Inclusion of Digital Competence in Educational Physics Study in Croatia and Slovenia

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***Abstract* - Technology is all around us in our daily lives, in mobile phones, televisions, computers, and smart devices. Teachers need to incorporate digital tools into their lessons and perform other activities to develop digital competence. There are three key competences that have been identified by the European Union (2019), and we believe there is an opportunity to address them in physics teacher education programs. These are mathematical competence, competence in science, technology and engineering, and digital competence. One of the important issues is experimental work in physics education, especially when we look at specific subgroups of students. For example, an ongoing challenge for teachers is to combine experimental activities with the development of different competences. We will address the questions, what are the essential knowledge, skills and attitudes related to digital competence, and do physics teachers acquire them during their studies? We focused on the inclusion of digital competence in physics teacher studies, and we examined the description of subjects in the physics curriculum at several faculties in Croatia and in Slovenia.**

Keywords – digital competence, educational physics study, study subjects

I. INTRODUCTION

The education of physics teachers should provide necessary knowledge and skills in physics, as well as the knowledge and skills for imparting knowledge to students. We are living in a time of rapid change, and after completing their education, teachers should have a basis for their work to build on through lifelong learning. The biggest changes are the possibilities and application of digital technology. It is necessary for physics teachers to acquire skills to promote the development of digital competences in students.

According to Tibor Navracsics (European Commissioner for Education, Culture, Youth and Sport, 2014-2019), there are necessary skills for coping with daily life, such as critical thinking, media literacy and communication skills, while the fundamental skills for lifelong education are digital skills, literacy, mathematics and science. The Council of the European Union issued a recommendation on eight key competences that should be encouraged and developed in the education system and continue to be developed through lifelong learning. Each competence consists of knowledge, skills and attitudes.

Digital competence includes the confident and responsible use of digital technologies for learning, work, and participation in society, as well as information and data literacy, communication, media literacy, digital content creation, safety, intellectual property, problem solving, and critical thinking. [1]

Following these recommendations, teachers should improve their level of digital competence on a daily basis. Furthermore, acquired knowledge and skills in these subjects, and their application in teaching, can help in assisting students with special needs.

In Chapter 2 we present methodology. In chapter 3, available study program documents from the University of Osijek, Rijeka, Split, Zagreb and Maribor will be analysed. Chapter 4 will describe the possible application of certain digital competencies in teaching physics at school and will give an example. The conclusion of the work will be given in the fifth chapter.

II. METHODOLOGY

The analysis in this paper relies on publicly available documents. Many documents in the public domain have been written by skilled professionals and contain valuable information [2]. According to LeCompte and Preissle, important considerations for document analysis include: the position of the researcher, choice of informant/respondents, social situations and conditions, analytic constructs and premises used, and methods of data collection and analysis [2].

According [1] digital knowledge: Digital literacy requires individuals to have an understanding of how digital technologies can facilitate communication, creativity, and innovation, while also being conscious of their potential limitations, effects, and risks. This involves having knowledge of the general principles, mechanisms, and logic underlying evolving digital technologies, as well as the basic functions and uses of various devices, software, and networks. Individuals should also possess critical thinking skills to evaluate the validity, reliability, and the impact of information and data that is accessible via digital means, and be mindful of the legal and ethical principles related to engaging with digital technologies. Digital skills enable individuals to use technology to support their social and professional goals, including active citizenship, social inclusion, and collaboration with

others. These skills include the ability to use, access, filter, evaluate, create, program and share digital content, as well as manage and protect information, data, and digital identities. Individuals should also be able to recognize and engage effectively with software, devices, artificial intelligence, and robots. Attitudes towards digital technologies should be reflective, critical, open-minded, and forward-looking, and include an ethical, safe, and responsible approach.

Official documents on the description of subjects taught in physics study programs are not standardized between universities. Certain information is not publicly available, so an analysis of the available documents was performed. The parts of the documents related to the development of digital competences are general. The assumption why they are written in such a way is that digital technology is developing very quickly, while the process of changes in course descriptions is much slower.

