Universal Digital Competences

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Abstract: *During couple of years when we were working on the project of natural competences we have investigated digital competences. Digital competence is one of generic competences that need to be acquired by educated individual who lives in the contemporary society. We have many attempts to standardize the competences with different courses and one of most known is ECDL (European Computer Driver License). But we know that competences that were guaranteed with the passing of the ECDL are just basic computer knowledge and most of the companies need even more digital competent employees. From the perspective of education system at all levels of education we wanted to research the universal digital competences that would update the current society requirement for digital competences. Our research based on the changed paradigm for learning material preparation - teach competences and not knowledge. This approach enables us to get better insight to the digital competences requirements and enables us to propose the universal digital competences. Results we propose were proven useful in the education and should be transferred to the future generations of scholars.*

Keywords: e-learning; distance learning, competences, digital competences, multimedia.

1 Introduction

Recent changes in the higher education uncovered the need for changes in the educational principles in general. High speed internet gives almost instant access to the all sort of information therefore broad knowledge retention is not that high valued. It is much better if individual know where to find the required information. We always find traditionalists which govern old principles fearing the new technology may break down in the critical moments. They have been proven wrong whenever new successful paradigm of learning was introduced. If something terrible happens to our civilization than most of our contemporary knowledge are going to be useless anyway.

In modern upbringing and education the term competences are frequently used [1]. Various explanations of the term actually raise some misunderstandings. In pedagogical area the term competences have more than one meaning. From a pedagogical point of view it is necessary to look for a multidisciplinary definition. We can talk about school competences, principal or teacher competences or student/pupil competences. With the latter we can identify specific competences, regardless of terminology differences, that are the result of a complete personality development comprising cognitive, emotional and psycho-motoric areas.

From the teacher's perspective we could define the theoretical construct named competences as hypothetical psychological processes that include cognitive, emotional, motivational, social and behavioral components that teacher obtain to a certain extent through learning process. Generally speaking, a competence "includes a complex system that is a combination of knowledge and abilities, but also strategy and routine, necessary for the use of knowledge and abilities in addition to certain emotions, aspects, and efficient self-regulation of competences." [2]

Regardless of the different interpretations of required competences, we can summarize some features of generic and subject-specific competences which are independent of teacher's years of practice or the level of education. Some of subject-specific competences are: being familiar with the curriculum, good expert knowledge of the subject, teaching, being

familiar with the contents of teaching, knowledge of a particular subject, being acquainted with subject contents and methodology. According to TESE-II [3] we can define competences as a combination of knowledge, understanding, skills, capabilities, and values. Competences are also expressed as the use of one's knowledge, capability of judgment, grasping communication skills, and skills which they require for further learning. In different courses students gradually gain their competences. They are expected to develop a wide array of generic and subject-specific competences which will guarantee success in their future work as teachers. Pedagogically competent teachers are expected to integrate their professional (pedagogical) **knowledge**, **skills** and **capabilities** into their work. Possessing personal features such as empathy, creativity, cooperativeness, ethics etc., they become a positive role model for their pupils [4]. They should not just use the expert knowledge produced by others they should produce such knowledge themselves. Teachers are facing new tasks that require additional training and develop a reflective approach to their teaching [5]. EU documents also support lifelong learning as one of the development priorities [6]. "Thus we expect that teachers possess an interdisciplinary academic education as well as the necessary qualifications to creatively engage in complex problems of TLS (teaching-learning-study) processes." [7].

We are still unable to replace teacher in the TLS processes. Teacher's role is vital and needs to be recognized as highly important. Many modern learning materials are for self-study. Such material minimize teacher's role in TLS processes. Proving the value of self-study materials is difficult. In one of our previous designed learning materials we have discovered that students actually love them but the knowledge retention was inadequate. With the help of teachers the retention of knowledge and proper location of that knowledge can be much higher. Therefore it is necessary to educate teachers how to use the e-learning materials properly.

