

Mobile Apps for Teaching Physics: Situation in Latvia

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Abstract: Mobile apps have immense potential for being used in Physics education as more innovative educational tools. They extend learning activities such as practice and application out of the classroom. The teacher needs to be guided to maximize the outcome of using the mobile apps and to reach the best results. When deciding to use mobile apps, the teacher should be sure to choose the most effective tool to reach the learning goal. This paper reflects current mobile app usage situation Latvian schools for teaching and learning Physics. The research was conducted using surveys, lesson observations, and focus group discussions. The number of participants were 1547 students and 67 teachers. Two main research questions for this study were: 1. How do Physics teachers utilize mobile apps in Physics education? 2. Which criteria do Physics teachers consider while selecting mobile apps for education? Study shows that almost all the teachers (n=64) agreed that mobile app integration into Physics subject activities could promote personalization. For students to develop content or educational product, teachers preferred apps such as Meter app (Sound meter, Light Meter, Lux Meter, atmospheric pressure), App Inventor, Scratch & Arduino.

1 INTRODUCTION

Education experts are now emphasizing not only the integration of mobile technologies into the learning process but also improving the efficiency of the learning process for both teachers and students. Success is based not only in the quality and quantity of the knowledge but also in an ability to think and act creatively. Currently, educators are confronted with a challenge of dealing with the change technology brings. Thus, alternative ways of teaching should be considered to prepare today's students for the changing future.

Observed trends in education: the focus is set no longer on how to acquire the technical skills of using mobile apps, but on the methodological skills of using mobile apps, which requires continuous support from the school's administration and a significant amount of time invested directly in developing the teachers' professional competence, which in turn can be realized with appropriate learning resources. When using technologies to develop young people's skills necessary for the labour market, it is not enough to invest in the acquisition of technology; the use of technologies should be aligned with both the specific content of the subject and its teaching methodology.

Physics teachers in Latvia do not have enough methodological support and practice in the purposeful use of mobile apps in the learning process (Juskaite, 2019). It is often discussed how frequently should technology be applied and how to purposefully use mobile apps while learning. It is also necessary to consider that their integration in the learning process takes time - so that the teacher can comprehend the opportunities offered by technologies both technically and methodologically.

In mobile apps-based solutions provides the possibility to ensure a targeted educational process and make it more effective. Mobile apps' tools, which are usually more personalized, when used in classroom, gives an opportunity to enhance certain skills and to read texts in e-environment quickly and effectively. Mobile apps-based solutions are flexible, which allows students to choose a proper pace for their learning process, using the tools suitable for them, thus making the learning process more productive (Hoy, 2007). Mobile app tools can work with (Vilks, 2008):

- E-books (textbooks; exercise books; hybrids; enhanced e-books)
- Task packages
- Teacher materials

- Skill-tests and online exams
- Training courses

1.1 Significance of the Study

It is significant to understand Physics context and be aware of the limitations of educational technologies before implementing them in educational practices and to effectively integrate mobile apps in teaching and learning Physics.

There are many comprehensive studies out there on how to use information technologies in the learning process, including the use of mobile apps (Lemke, 2009, EC, 2017, Yao, 2016). One of the conclusions of the researchers is that the use of technologies for the development of the skills is necessary for young people when entering the 21st-century job market and requires not only investment in technology acquisition, but also coordination of the subject content and its teaching methodology. Schoolnet, a network of European Ministries of Education, has compiled the results of 17 studies carried out in various European countries in recent years to determine the impact of technology-based learning on the students' academic achievement levels (European Schoolnet, 2017).

1.2 Limitations of the Study

Reaching Physics teachers who had experience in mobile app integration, more specifically, using mobile apps in Physics subject context was quite difficult since the use of mobile apps in Physics education is relatively new in the Latvian education system.

Mobile apps have immense potential for being used in Physics education as more innovative educational methods. They extend learning activities such as practice and application out of the classroom. The teacher needs to be guided to maximize the outcome of using the mobile apps and to reach the best results. While mobile devices are extensively used in almost all spheres of the society, Physics teachers are expected to utilize the opportunities of mobile gadgets in educational context and guide learners to use the mobile apps productively. When deciding to use mobile apps in the Physics learning process, the teacher should be sure that this is the most effective tool in the situation.