III. Analysis of study programs in Croatia and Slovenia

We analyzed the available documents of study programs for physics teachers in five universities in Croatia and in one in Slovenia: the University of Osijek, the University of Rijeka, the University of Split, the University of Zagreb and the University of Maribor. Students at these institutions can choose elective courses in which they acquire additional digital competences, but they will not be covered in this paper, since all students are not required to take those courses.

A. University of Osijek

At the University of Osijek, students can enroll in an undergraduate course in physics and after three years, a graduate course, to become a teacher of physics and computer science. Course descriptions for undergraduate studies can be found at [3] and for graduate studies at [4]. The graduate study of physics and information science has more subjects in the area of information science, and students are provided instruction in digital competences.

In the first semester of undergraduate study, students take Basics of Information Science, and Text Processing and Spreadsheets, in which they acquire knowledge about programming tools that will help them to continue their studies and professional development. In the second semester, they take Basics of Programming 1, in which they learn basic concepts of programming and software development. In the third semester, they take Programming Basics 2, a continuation of the course from the previous semester, and Practicum in Physics Basics 1, in which, in addition to acquiring experimental skills, they process the results using a computer. In the fourth semester, they take Practicum in the Basics of Physics 2, a continuation of the course from the previous semester, except that the experiments are in a different area of physics. In the fifth semester, the descriptions of compulsory courses do not explicitly state the development of digital competences. In the sixth semester, they take the Computer Physics course, with the goal of developing skills solving physical problems numerically in Python.

In the first semester of graduate study, students take the Practicum in Experimental Teaching of Physics 1, in which they acquire skills in conducting experiments adapted for teaching in primary and secondary schools using different devices and computers. In Statistical Data Processing Using Computers, they expand their knowledge of statistics. In the second semester they take the Practical Course in Experimental Teaching of Physics II, a continuation of the course from the previous semester. In the third semester, they take Computer Science Teaching Methodology, in which they acquire digital competences for computer science teaching, and Project Management, in which they acquire and apply digital competences for the creation and implementation of projects. In the fourth semester, there is a Practicum in Computer Science Teaching Methodology, in which the acquisition of digital competences is focused on computer science teaching, but it can also be applied to physics teaching with modification.

B. University of Rijeka

At the University of Rijeka, students can enroll in an undergraduate course in physics, and after completing three years, they can take a graduate course to become a teacher of physics and computer science or a course to become a teacher of physics and mathematics. Course descriptions for undergraduate studies can be found at [5] and for graduate studies at [6] and [7]. In our analysis of graduate studies, we will concentrate on joint courses. The graduate study of physics and information science provides students with formal knowledge in the field of digital competences.

In the first semester of undergraduate studies, students take Programming. In the second semester they take Experimental Data Processing in Physics, in which they acquire and apply digital competences. In the third semester, they take Physical Practicum I, in which they acquire experimental skills, and apply digital competences. In the fourth semester they take Physical Practicum II, a continuation of the course from the previous semester. In the fifth semester they take Physical Practicum III, a continuation of the course from the previous semesters. In the sixth semester, they take Physical Practicum IV.

In the first semester of graduate study, students take the courses Methodical Practical Demonstration Experiments in Physics, Didactics 2, and General Pedagogy, in which they acquire advanced digital competences. In the second semester, they take Methodological Practicum of Laboratory Experiments in Physics, in which they learn to use and analyze educational films in physics classes; the titles of the exercises are written, but there is no information on how they are carried out. In the third semester they take Physics Teaching Methodology II, in which they learn information and communication technology (ICT) in physics teaching. In the fourth semester, Methodical Practice in Physics provides competences for connecting professional knowledge in physics with pedagogical knowledge and modern teaching technologies (ICT).