Contemporary TLS paradigm is based on constructivist approach. Students should construct their own knowledge based on active mental situations [8]. Student can construct new knowledge only if he acquired required basic knowledge and understanding. TLS processes should not be designed only for one task. It should boost the innovative thinking for all involved parties. With this in mind we have discovered that our current TLS processes could be improved. With the ever growing number of required knowledge for individuals to function in the society we need to prepare them to understand the principles. Principles often remain the same even if the "hardware and software" are changed. These findings were the reasons that we start the project called Development of science competences. The aims of this project are: increase competences of student and teachers; and prepare the guidelines to the new paradigm of learning materials. It is true that we are bound to the natural science competences but digital competences are fundamental for everyone in today's world.

We should know that competences are not a monolith issue. At least three levels of competences are highly important:

- competences of students,
- competences of teachers; and
- competences of teachers teaching teachers.

Even though we know that the final goal of the education is the well competent student we first have to produce competent teachers. Since teachers need to know the content of the topic; pedagogical and methodical approaches in teaching the best model for their training would be Pedagogical content knowledge [9] and its modern evolution Technological pedagogical content knowledge [10].

Competences are described as combination of **knowledge**, **skills** and **relations between compatible situations**. The key competences are the described in the eight topics framework in the European legislation [11]:

- **Communication in the mother tongue** which is the ability to express and interpret concepts, thoughts, feelings, facts and opinions in both oral and written form (listening, speaking, reading and writing), and to interact linguistically in an appropriate and creative way in a full range of societal and cultural contexts;
- **Communication in foreign languages** which involves, in addition to the main skill dimensions of communication in the mother tongue, mediation and intercultural understanding. The level of proficiency depends on several factors and the capacity for listening, speaking, reading and writing;
- **Mathematical competence and basic competences in science and technology**. Mathematical competence is the ability to develop and apply mathematical thinking in order to solve a range of problems in everyday situations, with the emphasis being placed on process, activity and knowledge. Basic competences in science and technology refer to the mastery, use and application of knowledge and methodologies which explain the natural world. These involve an understanding of the changes caused by human activity and the responsibility of each individual as a citizen;
- **Digital competence** involves the confident and critical use of information society technology (IST) and thus basic skills in information and communication technology (ICT);
- **Learning to learn** is related to learning, the ability to pursue and organise one's own learning, either individually or in groups, in accordance

with one's own needs, and awareness of methods and opportunities;

- **Social and civic competences**. Social competence refers to personal, interpersonal and intercultural competence and all forms of behaviour that equip individuals to participate in an effective and constructive way in social and working life. It is linked to personal and social well-being. An understanding of codes of conduct and customs in the different environments in which individuals operate is essential. Civic competence, and particularly knowledge of social and political concepts and structures (democracy, justice, equality, citizenship and civil rights) equips individuals to engage in active and democratic participation;
- **Sense of initiative and entrepreneurship** is the ability to turn ideas into action. It involves creativity, innovation and risk-taking, as well as the ability to plan and manage projects in order to achieve objectives. The individual is aware of the context of their work and is able to seize opportunities which arise. It is the foundation for acquiring more specific skills and knowledge needed by those establishing or contributing to social or commercial activity. This should include awareness of ethical values and promote good governance;
- **Cultural awareness and expression** which involves appreciation of the importance of the creative expression of ideas, experiences and emotions in a range of media (music, performing arts, literature, and the visual arts).

2 Digital competences

From all previous counted competences our task was to focus on only two: *mathematical competence and basic competences in science and technology*; and *digital competence*. Other researchers focused on other competences and their research is beyond the scope of this article. Despite the fact that all competences are required today these two competences presets the foundation for natural science in education. For the purpose of this article we focus on digital competences only.

Digital competences are needed everywhere and are not limited on either natural science of social science competences. Broad definition of digital competences would be: confident and critical use of ICT for employment; learning; self-development; and participation in society [12]. Analyzing the new Bologna study programs we discovered that digital competences are not equally included into all study programs. The tests of basic digital competences are included into the ECDL (European Computer Driver License) exams. The ECDL foundation recognized the lack of previous Syllabus and included basic skills of multimedia in the SV4 (Syllabus version 4). But these skills are for the manipulation of home equipment mainly (digital camera, PDA, GSM ...).