Education experts agree that not only the integration of mobile technologies into the learning process is important. It is also important to improve the productivity of the learning process for teachers and students. The learning can be considered as

successful not only by evaluating the level of knowledge but the ability to think and act creatively as well. Educational learning process using mobile apps is based on Educational Technology Competency Standards for Teachers in Latvia. Obviously, teachers face a lot of challenges while trying to manage the changes and innovations technology brings. For this reason, it is important to consider the new ways of teaching in order to prepare students for the changes in the future. For example, when studying the working principles of Sound measuring instruments, a student, having watched the demonstration, should conclude what process underlies its operation.

2 METHODS AND MATERIALS

The teacher should be able to determine whether the students understand the working principles of the measuring instruments. There are four significant points for mobile apps evaluation:

- Compatibility with the current approaches of learning;
- Consideration of the influence of context;
- Recording and analysis of various data and measurements;
- Opportunity for learners to participate as co-designers or co-researchers.

To evaluate the success degree of each of the four above mentioned points in the context of teaching Physics in Latvia, a study research was carried out among the students and Physics teachers from Riga and from different regions of Latvia. The number of participants were 1547 students and 67 teachers.

Two main research questions in this study:

1. How do Physics teachers utilize mobile apps in Physics education?
2. Which criteria do Physics teachers consider while selecting mobile apps for education?

In Figures 1 and 2 is given a graphic gender and age distribution representation among the teachers and students. In Figure 1 it can be seen, that most of the teachers that participated in the study were in the age groups of 46 – 55 (46%) and 36 – 45 (37%) years old. Considerably less were those of greater and younger age – 9 % age 28 – 35 and 8% age 56 – 64. If we talk about gender distribution among teachers, there were considerably more female teachers (48 or 72%) than male teachers (19 or 28%), which is a typical scene in Latvian schools. There were more male teachers in the age group 28 – 35 years old (66%) though, the age group of 36 – 45 was more balanced (56% female,

44% male), but in the 46 – 55 and 56 – 64 age groups there is a big predominance of female teachers (90% and 80% respectively).

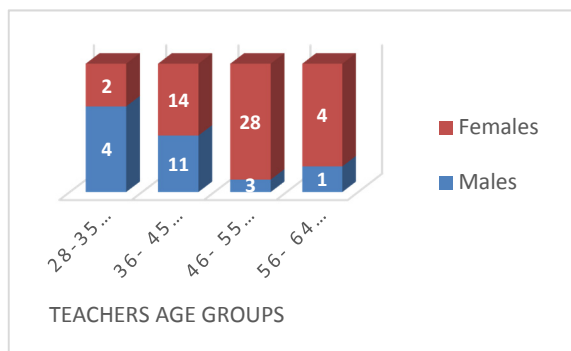


Figure 1: Distribution of teachers by age and gender.

As to students, the distribution of different age groups (13-17 years old) is balanced. The age groups match the student age in upper secondary school and first two years of high school in Latvia.

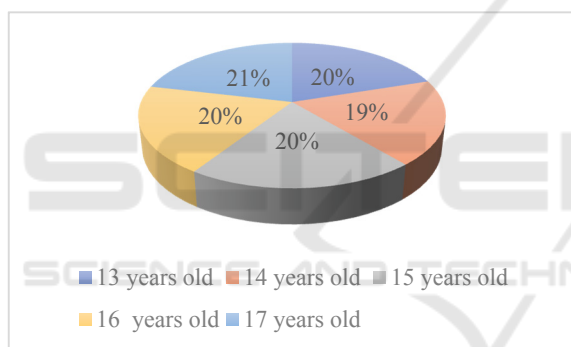


Figure 2: Distribution of students by age.

