TEACHERS` CONTINUOUS PROFESSIONAL DEVELOPMENT AND USAGE OF ICT IN TEACHING/LEARNING PROCESS

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Abstract

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Key Words: *Teacher CPD model, ICT, Science and math teaching/learning process*

Acquisition of information communication technology (ICT) skills has become an integral part of the contemporary teaching/learning process. Ten years of experience of the Center for Science and Mathematics of the University of Latvia working in the field of teacher professional development shows that the teachers who have successfully mastered their ICT skills during teaching/learning process have accomplished several professional development stages since 2005. The first stage includes acquisition of various ICT usage tools, as well as identification of the resources available for the organization of the teaching/learning process in science and math. The second stage addresses development and enhancement of ICT skills for organization of the teaching/learning process and engagement of students with the content.

The purpose of the research is to observe ICT usage in the science and math teaching/learning process in a real classroom environment and to develop the next stage teacher continuing professional development (CPD) model according to the current needs. Lesson observations indicate: 1) limitation in ICT usage; 2) the need to create a next stage CPD training model, where teachers will be able to design their own lessons with purposeful application of ICT tools and resources in the teaching/learning process. The initial stage of the model is described in this article.

The research has been in progress since 2014 and is supported by National Research Program Project VPP 2014 - 2017.

Kopsavilkums

Skolotāju nepārtrauktā profesionālā pilnveide un IKT lietojums mācību procesā

Atslēgvārdi: *skolotāju profesionālās pilnveides modelis, IKT, dabaszinātņu un matemātikas mācību process*

Informācijas komunikāciju tehnoloģiju (IKT) lietošanas prasmju apgūšana ir kļuvusi par neatņemamu mūsdienu mācību procesa sastāvdaļu. Latvijas Universitātes Dabaszinātņu un matemātikas izglītības centra desmit gadu pieredze skolotāju profesionālajā pilnveidē rāda, ka skolotāji, kas apguvuši un pilnveidojuši savas IKT lietošanas prasmes mācību procesā, kopš 2005. gada ir gājuši cauri vairākiem profesionālās pilnveides posmiem. Pirmais posms: apgūt prasmes lietot dažādus rīkus, kā arī apzināt dažādus interneta resursus, kas piemēroti dabaszinātņu un matemātikas mācību procesa organizēšanai. Otrais posms: attīstīt un pilnveidot IKT prasmes organizēt mācību procesu, kā arī iesaistīt skolēnus mācību procesā ar atbilstošu saturu.

Pētījuma mērķis ir, vērojot IKT lietojumu dabaszinātņu un matemātikas mācību procesā skolā, izveidot profesionālās pilnveides nākamā posma modeli. Stundu vērošana rāda: 1) IKT lietojuma ierobežojumus; 2) nepieciešamību izveidot nākamā posma profesionālās pilnveides modeli, kurā skolotāji paši spēj plānot un realizēt savās stundās mērķtiecīgu IKT rīku un resursu izmantošanu. Ir aprakstīts sākuma posms jaunajam profesionālās pilnveides modelim.

Pētījums turpinās no 2014. gada un tiek īstenots Valsts pētījumu programmas VPP 2014 - 2017 ietvaros.

Introduction

ICT skills have become an integral part of the teaching/learning process in modern schools. Education experts focus on both the integration of ICT in the teaching/learning process and improving its efficacy when teachers and students use ICT (Becta, 2006; Lemke, Coughlin & Reifsneider, 2009). Supply with ICT equipment (computers, data loggers, sensors, interactive

whiteboards, document cameras, clickers etc.) and support materials for the science and math classrooms for lower and upper secondary schools (grade 7-12) has been initiated and implemented in Latvia the period from 2005 to 2011 by support from EU structural funds. Teachers were offered courses for acquisition of ICT tools and software application skills.