Faculties we work for have also educational programs and educate future teachers. Today's teachers need much more of multimedia skills. At least intermediate skill level of video, sound and image editing is required for the natural science teachers. Multimedia enables teachers to prepare their own (customized) learning materials and produce competent learners.

3 Application of computer in education

In the recent past we design and develop learning materials with one focus mainly. It emphasizes efficient transfer of required knowledge to students. The other desired effects are: high retention of the knowledge and transferable skills [13]. In the last years when we have to implement the Bologna declaration and prepared new study programs for higher education we discover another topic – competences. Though we admit that current study programs could be much better if enough time and resources would be available during their preparation we all learn something. All topics are interconnected. The content of the study courses, the objectives of the courses, competences of students attending the courses and transferable skills need to be compatible. Above all we need to start from the competences when we develop courses and the rest must support desired competences.

Transferring the findings gathered during the preparation of the learning materials we discovered that learning materials should be prepared using this new paradigm – start from the competences.

In all attempts when we try to make the mental model of digital competences we were not fully successful. Too many times we forget something vital in our model. Therefore we try different approach and prepare the learning material with the different educational paradigm in mind and research all aspect of digital competences in practice.

We prepare the digital learning material for simple refraction. What we have to consider preparing these learning materials was surprise even for us.

Law of refraction (Shell's law, Descartes' law) is the popular topic in physics. It is relatively easy to explain the concept and to show the effect. Starting from the studying the learning material from the curriculum and other learning materials of this phenomena we prepare our ground knowledge. After this initial step we started systematically to include competences that involve the digital competences. We decide to prepare the material in traditional way and digital way. The learning material was prepared for secondary vocational schools and involves generic and specific competences. Traditionally the

phenomenon is described with the schema (see Fig. 1).

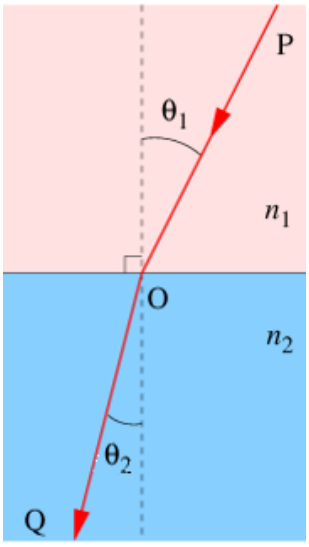

Figure 1: Shema of refraction

As we can see the schema is simplified for the secondary vocational school and is still valid just the speed of light in the translucent matter is omitted.

What we want students to conduct the experiment (see Fig. 2). For each measurement they need to take the measurement and the image with the digital camera.

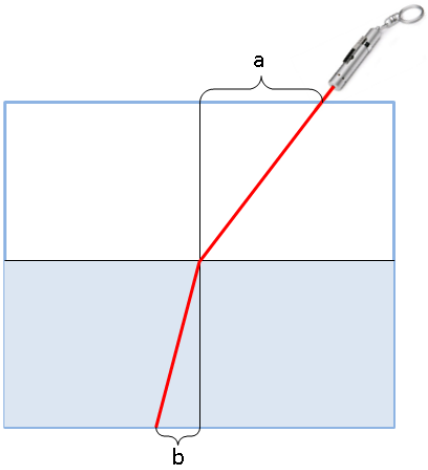

Figure 2: The schema of experiment

The experiment looks simple in theory but reality shows totally different picture. You cannot get accurate measures from this kind of experiment.

If we apply the digital image and computer we get a whole different perspective to the experiment. We take an image (see Fig. 3) at different angle and copy them to the computer. Even though reality is different from the picture the digital measurement is much simpler and sufficiently accurate.