Most of the teachers, who participated in the research have attended the improvement courses for pedagogues and applied received knowledge in their lessons or extracurricular activities. Afterwards, the teachers participated in the survey about the material of the courses and the ways they have adjusted it in the practice. Moreover, they evaluated students' work and behaviour in the classroom and shared their observations and experiences. There were some discussions on this topic organised in teachers' training courses, various seminars, focus groups and conferences ("Use of IT tools in physics learning"-conference Latvian School i-Technology Exposition, October 2017; "Technology in Education (Introducing SlideWiki and Mobile Learning)"-Latvian Physics Teachers Association 20th Conference, October 2018; "Mobile Technology in Education, organized by Riga Technical University Distance Education Study Centre September-

October 2018; 21st Century Challenges for High School Physics Course & The challenges of the knowledge society in the course of primary school physics, organized by Riga State Gymnasium Nr 3 May- July & August- September 2018).

The teachers were asked to describe how they integrated mobile apps into education and which possibilities, in their opinion, mobile apps had within Physics subject context. Teachers were asked to explain what kind of mobile apps they used and for which purposes (communication, interaction, content presentation, sharing, collaboration, etc.).

For further analysis, all the responses of the participants in the interview were imported to SPSS Modeler qualitative data analysis software. The utilization of a qualitative data analysis tool helped to easily store, organize and analyse the obtained data. In addition, quantitative data gathered from the research was also included. Quantitative data obtained in the study were imported, organized and analysed through Microsoft Office Excel. Preliminary results are presented in this paper. For more detailed information on the gathered data, please, contact the corresponding author.

3 RESULTS AND DISCUSSION

3.1 First Research Question: How Do Physics Teachers Use Mobile Apps in Education?

Almost all the teachers (n=64) agreed that mobile app integration into Physics subject activities could promote personalization. It means that students could easier reach the content, perform autonomous learning, do research, calculations or measurements during activities, and they could learn without constraints of time or place. For example, for students to develop content or educational product, teachers prefer apps such as Meter app (Sound meter, Light Meter, Lux Meter, atmospheric pressure), App Inventor, Scratch & Arduino.

In a survey from teachers' courses teachers were asked to estimate the frequency and regularity of mobile app usage during the lessons (2018/19 study year). The results showed (Table 1) that most of the teachers (n=67) use mobile apps a few times a month or less frequently than once a month (n=12).

Table 1: Frequency and regularity of mobile app usage during the lessons (2018/19 study year) by Physics teachers in Latvia.

Frequency	Share of users, %
Every day	2
Once a week	4
A few times per week	4
Once a month	8
A few times per month	67
Other	12
Never	3

Criteria that Physics teachers consider while selecting mobile apps for education are, firstly, the accessibility and possibility of fast representation of the process. For example, to measure the height of a sound it is enough to turn on a smartphone, choose the proper application and demonstrate the process. It is also easy to demonstrate the process to the class by connecting the smartphone to the projector and commenting the process and the shown graphs on the screen. Other additional gadgets and installations are not necessary. Moreover, almost all the students (98,9% of the respondents) have smartphones and using Mobile Apps does not require additional resources consequently.

3.2 Second Research Question: How Do Physics Teachers Utilize Mobile Apps in Physics Education?

In Latvia there is practically no comprehensive research on the impact of the use of mobile apps on the Physics learning process and the development of academic skills. The lack of appropriate teaching materials in the Latvian language is a significant obstacle in the use of technology during lessons. As the preparation of such materials by the teachers requires both a high level of competence and a considerable time investment (Microsoft Latvia, 2015, Daugavpils municipality, 2013). This means that the teachers of Physics often do not have enough methodological support and practice in the purposeful use of mobile apps in the teaching process.

By implementing mobile apps into the Physics teaching/learning process, it is possible to demonstrate and study various fast and invisible real processes, like sound wave recording with a microphone sensor, to measuring the quantity of the electric charge on the surface of the electrified bodies with an electric charge sensor, etc. Furthermore, it is possible to perform research without human presence by recording data over a longer period of time.

By working purposefully in the computer lab, students develop and deepen their understanding of physical concepts and processes, gain information about the characteristics of the processes and their changes – both numerical data and graphical characteristics change (Russell, 2004). Moreover, students also gain experience in making research and learn the way scientists work.

However, stationary and portable laboratory equipment is very expensive and takes up a lot of space. Moreover, it requires constant maintenance carried out by specialists. Furthermore, the help of the IT specialist is very often necessary for the Physics teachers because of the changes of configurations and the updates, and changes in the infrastructure which also requires a lot of resources.