The aim of this article is to analyze the purposeful of ICT usage in the science and math teaching/learning process in the schools involved in the research, as well as describe the next stage CPD model for teachers in that context. To achieve the aim, lesson observations were carried out as well as a review of previous research results and scientific literature.

In this article the authors: a) analyze targeted of ICT usage in the observed science and math lessons; b) give an overview of CPD stages for obtaining ICT skills, as well as focus on a new stage in CPD for science and math teachers.

Methodology of Research

The research has been in progress since 2014, and so far 64 science subject lessons (physics, chemistry, biology and geography) have been observed in grades 7 – 12. The study involved 10 schools from the same municipality in Latvia. The schools represented all types – small rural schools, large urban schools, as well as gymnasiums. A group of trained experts from the Science and Mathematics Education Centre of the University of Latvia carried out lesson observations. The aim of the research is to find answers to the following questions: 1) how purposeful was the usage of ICT tools in the science and math teaching/learning process; 2) what information do CPD course developers obtain.

The expert transcribed the teaching/learning process during the observation: he/she described activity in the classroom specifying teacher and student performance and actions. The lesson description was then used to analyze: 1) how the planned achievable outcome is communicated to the students; 2) how teacher and students determine if the planned outcome is achieved; 3) how effectual are the methods used in the lesson; 4) how deep is students` engagement in the teaching/learning process; 5) cooperation among students as well as between student and teacher; 6) how purposeful is the usage of ICT (if at all) in the lesson.

To identify the level of engagement with ICT by students in the classroom, availability of ICT tools for active construction of knowledge and development of new products an adapted rubric was used to analyse the data collected during lesson observation: (Table 1) Use of ICT for Learning (Microsoft Partners in Learning).

The experts transcribed the conversations with teachers after the lesson. Comments were coded and content analysis was used. Numerical data were processed using R.3.1.2. software.

Table 1. Usage of ICT for Learning: Rubric

(Microsoft Partners in Learning (2012). 21CLD Learning Activity Rubrics. ITL Research)

Level	Criteria
1	• Students do not have the opportunity to use ICT for this learning activity
2	• Students use ICT to learn or practice basic skills or reproduce information, but they are not constructing knowledge.
3	• Students use ICT to support knowledge construction, but they could also construct the same knowledge without using ICT.
4	• Students use ICT to support knowledge construction and the ICT is required for construction of this knowledge.
5	• Students do create an ICT product for authentic users.

Usage of ICT in teaching/learning process

Over the past decade a number of comprehensive studies on the use of ICT in the teaching/learning process have been carried out. The ICT impact report (European Schoolnet, 2006) summarized the results of 17 international studies on the use of ICT in the teaching/learning process and its impact on student academic achievement. Some of the science related studies conclude the following: 1) the use of ICT in the teaching/learning process increases student motivation to engage in the learning process, develops digital literacy, independent learning and promotes cooperation. Students can take on more responsibility for learning, because they can master ICT usage skills at their own pace according to their desires and needs (Rodrigues, 2010); 2) teachers can more readily differentiate the teaching/learning process by working with both advanced and weak students (Dias, 1999).

Student basic skills, higher-level thinking skills, ICT skills, cooperation skills, and student involvement in the learning process with ICT have been assessed (Lemke, Coughlin & Reifsneider, 2009). Studies show that investment in technology acquisition and its use is not sufficient alone to teach young people the necessary skills for today's competitive labor market. The availability of technology does not automatically ensure a change of a teacher's pedagogical approach (Campbell & Martin, 2010).

Context of Teacher Continuous Professional Development in Latvia

The change and improvement in the standards and curricula of math and science subjects in primary and secondary education were implemented in Latvia by EU financial support.

- Development of learning content and teacher continuing education in science and mathematics subjects (2005 – 2008).
- Science and mathematics (2008 – 2011).
- Resource base and equipment for quality learning of science and mathematics subjects (2008 – 2011).
- Continuing teacher professional development (2012 – 2013).