C. University of Split

At the University of Split, prospective students in the Faculty of Science and Mathematics can enroll in the undergraduate study of physics and undergraduate study of physics and mathematics (teaching). After completing the first cycle, they can enroll in graduate studies in physics (teaching), physics and information sciences (teaching), and physics and mathematics (teaching). In our analysis, we concentrated on the physics major because there was not enough publicly available information on the physics and mathematics majors (for teachers). At the graduate level in physics and information science (for teachers), students acquire more digital competences through formal education. We focused on the common subjects that all majors share. Unlike other universities, the subject descriptions at the University of Split explicitly state what percentage of e-learning is represented in which subject. This analysis does not pay much attention to it because there is no explanation of what it entails. E-learning can be merely a different form of work that does not necessarily result in the development of digital competences.

In the first semester, both majors offer textual and graphic programs for physicists, in which the main goal is to enable students to use Gnuplot and LaTeX in order to successfully continue their educations [8]. Physics students attend the course Programming in the Profession, in which the goal is to learn the basics of programming that they will need in their further education and work [9]. In the undergraduate teacher training program in physics and mathematics, this subject is offered in the fifth semester. In the second semester, students take the course Programming Tools in Physics, with the goal of learning different programming tools that can be applied to concrete examples [10]. In the third semester, the compulsory courses do not explicitly mention the development of digital skills [11]. In the fourth semester, students apply digital skills in the course Practicum in General Physics II, which is a continuation of the course from the previous semester [12]. In the fifth semester, they take a continuation of the course Practicum in General Physics III [13] and apply the acquired digital competences in the course Mathematical Methods of Physics III [14]. In the sixth semester, they also have a continuation of the General Physics Practical IV course [15].

In the first semester of graduate studies in all majors, none of the courses explicitly states that they develop digital skills. There are courses in the physics and information science teaching program where digital skills are developed, but these are related to the narrower field of information science. In the second semester, all students attend the Physics Teaching Methodology course in which they acquire digital competences [16]. In the third semester, certain subjects are compulsory in some programs, while in others they are optional. These include E-learning Systems [17] and Physics Teaching Methodology II [18]. In the fourth semester, the courses are partly conducted in schools and, depending on the mentors in the classrooms, students acquire and develop digital skills. They are not described in detail in the subject descriptions because many factors affect the amount and type of digital competences [19] [20].

D. University of Zagreb

At the University of Zagreb, Faculty of Science and Mathematics, students can enroll in four combinations of majors for physics teachers. These are Teaching Physics, Teaching Physics and Information Science, Teaching Physics and Chemistry, and Teaching Physics and Mathematics. Each major lasts five years. The description of the course for Teaching Physics and Mathematics is not publicly available, so we omitted it from this article. The Physics and Information Science Teaching Major has more information science subjects, which is self-explanatory, and thus students acquire and develop more digital competences through their formal education. In the first three years of study in all majors, there is a greater emphasis on general subjects in physics, while in the last two years, knowledge and skills are acquired in pedagogy, psychology, didactics, and physics methodology. We will concentrate on subjects that all majors have in common to gain insight into what competences a physics teacher acquires. Certain subjects require writing a seminar paper or a similar work in which general critical thinking and the use of digital technology for creation and presentation are encouraged. Some courses mention e-learning, which is a form of teaching that is carried out and does not necessarily have to be for the development of competences, which is why it is not emphasized in our study.

In the first semester of the Physics major and the Physics and Information Science major, students take the course Word Processing and Spread Sheets, in which they learn the basics of LaTeX, MS Word and Excel in order to successfully continue their studies and future work at school [21]. The Physics and Chemistry teaching major does not have such a course. In the second semester, students in the programs of Pedagogy of Physics and Chemistry take the subject Computers and Operating Systems, in which they theoretically and practically learn about computers and programs [22]. The Physics and Information Science Teaching major offers a more specialized course called Fundamentals of Programming. All three majors offer the subject Fundamentals of Physics Measurements, in which they use the computer programs Excel, Statistica and Qplot to apply acquired theoretical knowledge to processing experimental data, as well as the results of student work [23].

