

**University of Sopron**

**Theses of doctoral (PhD) dissertation**

**"Methodical development of the practical subjects of the  
Science and Environment teacher training program  
through the examination of environmental elements in  
the Hungarian territory of the Kőszeg Mountains"**

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2017.

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## 1. Objectives of the research

Students' interest in natural sciences and mathematics declined significantly by the 21st century. Science education - which provides the basis for the students' world view - is in crisis. In order to escape this crisis a paradigm shift is needed in education. The methodological culture of natural science public education and the training of natural science teachers must be renewed. This renewal is supported by pedagogy of sustainability, environmental pedagogy. Its goal is to develop responsible, environmentally conscious behavior, and its educational strategy is project teaching. Project teaching primarily uses methods which require action, promote student autonomy, learner's freedom and increase student activity. They create a new learning environment and by using methods relying on creativity and discovery they can promote the learning of learning and collaboration with other students.

One of the aims of this dissertation is to explore problems related to the teaching of natural sciences through the review of the literature and analysis of documents and to investigate the steps taken to solve these problems at the level of OECD countries, in the European Union and also in Hungary.

*The major goal of my dissertation* was the development of a *methodology* for the teaching of the practical subjects of the Science and Environment teacher training program. The new learning environment is field work, the Kőszeg Mountains area is well suited for this purpose. The subject Science plays an important role in public education because students have the opportunity to get like natural sciences through the understanding of phenomenon, processes and secrets of the natural environment.

My goal was to develop a series of measurements which promote project work and inquiry-based learning or students and the obtained results can also be used in education. The measurements will be performed using instruments that can collect and register data concerning some physical parameters of the inanimate environment. In addition to environmental research, further goals of the measurements are to provide a large number of real-time data *to support research-based learning* and to make these data available on the Internet.

During my doctoral studies and during this research period a technical-communication revolution took place in the world. The use of smartphones became part of our daily lives and got particularly popular with students. These devices are, in my experience, ideal for field use,

determination of location, data collection, image, film and sound recording and sharing the collected data over the Internet.

*I set as my goal the examination of the possible use of mobile phone applications in field education and to develop a project for electronic recording of the parameters of natural environment. It was also my goal that the prepared electronic questionnaires could be used as samples for similar surveys.*

*Another goal of the work was to create a quiz show that promotes data gathering on the field and which explores the values of our environment. It intended to reduce the gap between generations while promoted the collection of data with mobile phones.*

*My further goal was the examination of the usability of mobile devices in public education. In order to know more about usage of digital devices, an online questionnaire was created and an online survey was evaluated among primary and high school students.*

## **2. The hypotheses of the research**

- 1) The European Union supports the programs for the renewal of science education, the development of innovation and digital skills in schools, the wider use and accessibility of open educational aids.
- 2) A paradigm shift is needed in the methodological culture of education. A new learning environment, activity based methods and new tools should play a major role in this change. The development of digital technology and the spread of mobile phones can facilitate this process. It can create new opportunities, free access to information and quick feedback.
- 3) There are devices capable of recording data, which can be used to gather a large number of environmental data, and databases from these measurements can support learning.
- 4) There are free application suites that can be used on the Internet and also on smartphones that can meet the unique needs of field data collection. In addition, they are capable of collecting the required data from multiple mobile phones, multiple geographies, and sharing them in a common database accessible on the Internet.