During the development projects (2006 – 2011) science and mathematics teachers attended continuous training on application of ICT which focused on introducing technologies and practical skills of ICT usage in the classroom. It was one module of the program and it covered planning, evaluation, laboratory test, organization of modelling as well as other significant teaching/learning process related questions. Teachers who lack confidence and knowledge about a particular tool do not offer the students an option to use it in their lessons. The above mentioned training is first stage professional competency development program, a knowledge transfer model (Table 2) that helps teachers to understand the operation of a particular tool and learn the skills to work with it. The Internet offers different resources - videos, animation, virtual laboratories, etc. that can successfully be incorporated in science lessons. However, most of these resources are available only in English. Language might be an additional obstacle for the teacher and hinder the usage of ICT in the lesson. To help, the following support materials for teachers were developed within the ESF projects: video films, animations and presentations in Latvian according to the requirements of the subject and curriculum, as well as descriptions of laboratory tests, demonstrations and lesson samples which describe the methods, including how to use ICT to achieve the planned outcome. Consequently, the focus on the second CPD level (Table 2) lies on teacher skills to plan and organize teaching/learning process to include the available support materials in Latvian, learning from colleagues' best practices, modelling a teacher's own lesson fragments and offering use of available resources to students.

The teacher is the implementer, participant and co-creator of reforms in classroom practice. Teachers cannot develop their professional competence in the use of ICT from books, but in practical use of technology in the context of the subject (Duran, Brunvand & Fossum, 2009).

Table 2. Continuous professional development (2006 – 2011): A knowledge transfer model and support system model

	Stage I (2006 – 2008)	**Stage II (2008 – 2011)**
ICT tools and resources	To acquire the technical skills to use various tools: - data loggers, sensors, interactive whiteboard, web camera, data camera Teachers identify the resources available for the organization of the teaching/learning process in science and math: - videos, virtual labs, animations etc.	To use the developed teaching materials, ICT tools and resources in the teaching/learning process (mostly in Latvian): - lesson plans - Worksheet for virtual labs etc. To learn from colleagues' 'good practice' examples. Students identify the resources available for the learning process in science and math: - videos, virtual labs, animations etc.
	A knowledge transfer model	**Support system model**
The aim of teaching and learning	To use ICT in the teaching/learning process - for visualization - to demonstrate content to students - to deliver information	To develop and enhance ICT skills for organizing the teaching/learning process: - to plan according to the achievable outcomes - to engage students with content - to facilitate cooperation during lessons and beyond

Therefore, teacher professional development is of the utmost significance. Learning of digital competencies in a rapidly developing ICT era is absolutely necessary to ensure the effectiveness of teachers – whether student teachers, new teachers, or experienced teachers (Ertmer & Ottenbreit-Leftwitch, 2010). In addition, the use of ICT promotes improving student learning outcomes only when teachers have the knowledge about the efficient and purposeful use of ICT in the teaching/learning process (Ertmer & Ottenbreit-Leftwitch, 2010).

Results after Implementing ICT Tools in Science Classes

Our previous research showed the following: 1) since 2006, ICT tools and resources have been incorporated in teaching/learning at schools. The main ICT tools used in teaching/learning of science subjects in schools in Latvia are multimedia, data loggers and sensors for experiments in science laboratories, the Internet as a tool for learning and cooperation, as well as specific software for the subject. An interactive set of e-materials prepared in a systemic way according to the curriculum coordinated in all science subjects is available on the Internet for every student

and teacher; 2) the teacher`s path to regular ICT use in the classroom from the application of basic skills to specific ICT skills in the subject (Dudareva, Brangule, Nikolajenko, Logins & Namsone, 2011).

In Latvia amount of time what students spend online during the teaching/learning process is on the average approximately half that of their counterparts in OECD countries as a whole. Data summarized based on PISA OECD Research form 2012 (Figure 1).