Mobile apps on the other hand, can be used by many students at the same time, after installing the particular application in their smartphones and it does not require additional resources or technical help. For example, using Light Meter or Sound applications it is possible to make measurements, to see the visual graphics and to make data analysis everywhere.

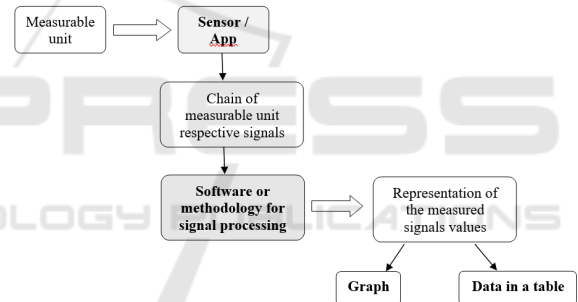


Figure 3: Mobile app working principle schematic representation from measurable unit until the visual result.

Figure 3 shows the principle scheme of using a mobile app in a learning process. We start by choosing the desirable measurable object/unit, then chose the appropriate sensor and app for it, in accordance to the strength and type of the signal/force, attach the sensor and start the measurement process, during which we receive (and record) respective chain of signals, which afterwards needs to be processed with an appropriate software or methodology. In the end we get a visual representation of the measured signals' values either graphically or as data (table).

3.2.1 Examples of App Usage

When using a microphone sensor, it is possible to record and visualise sound source induced air

pressure changes. The example of graph generated by a Sound Meter application can be seen in the Figure 4.

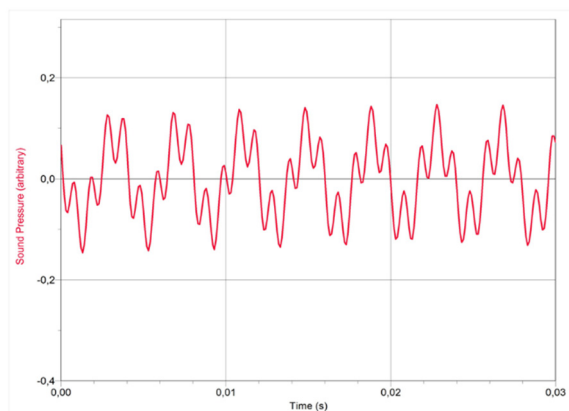


Figure 4: Sound pressure measurement graph recorded in a Physics lesson in Latvia.

As data registration takes place automatically, there is extra time in the learning process when students can ask questions, predict the process and results of the process under different conditions, analyse the obtained data, draw conclusions and ask more questions to the teacher. In this process, the students develop and improve their problem-solving skills (Kapenieks, 2016), as well as skills for plotting and analysing graphics (Russell, 2004, Linn, 1987, Krajcik, 2001).

For example, by using a motion mobile application, students get a graph with coordinates of a moving object and a speed-time graph online. They can observe the moving object or analyse the given graphs. Furthermore, it is possible to repeat the movement shown in the graph. The mobile application features that ensure graphical representation of the change of the characteristics in the observed process online are mentioned as the most significant benefit of the technology-based learning process compared to the traditional way of work (Russell, 2004, Gonzalez, 2014, Ferreira, 2015).

Students working in mobile apps lab can follow the ongoing process, and the graphical representation of its characteristics change at the same time, thus clearly linking the reality with the mathematical description of the process. The more students' hypotheses are tested experimentally, the deeper understanding of the process they get (Pedretti, 1998, Cziprok, 2014, Trumper, 2003). Smartphones with Mobile Apps are only digital devices, and while researchers point out the impact of their purposeful use on student achievement, this impact, however, depends on the careful organization of the learning

process by the teacher: whether the learning process is organized in a way to promote testing of new ideas, restructuring of previous knowledge and establishing a link to the new experience (Trumper, 2003, Caballero, 2018).

Teachers are also using mobile apps for solving various tests and exercises. In this process, students can master the main information and the basic subjects in a short period of time.