- 5) Young people's interest in mobile phones, digital media and social media can be exploited to make them aware of their natural environment surrounding them. A project can be created that encourages the observation of nature and active participation, which facilitates learning with the pleasure of discovery, which promotes data collection with interesting creative recordings. Projects developed on the basis of the Project of Nature's Calendar are suitable for extending the offerings of the Thematic Project Weeks in public education and encourage the work in the new learning environment.
- 6) Application of mobile devices promotes field work in the practical subjects of the science and environment teacher training, independent work of students, acquisition of direct experience and the development of responsible behavior.
- 7) The range of specific learning organization procedures that promote environmentally conscious behavior can be expanded with a novel environment and nature conservation contest, and the range of specific learning tools can be expanded by collecting data using smartphones and the internet.
- 8) Access to the Internet and the infocommunication services that enabled Internet access have transformed our lifestyle and habits. Internet usage has become increasingly common among students, they are spending most of their time on the Internet using social media. The conditions for applying the BYOD principle are given for students. They have smartphones, the device has become widespread in grades 5-8. All forms of online communication can be accessed through applications developed for mobile telephony. We can be in touch with others at anytime, anywhere, even when traveling. Access of social media is mainly done by mobile phones. Most applications on smartphones are serving community relations.
- 9) Students who have been using cell phones for a longer time have more skills in using learning promoting and other applications. Students are less familiar with learning apps but they are open for using them. Teachers are less familiar with learning apps. The most popular learning applications are for language learning. The knowledge and use of these apps increases

with the number of years spent in school. For field measurements, smart phones incorporate sensors and it is also important that data can be downloaded after the successful data collection. The built-in sensors are not known by most of the students and they did not use it consciously. A large number of students know some way of transferring data between the mobile phone and the computer.

- 10) In support of digital education, there are wide differences depending on students age, gender, and place of home. The majority of students will support digital education.

### **3. Methods of the research**

#### ***Literature search***

Overview of the literature concerning the recent crisis of science education, international comparative measurements and sustainability. Internet based research on mobile devices, applications, extended and virtual reality. Examination of the literature related to the use of mobile devices in education.

#### ***Document analysis***

Documents of the European Commission: "Education and Training 2010" Work Program, Documents of the Committee working on Key Competences. 2006/962 / EC recommendation on key competences for lifelong learning. Strategic Framework - Education and Training 2020. Open Learning Action Plan. Erasmus + program documents.

International comparative measurements TIMSS, PIRLS, PISA documents.

*Documents on Hungarian public education:* The status of science education in Hungary Report of the OKNT Committee. Wisdom Council Wings and Weights Recommendations.

*Documents related to Sustainable Development:* UN Millennium Development Goals, 2000. Gothenburg Strategy, Community Sustainable Development Strategy, 2001 UN Sustainable Development Goals - SDG (2015).

Documents related to Sustainable Development in Hungary: National Sustainable Development Framework Strategy "National Concept for Transition to Sustainability".

*Educational policy documents:* 2011 CXC. Act on National Public Education. National Core Curriculum 110/2012.(VI.4) Government Decree. A 8/2013. (I.30.) EMMI regulation on the common requirements of teacher training and

the training and output requirements of specialized teacher curriculums. 18/2016. (VIII.5) EMMI Regulation on the training and output requirements of higher education vocational training, basic and masters programs and the common requirements for teacher preparation. Digital Educational Strategy (DOS) 2016. Shift in Higher Education Medium Term Policy Strategy, 2016. Horizon Report 2014: New Technologies and Trends in Education - European Schools Issue.

### ***Field tests***

We performed microclimate measurements in the vineyards of Kőszeg Mountains, Kissomlyó and Somló together with the students. We investigated the effect of basalt and basalt supports. Data were collected and analyzed for the partial eclipse of March 2015. Based on our measurements and electronic data collection we discovered the process of frost and its effects on vineyards in April, 2016. We performed water quality measurements on the field, environmental physical measurements, water quality investigations of springs, streams and rivers in the Kőszeg Mountains. In addition to environmental research, further aim of the measurements was to provide a large number of real-time data to support inquiry-based learning and to make these data available through the Internet.

*Online programming, preparation of electronic questionnaires for smartphone applications. Implementation of electronic data collection with electronic questionnaires. Nature Calendar Implementation Project.*

### ***Data-survey***

I performed an online survey concerning usage of internet and mobile applications among primary and high-school students. The goal of the online questionnaire was to survey the students digital competence in usage of internet and mobile applications. 806 students completed the questionnaire. The responding 10-18 years old students belonged to a primary school in a small village, two primary schools in a small town, a primary school in a district center, a primary school in the Capital and a high-school in the Capital.

### ***Statistics, calculations***

38 closed and 10+1open questions were evaluated in the survey.