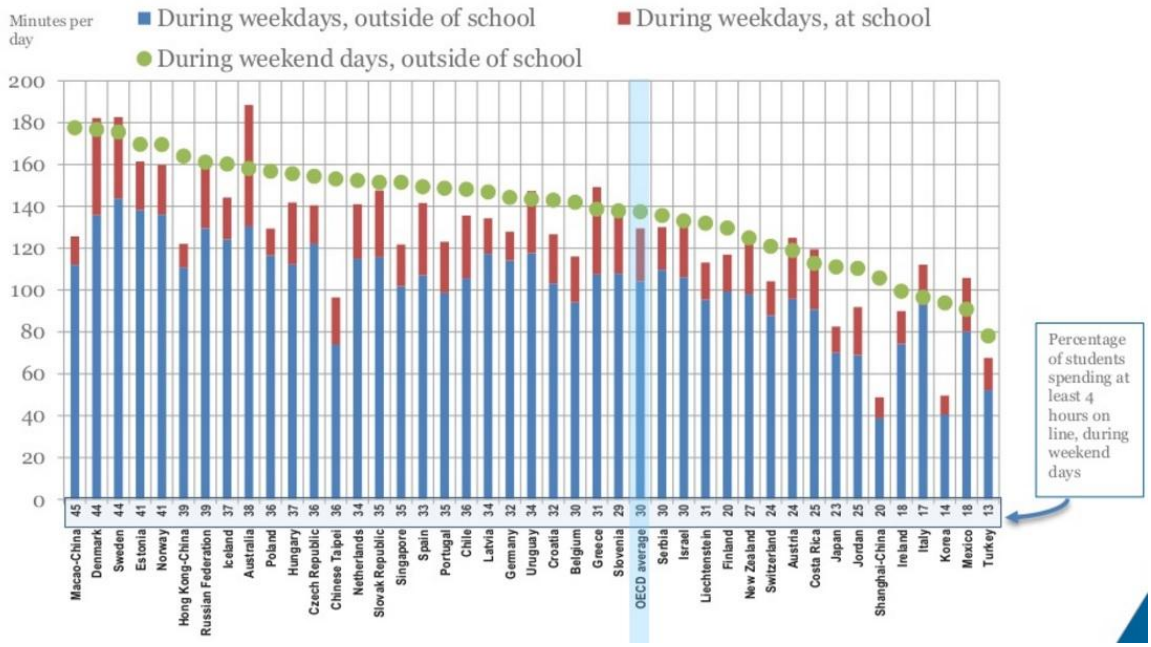

Figure 1. Time spent online in school and outside of school (Schleicher, 2015)

Discussion

Analyses of the lesson observation data produced the following:

1. Lesson observations revealed the use of ICT in 78% of the 64 lessons. However, in only 22% of the cases was ICT used by students and in 94% of the cases by teachers (Figure 2).

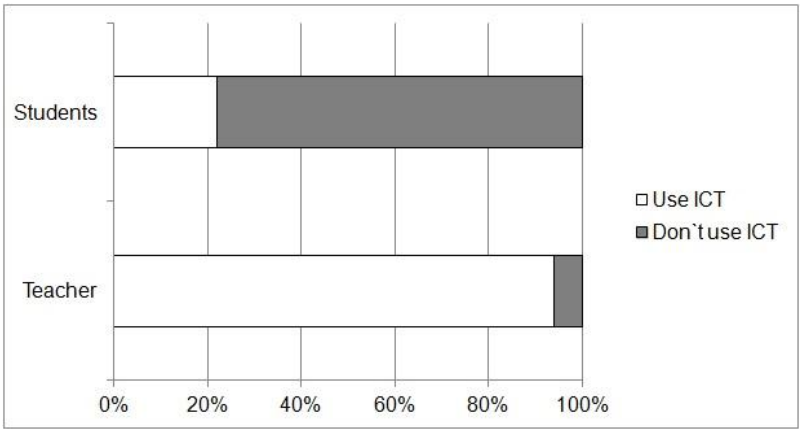

Figure 2. The use of ICT tools in science lessons.