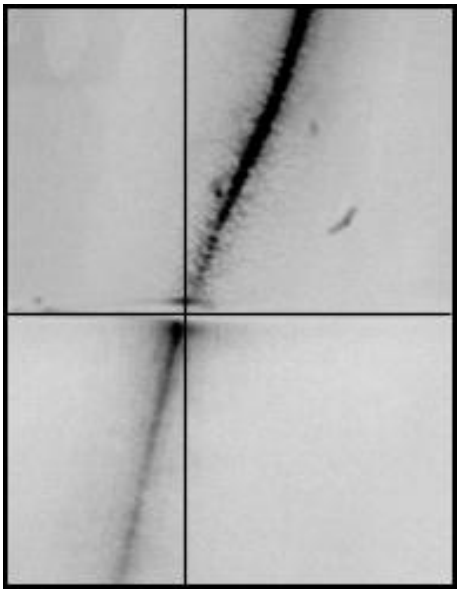

Figure 3: The image of the experiment

Image is inserted into presentation software (PowerPoint or Impress) and all student have to do is to draw the lines on top of the image. After they remove the original image the lines are aligned to the background digital goniometer (provided to them as vector image) and read the angles (see Fig. 4).

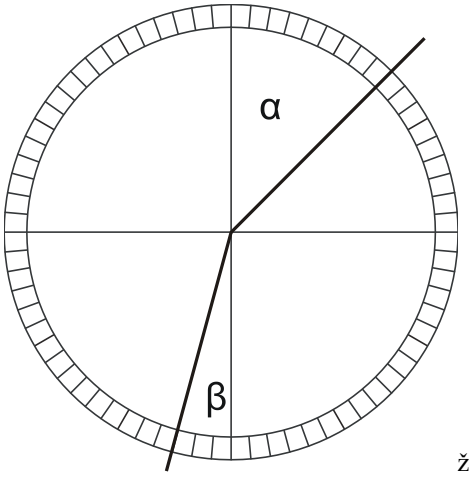

Figure 4: Processes image

Comparing two different approaches they prepare spreadsheet and enter the measured data. They should know that it is mandatory that each row contains the data from the same experimental measurement.

The results of this experiment introduce the following competences:

- **Mathematics**. It does not involve only the mathematics skills but also the skills of spreadsheet programs (data manipulation and use of equations). Additionally they gain the insight that different measures are needed to provide the mean measure of all measures reducing the effect of error in the measurement process.

- **Transfer theory to practice**. They know that the similar procedures can be used for all translucent matter.
- **Oral and written communication**. Since this experiment is almost impossible for one person to conduct they need to practice the communication. Written communication presents the report of the experiment.
- **Individual and team work**. As we have previously said students work in groups and they have to organize themselves and share the workload.
- **Organization and design**. They need to share the results and explain the finding to the entire group so they are capable to advocate their work.

Skills involved in this experiment are the following:

- Data gathering
- Mathematics techniques
- Transfer theory to practice
- Organizing and planning
- Digital image processing

We discovered that most troubled skills are digital image processing. The process of acquiring image is not simple. Students need to position camera directly in front of the experiment. If they take image from any different angle their results are useless. They need to discover how to take the image. Because of laser they need to use black background and no flash. They need to setup the digital camera manually (increase ISO value, increase expose time, open the iris). In dark condition the tripod is almost mandatory and delayed trigger prevents shaking the camera.

4 Universal digital competences

From the learning materials development described in previous topics we have gain insight to the environment that influences different competences. We have also prepared the scenario to outline the learning path of the students, required outcomes, and as we have said before we have concentrate to the digital competences.

In the problem based approach and project work multiple computer disciplines are interconnected. We divide them to the topics where we describe knowledge, skills and relationships. In the relationship we only include mutual relationship inside digital competences.

Our findings are therefore concentrated into following topics:

Topic: Word-processing

Knowledge:

Every project's documentation is a text document with images, tables and graphs. Students must learn how to prepare the documentation from the beginning of the education. As they progress in the education levels documentations must become more elaborate and formatted as required in the specifications. We must not forget in this topic that importance of references must start as soon as possible in the education. Today generations are called "copy/paste" generations. This is not desired effect of education.