#### **4. Results of the research**

The dissertation gives an overview of the challenges of education in the 21st century based on the literature and document analysis. It outlines the main problems and describes the major steps taken by the European Union and Hungary to address the problems.

The changed educational training needs, the need for lifelong learning, the crisis in science education, the challenges of exploding and proliferating Internet and mobile phones, and sustainability require a paradigm shift in the methodology culture of education. The new learning environment, the activity-based methods and the new tools should play a crucial role in this shift. The development of digital technology and the spread of mobile phones can facilitate this process. It can create new opportunities, free access to information and quick feedback.

The thesis introduces a series of measurements targeting specific environmental problems, which through the measurement of environmental parameters and through the creation of a database from the measured environmental data can promote inquiry-based learning. These measurements are also good examples of research done together with students and the use of measurement data in education. Climate measurements in vineyards represent a long-term series of measurements, the number of measurements are more than 4 million. The database is available on the Internet.

The Nature Calendar project, which was completed and tested in several areas, proved to be suitable for the electronic recording of natural environment values. The project can be adapted and used for the teaching of any medium or high-level subject concerning field measurements for the development of environmental awareness and competence.

Use of mobile devices promote field work, independent activity of students, direct acquisition of experience and thus the development of responsible behavior in the teaching of the practical subjects of Sciences and Environment teacher training. The research suggests that there are good usable smartphone applications, ranging from the measurement of physical parameters to classification and orientation in the field. Electronic data collection can be useful in field work.

Further result of the work is the introduction and test of a novel environment and nature conservation contest. The topics of the project named "To Save as Treasure" is data collection with smartphones and internet.



A survey, conducted in the framework of the research, investigated the possible use of mobile devices in public education. 806 students completed the online questionnaire concerning with the usage of digital devices.

Based on the analysis of the answers, it can be stated that the conditions for applying the BYOD principle supported by the Digital Educational Strategy are given for the students participated in the survey. According to the survey, nearly 93% of the 10-18 years old students have smart phones and three quarters of them are online daily. Students are more like passive consumers than content creators. Students, who were using the phones for a longer time, have more skills in using learning and other applications. Students are less familiar with learning apps but are open for them, most learning apps are used for language learning. More than 80% of respondents know some way of exchanging data between the mobile phone and the computer, this makes data collection in the field possible. Most students does not know the sensors built in the phones and did not consciously use it.

The results show that the distribution of answers supporting and opposing digital education: not differ in the place of residence, depends on the type of school, a lower proportion of secondary school students supports digital education than primary school children. Students generally support digital education. More than two thirds of all students would support digital education. The girls support the planned change in a far less proportion than the boys. Support depends on the frequency of using the Internet and the use of digital games: who play more often on the mobile phone supports "digital education" in a higher extent.

## **5. Theses of the dissertation**

1. The European Union supports a number of international cooperative programs aimed at renewing education. Natural science education is supported by the Science on Stage project and the Scientix program whereas the eTwinning program supports the collaboration of the European schools with the help of ICT. The Erasmus + program aims to develop key competences and skills in the field of education. The Open Educational Initiative aims to promote the wider use and accessibility of open educational materials to disseminate innovation and digital skills.
2. For the renewal of public education and for the success of education in sustainability a paradigm shift is required in the methodological culture of education. In this shift the new learning environment, activity-based

methods and new tools should play a crucial role. The development of digital technology and the spread of mobile phones can facilitate this process. This can create new opportunities, free access to information and quick feedback. Based on the projects carried out during the research, it can be concluded that the application of digital technology contributes to the renewal of the methodological culture.