Teachers mostly used a computer with a projector, an interactive whiteboard, a web camera and a data camera for visualization and demonstration of images, tasks, solutions, as well as experiment devices and measurement tools. Students used sensors and mobile phones during laboratory work for data recording and processing; they performed tasks at the interactive whiteboard, used different applications and the computer to find information on the Internet and to prepare presentations on the respective topics. This corresponds to the OECD PISA Research conclusions that regarding usage of ICT, the teaching/learning process is teacher centred.

2. During lesson observation, the experts used Likert scale to rate how targeted the ICT use was according to the learning goals (0 – pointless; 1 – capable without ICT; 2 – incapable without ICT; 3 – meaningful) and whether the ICT tool selection turned out to be the most effective means to achieve the goals (Figure 3).

40% of the lessons indicated that teachers use poor quality teaching materials with ICT or carried out activities that are capable without ICT (0 or 1 on Likert scale). Expert conclusions on the observed lessons described the use of ICT as ineffectual in many cases: *the presentation of more than 30 slides; the teacher uses self-developed teaching material, but images are unclear; presentation is required, but the problem is how it is used; tasks are formulated unclearly, therefore low efficiency of the process observed.*

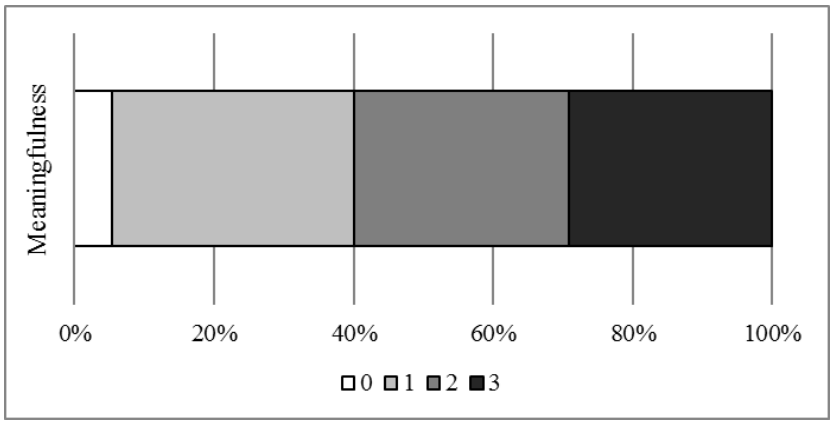

Figure 3. Meaningfulness of ICT tools usage according to the learning goals (0 – pointless; 1 – capable without ICT; 2 – incapable without ICT; 3 – meaningful).

Possible causes of the situation may correspond to the above mentioned views of other authors that purposeful use of ICT tools requires educated teachers – equipped in teacher training

programs in college (Tondeur et al., 2012), professional development courses and sharing good practices on purposeful usage of ICT at the school (Horn and Little, 2010; Resnick et al., 2010). Knowledge of a small size ICT model (12 h) is insufficient.

3. The obtained data were analysed based on the level of appropriateness of the use of ICT to the chosen teaching method, technique of methods and feedback. The use of ICT in the classroom will be purposeful if the teacher has the appropriate skills that allow him/her to choose the most efficient method for the lesson, and if the teacher knows how to apply this method in order to achieve the goals (Figure 4).