Skills:

- Editing text (typing, insert, delete, find, replace, ...),
- Tables (format, functions),
- Graphics (position, inline, above/behind),
- Equation,
- View & layout,
- Styles,
- Table of (content, images, tables),
- Conversion (DOC, RTF, PDF,...).

Relationship:

- Spreadsheet manipulation
- Image processing
- Presentation techniques
- Internet and communication

Topic: Spreadsheet manipulation

Knowledge:

All experiments are measurable. From the initial data the results are computed. Analysis of the data and results introduce the new knowledge. Therefore manipulation of data is mandatory in all levels of education but the analysis can differ in complexity. It would really be nonsense for a primary school student to perform high level statistical analysis. But the basic descriptive statistic is enough for their comprehension level.

Skills:

- Editing (typing, insert, delete, find, replace, ...)
- Functions (math, text, statistics, ...)
- Pivot tables

Relationship:

- Word processing
- Image processing
- Presentation techniques

Topic: Image processing:

Knowledge:

Advances in the technology today enable almost anyone to have an image capturing device. From GSM build in digital camera to the different types of purposely build digital cameras. The skills of taking image; transferring image; and processing image are not the same. Taking image is often neglected since anyone can push the button. But the difference between poor and good image is huge. Student must know that right illumination is mandatory for image capturing. The composition of the processed image should be foreseen even before the image is captured.

Skills:

- Painting, drawing, cut/paste (objects)

- Image types and files
- Color coding and color transformaton
- Photography
- Scanning
- OCR

Relationship:

- Word processing
- Spreadsheet manipulation
- Presentation techniques
- Interent and communications

Topic: Video & sound processing:
Knowledge:
In some cases even the video should be captured. From the archiving purposes of documented procedures to the promotional video for the projects all require video recording. Students must know that is good and what is bad recording. They need to know what is good and bad video composition. They should practice techniques: hand shaking; panning; and zooming. There are also the issues with the digital processing of video and sound.
Skills:

- Sound and video recording
- Sound and video editing
- Formats and codecs

Relationship:

- Word processing
- Image processing
- Presentation techniques
- Internet and communications

Topic: Presentation techniques
Knowledge:
Today it is widely known that promotion is a must. Presenting the results of the project is not just another nuisance. It is very important topic and should be regarded as fundamental step to another project. If a team prepare bad presentation their chances to acquire another project becomes lower. In the presentation a right mixture of text, image, graphs and tables; and video are mixed. Therefore this topic actually requires knowledge from all other digital skills. Students should learn from the beginning - bad commercial is often the last commercial.
Skills:

- Layout
- Color transformations
- Presentation techniques
- Types and files
- Active elements

Relationship:

- Word processing
- Spreadsheet manipulation
- Image processing
- Video & sound processing
- Internet communication

Topic: Internet & Communication
Knowledge:
Communicational skills are mandatory. Students today often know the techniques. What they do not know is the importance of formal methods in communication. Sending work over internet require knowledge of compression and decompression. How digital certificates work. Protection on the internet.
Skills:

- Knowing different types of communication
- Setting e-mail, forums, chats
- Types and layout of e-mail, forums, chats
- Electronic certificates, phishing, spoofing, security
- Sending data files over communication means
- Web searchers, public/payable databases

Relationship:

- Word processing
- Presentation techniques
- Image processing
- Video & sound processing

Conclusions

It was time to change TLS paradigm. Since computers are used in education we have problems how to adapt to the changing reality. The project "Development of Natural Science Competences" wants to change the way we teach students. Step by step approach with gradual changes we develop new learning materials with changed paradigm in mind - teach the competences. Gathering enough information we laid the foundation for universal digital competences. We hope that this new paradigm with the new set of required competences will change the educational processes and perform better in contemporary world. Digital competences are subjected to the fast changes in technology and our work should be observed just as a start to the endless changes that will follow.

Acknowledgements

We greatly acknowledge the support of the Ministry of Education and Sport of Republic of Slovenia and European Social Fund in the frame of "Project: Development of Natural Science Competences" on Faculty of Natural Sciences of University of Maribor.

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