In the third semester of the teacher's course in Physics and Information Science, students take professional subjects in the field of information science in which digital competences are developed. The Physics major offers the subject Computing Lab 1, in which students improve practical competences, connecting physics with information technology [24]. The teaching department of physics and the teaching department of Physics and Chemistry offer Physics Lab 1, in which students develop experimental skills in conducting experiments in physics, as well as digital competences. Students use programs for statistical analysis and to display numerical and graphical results. In the fourth semester, there are no explicitly stated outcomes of the development of digital

competences in the physics and chemistry teachers' course, but the Physics and Information Science teachers' program offers professional courses in the field of information science. The Department of Physics offers Computing Lab 2, [25] and Physics Lab 2, which continue the subjects from the previous semester, including exercises from other areas of physics [26].

In the fifth semester, students majoring in Physics and Information Science have professional courses in information science, as well as Physics Lab 1, which develops their digital competences. Physics Lab 1 is the same subject taken by students of the teachers' course in Physics in the third semester. For the teaching major of Physics and Chemistry, the outcomes that would develop digital skills in the fifth semester are not explicitly stated. In the fifth semester, physics students take Physics Lab 3 in which they apply their acquired digital knowledge and skills [27]. In the sixth semester, students majoring in Physics take Physics Lab 4, but unfortunately there is no publicly available course description. The Fundamentals of Electronics course mentions the outcome related to the use of computers and different sensors in physics experiments [28]. Physics and chemistry teaching students and physics and information science teaching students take the subject Physics Lab 2, which was previously described.

In the seventh semester, all teaching majors have Laboratory in Physics Education 1, in which they learn to perform experiments properly and use digital technology [29]. In the eighth semester, all teaching majors take Laboratory in Physics Education 2, which is a continuation of the course from the previous semester, except that there are exercises from other areas of physics [30]. The Physics and Information Science teaching major offers Fundamentals of Electronics, which was previously described. It also offers Computers in Education, which develops digital competences according to the stated outcomes [31]. In the ninth semester, all teaching majors take the subject Teaching Practice in Physics 1, in which students go to practice at schools; the description of the subject is very general, so digital competences cannot be explicitly read [32]. Physics teachers take another subject, Laboratory in Physics Education 3, in which they acquire additional digital competences [33]. In the tenth semester, all majors take the Course Teaching Practice in Physics 2, a continuation of the course from the previous semester [34].

E. University of Maribor

At the University of Maribor, prospective students can choose different combinations of teaching majors. In this paper, we will deal with the subjects that students of the teaching major in physics must pass. The entire study program lasts five years. In almost every study subject, teaching methods include the use of information technology, so this will not be emphasized in the text because it is not explained for each subject how it is used.

In the first semester, students attend Computational Physics, about the construction and operation of computers, and learn the knowledge and skills they need for further education and work [35]. Also, students take Mechanics, in which they have laboratory exercises where they learn and acquire digital competences [36]. In the second semester, students attend Physics Experiments 1, where they analyze data using a computer and use computer simulations in class [37]. In the third semester, they attend the continuation of the course from the previous semester, Physics Experiments 2, in which they continue to develop their digital competences [38]. In the fourth semester, Physics Experiments 3 continues, in which they continue to develop their digital competences [39]. In Thermodynamics, students acquire the skills to use modern computer software for quantitative calculations and plotting dependencies among variables with varying parameters [40].

In the fifth semester, students attend Physics Experiments 4, in which they continue to develop digital competences [41]. In Didactics of Physics 1 with Practicum, they acquire digital competences with an emphasis on quality in teaching [42]. In the sixth semester, students in Didactics of Astronomy connect astronomy and digital technology, thereby developing their digital competences [43]. In the seventh semester, they take Didactics of Physics 2 with Practicum, a continuation of the course from the fifth semester, and learn and apply digital technology in other areas [44]. In Measurements in Physics, they process data and use digital technology, further developing digital competences [45]. In the eighth semester, they attend Astronomical Observations, in which they use astronomical computer programs and digitally process data, improving their digital skills [46]. In the ninth semester, they take subjects in which they use digital technology, but it is not explicitly written in what way. In the tenth semester, students write a graduation thesis and take electives that they choose according to their own preferences.

In the table 1. we present the results of the study program analysis, where the number of shaded squares represents the number of courses in that semester with explicitly written digital competences in their course descriptions. Elective courses were not taken into consideration.