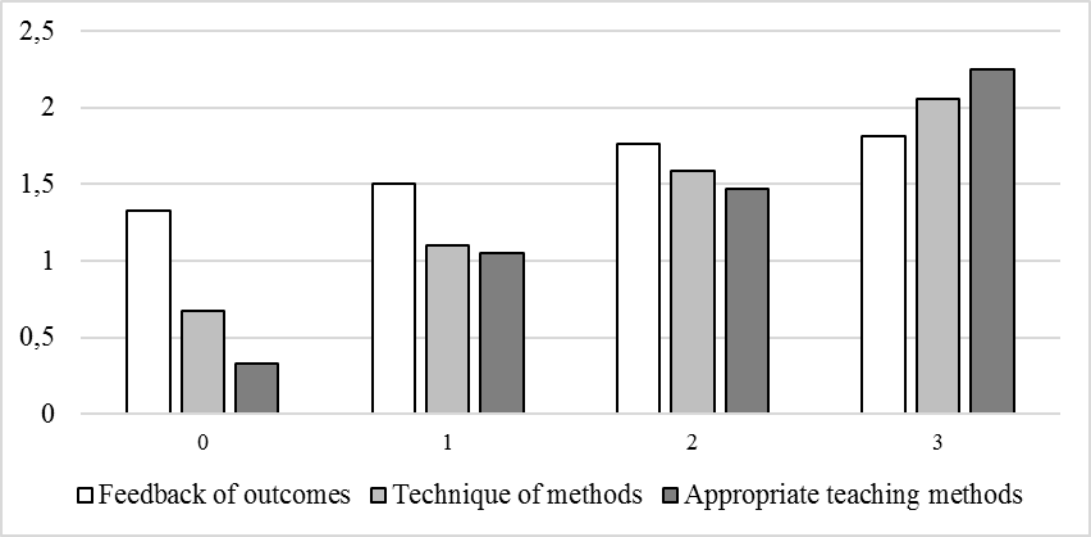

Figure 4. The correlation between the use of ICT and implemented teaching methods

Since 2006, teacher training has focused on teacher communication with students about the learning goals to the extent that students can understand the goal of the lesson and are able to follow the knowledge they are acquiring. This was supported by the results of this research. Even if the teacher fails to choose the most effective method to achieve the goals or he/she has not mastered the method completely, it is important that the teacher never forgets to provide feedback to students about the progress achieved.

It corresponds to the (Ertmer & Ottenbreit-Leftwich, 2010) idea that if teachers have the knowledge of a meaningful use of ICT and if they can manage the teaching/learning process according to the goals, the students will perform significantly better.

4. Analyses of the observed lessons according to the rubric (Table 1) Use of ICT for Learning (Microsoft Partners in Learning) show that in most cases ICT is unavailable to students in the

lesson (Level 1). However, when ICT is available, students use it to learn, improve their basic skills or reproduce information (Level 2). Usage of ICT to construct knowledge is extremely limited (see Figure 5).

