforced by the following factors: exercise thinking and share important issues, individual work at school, colleagues' support and the team leader, who has a special role in the organization of successful work of the learning team.

Undoubtedly, the learning team as a new and successful teacher professional development form in Latvia needs to be further encouraged.

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