3.2.2 Mobile Apps-based Solutions – Online Physics Tests

In 2017, Latvian e-publishing house i-Zvaigzne.lv presented a new cloud-based solution "Online Tests in Physics for Grade 12" (Juskaite, 2017), that was partly made by one of this research paper authors, and "Physics: High School course!" (Cabelis, 2017). These are extensive electronic collections of online learning tasks, tests, task solution examples and tasks for self-testing in the Latvian language. The use of mobile apps solutions and the use of resources have many advantages over locally installed solutions and the use of stored resources. The main advantage of choosing mobile apps for an educational institution is that there is no need to support and manage the infrastructure (EADSNE, 2013). Teachers can manage all their classes and tasks online, creating and administering assignments and assessments, collaborating with other subject teachers, and providing feedback to their students. Students can collaborate with their teachers and classmates, as well as have access to all materials directly from the smartphone.

3.3 Issues with App Usage Implementation in Education

A new trend can be observed in education: the focus is no longer on how to acquire the technical skills of using mobile apps, but on the methodological skills of using mobile apps, which requires continuous support from the school administration and a significant amount of time to invest directly in developing teachers' professional competence, which in turn can be realized with appropriate learning resources. The frequency of technology use and purposefulness in the learning process are often discussed.

Teachers' responses about the development of their and their students' skills using mobile apps:

- During the last two years, my skills of using mobile apps in the learning process have improved.

- I use mobile apps purposefully in my lessons.

The availability of mobile apps in the classroom does not automatically guarantee results. Even more important is teachers' accumulated experience in working with technology, including mobile apps and their software, and the knowledge of what students can do with mobile apps in the learning process. If teachers are not sure about the opportunities that mobile apps provide and think that mobile apps are some kind of toy, they will not be convinced that the physical processes can also be studied using these tools and will not apply them during lessons. Thus, the most important role for the purposeful introduction of mobile apps into the Physics learning process belongs to teachers who are able to explain the benefits of mobile apps to their students and to offer using them in the classroom.

The use of mobile apps in the learning process increases each year and is positively evaluated by students and teachers. In the last two years, mobile apps have become the most often used devices in Physics classes with teachers making use of relevant applications.

Methodical support problems were mentioned as the most common issues with using mobile apps during lessons. Teachers also point out that it takes time to learn how to use mobile apps and plan a lesson where mobile apps would be used the most efficiently. One of the most frequent answers to the question about needed help to effectively use the available mobile technologies in the learning process is: more materials for mobile technologies, methodological support if necessary and professional development courses. Having evaluated each teaching material, teachers introduced their comments on the problems they observed in an electronic environment, regarding the necessary improvements and corrections in wording. A more detailed description about this process and the results will be published in our future papers.

4 CONCLUSIONS

Mobile app diversity and usage possibilities in education are increasing fast, and they are applicable in most of the areas of life, science and education.

Study shows that almost all the teachers (n=64) agreed that mobile app integration into Physics subject activities could promote personalization. It is already well established that personalization is one of the key directions where our education will develop, since it allows students to learn within their

capabilities and talents. Students could easier reach the content, perform autonomous learning, do research, calculations or measurements during activities, and they could learn without constraints of time or place.

Most of the teachers that participated in the study were in the age groups of 46 – 55 (46%) and 36 – 45 (37%) years old. Considerably less were those of greater and younger age – 9 % age 28 – 35 and 8% age 56 – 64 and there were considerably more female teachers (72%) than male teachers (28%), which is a typical scene in Latvian schools, although, there were more male teachers in the age group 28 – 35 years old (66%).

Most of the teachers (n=67) use mobile apps a few times a month or less frequently than once a month (n=12), so it can be concluded that Physics teachers in Latvia use apps for educational purposes quite often and regularly, and it has become a well established routine to do so, especially if we are taking into consideration a fact that Physics lessons usually take part once or twice a week. It is also important to note that the teachers that took part in the experiment for the most part also participated in the teachers' courses where they were introduced to the technological possibilities in Physics learning process, so one might say that the results also show the success of these type of courses, since the teachers' engagement into using the mobile apps are considerably high.

It is also important to mention, that the situation in Latvia "infrastructure" wise is also ready for wider app usage in education because almost all the students (98,9% of the respondents) have smartphones and using Mobile Apps does not require additional resources consequently.

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