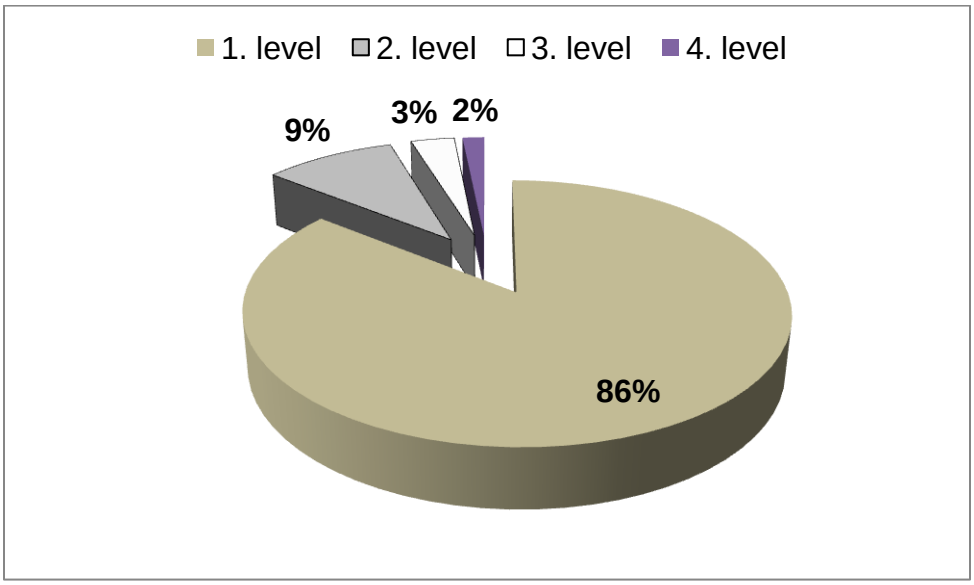

Figure 5. Usage of ICT in science lessons according to the rubric criteria

One of the conclusions based on a PISA study shows that regardless of the fact that ICT tools are available on a daily basis and the youth has sufficient skills for the use of ICT tools, the application of ICT tools is not sufficiently included in formal education. One of the main factors influencing that is the level of teacher skills to both use ICT tools and, more importantly, develop and offer their students tasks and problems to solve using ICT tools. This conclusion supports the results of our research (see Figure 5).

Teacher professional development

In our practice we act in the way research (Mayer, 2010 etc.) says that it is not the technological medium itself, but the instructional method used, which supports and causes effective teaching and learning. Having learnt the existing situation in a classroom, the necessary support for working teachers and development of study programs for teachers-to-be can be offered. There is a clear need for science subject teachers to combine ICT use with focused pedagogical tasks.

Developing new types of CPD for teachers would be a good way to support teachers in learning more about ICT, helping them fully and purposefully integrate ICT into their teaching. Teachers need to be active agents, not just in the implementation of innovations, but also in their design (Schleider, 2015).

Table 3. Continuous professional development next stage: Deeper learning model

	Stage III
ICT tools and resources	To acquire the technical skills to use ICT tools for personalized learning (tablets, mobile phones, digital platforms etc.) To identify and acquire new generation ICT education tools and resources for CPD, for example: - Learning Designer (http://learningdesigner.org) -InstaGrők (https://www.instagrok.com) etc.
	Deeper learning model
The aim of teaching and learning	To design own lessons with purposeful use of ICT tools and resources in teaching/learning process: - to encourage students to think in new ways, to persist in the face of challenges - to help students actively construct knowledge, to solve complex problems - to encourage students to communicate effectively, to cooperate, to work well in teams - to develop student skills to monitor and direct their own learning

Therefore, the next stage of professional development should focus: 1) on 'next generation' ICT tools that encourage personalised learning and immediate feedback; 2) on developing assignments and problems that require usage of ICT and thus facilitate construction of knowledge and/or development of new products by students. Analyses of the data obtained during the research and evaluation of continuing education classes (commenced in 2005) help us develop the next stage of professional development (Table 3), which is currently under approbation in the teacher-leader group of the Centre for Science and Mathematics of the University of Latvia. Therefore approbation results will be relevant for discussion after some time passes.

Conclusions

The observed lessons allowed us to detect the presence of ICT in teaching and learning process compared to 2006 when it was virtually non-existent in Latvia. However, ICT is still mainly used by teachers as a tool for transmitting information and the involvement of students in the application of ICT is low. Thus, similarly to Europe, schools in Latvia are only in the beginning of the second stage towards the transition into a new educational paradigm. As widely

acknowledged, change and transformation in education, which results in better learning and teaching, are long-term processes.

Since 2006, professional development for science teachers in Latvia has been practiced in two stages (Table 2): to master technical ICT usage skills and to use ready-made support materials to organize teaching/learning in the classroom. Lesson observation data show the need for the third stage that will have enhanced focus on achievement of pedagogical goals and will facilitate student involvement with ICT during lessons, including construction of new knowledge and development of new products.

Third level CPD program (Table 3) is currently developed in the initial stage, offered for piloting to a group of teachers. Further research will be carried out to investigate the progress of piloting.

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