3. The series of measurements developed within the framework of the dissertation supports project work and inquiry-based learning. Based on the programmable registration tools a database can be created containing a large number of environmental data. These measurements are good examples of research performed together with students and the use of measurement data in education. Climate measurements in vineyards represent a long-term series of measurements producing enormous amounts of data, the number of measurements is over 4 million.
4. The Epicollect application suite, which is able to meet the unique needs of field data collection, consists of a web-accessible part and an application that can be used on a smartphone. An online form containing questions that may be needed for a data collection task can be created online. The electronic form can be downloaded with an application installed on the mobile phone and data collection tasks can be performed on the field. The application is capable of collecting the required data from multiple mobile phones, multiple geographies, and share them in a common database available on the Internet.
5. Young people's interest in mobile phones, digital media and social media can be exploited to make them aware of their environment and the surrounding nature. The Nature Calendar project, developed and tested in the framework of the dissertation, provides a model for the electronic recording of the natural environment values, observation of nature, promote active participation, boost knowledge with the joy of discovery and help data collection with playful creative recording. The project can be adapted and used in the teaching of any medium or higher level subject which involves investigations in the field for the development of environmental awareness and competence. Projects developed on the basis of the Nature Calendar project are suitable for the expansion of the offerings of the sustainability-environmental awareness week and the digital theme week program.
6. Application of mobile devices supports the work in the field, the independent work of students, the acquisition of direct experience and

thus the development of responsible behavior. There are good usable smartphone applications from measuring physical parameters through classification to field orientation. Electronic collection of data is useful in field work and forms created for this purpose can be used for the fieldwork report. Students are able to program the forms required for electronic data collection independently and use the forms to complete the collection of data.

7. The range of specific learning organization procedures that promote environmentally conscious behavior can be expanded with a novel environment and nature conservation contest, and the range of specific learning organization tools can be expanded by collecting data by smartphone and through the internet. The digital project called "To Save as Treasure", which involves the preservation of natural and cultural values, contributes significantly to linking generations, recognizing values and appreciating the work of the predecessors.
8. Internet usage became increasingly common among students completed the survey, they spend most of their time on the Internet using social media. The conditions for applying the BYOD principle are given for the students. They have smartphones, the device has become widespread in grades 5-8. The vast majority of smartphones use Android as OS. The social media is mainly accessed by mobile phones. Most applications used on smartphones are connected to maintenance of community relationships.
9. Students in the survey who have been using cell phones for a longer time have more skills in using learning and other applications. Students are less familiar with learning apps but are open for using them. The most popular learning applications are for language training. Their knowledge and use increases with the number of years spent in school. Most students does not know the sensors installed in the smartphones and did not consciously use it. Most of the students know some way of transferring data between the mobile phone and the computer.
10. There is wide differences in support of digital education depending on the age of the students, their sex, and place of residence. Students favor digital education, majority will support it. High-school students support digital education less than primary school pupils. The girls support the planned change far less than the boys. The survey data do not show any differences in the place of residence. Support for digital education

depends on whether or not the smartphone is used to play – students play more often on the mobile favor "digital education" more.

## **Proposals**

According to the Digital Educational Strategy: "Digital tools and approaches must be integrated into classrooms as they are integrated more and more into our everyday life. For this, however, it is necessary to change the attitudes of social thinking". The practical applications described in this dissertation can be the first steps towards this change. On the basis of the investigations I suggest the followings:

In science and environment teacher training, more attention should be paid to IT tools, in particular to the use of smartphones that are useful in field studies.

In the field of public education, in the teaching of science and natural sciences the implementation of research-based learning should receive priority and the toolkit of methodological culture should be expanded with the use of smartphones and tablets.

I find it important that the extension of the tools of the teaching and learning process should be performed preferably in the case of non-curricular activities (School days, Thematic days, celebrated days, theme week) and out-of-school opportunities (nature schools, field practice, thematic camps, creation of educational paths), because on these occasions it provides concrete real experiences for the development of responsible, environmentally conscious behavior. In teacher training methodology culture and practical presentations should be in focus, which will present the implemented tasks and their results.

I find it necessary to expand the current system of study competitions and contests, and I propose to create forums that, in addition to primary school pupils, involve students of vocational schools, high-schools and gymnasiums and motivate and develop their participants.

This is supported by the launch of a novel environment and nature protection contest that apply data collection with smartphones and internet. I find it important that, on the basis of the results presented in the dissertation, we

should extend the above mentioned proposals to the territory of Hungary and the Carpathian Basin.

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