TABLE I. PRESENTATION OF THE NUMBER OF COURSES THAT USE DIGITAL TECHNOLOGIES

Semester / University	*Osijek*			*Rijeka*			*Split*			*Zagreb*			*Maribor*		
1	■	■		■			■			■			■	■	
2	■			■			■			■	■		■		
3	■	■		■						■			■		
4	■			■			■			■	■		■	■	
5				■			■	■		■			■	■	
6	■			■			■			■			■		
7	■	■		■	■	■				■			■	■	
8	■			■			■			■			■		
9	■	■		■						■	■				
10	■			■						■					

IV. THE FUTURE OF THE APPLICATION OF DIGITAL COMPETENCES IN PHYSICS TEACHING

By properly including and using digital technologies in physics classes, students' digital competences can be

improved. The example chosen for this paper is the introduction of total resistance when resistors are connected in series. [47]

First, the teacher connects two resistors in series and measures the voltage across those two resistors and the current, then connects three resistors and measures the current and voltage (Figure 1.). If the school equipment allows, it would be even better if the students connect the circuits themselves. When the students have seen a certain regularity, the computer can be included in the experiment. The two previously described circuits are reconnected, but now a computer is used (Figure 2). Phet's simulation can be used to further improve students' digital competences by repeating the entire process (Figure 3.) [48]. Also, additional combinations can be made in the simulation.

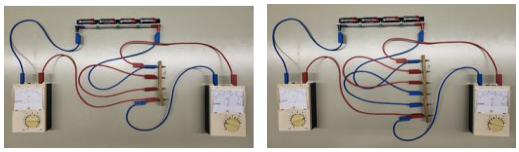

Figure 1. The image on the left shows two resistors connected in series. The picture on the right shows three resistors connected in series. The voltage and current in the circuit are measured using an ammeter and a voltmeter.

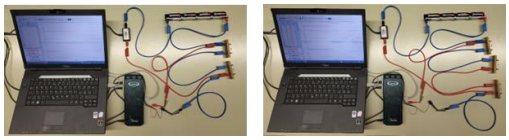

Figure 2. The image on the left shows two resistors connected in series. The picture on the right shows three resistors connected in series. This experimental setup includes sensors that are connected to a computer.

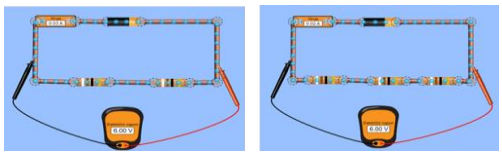

Figure 3. The picture shows the circuit simulated in Phet's simulation [48]

Physics teaching should rely on experiments carried out by the teacher in cooperation with the students. The experiment as a starting point for the study of any teaching material can be modernized by using computers, and sometimes simulations. Research [49] shows that half of Croatian secondary school teachers do not have adequate digital competences and that the attitudes and educational values, computer anxiety, self-efficacy etc. are related to the perceived Croatian secondary school teachers' intention to use e-learning technologies in their teaching after the COVID-19 pandemic.

V. Conclusion

During their formal education, students of the physical sciences acquire digital competences that they can apply in their future work as teachers. Because of recent rapid changes in the digital sciences, it is very important that teachers continue with further education in order to better attain and transfer digital competences to students. Further research is needed in order to gain insight into the quality of the acquired digital competences needed in today's schools. Future research should try to incorporate study programs from many nations in order to acquire a more thorough grasp of digital skills across various educational systems. Even if the present examination of the descriptions of the available physics study programs yielded useful insights, including interviews with the course instructors and polling the students could provide other viewpoints.

References

[1] European Commission. (2018). Key Competences for Lifelong Learning. doi:10.2766/569540

[2] L. Cohen, L. Manion, and K. Morrison, Research Methods in Education, 6th ed. Routledge, 2018.

[3] Sveučilište Josipa Jurja Strossmayera u Osijeku, Odjel za fiziku. (2022). Izvedbeni plan preddiplomskog studija Fizika akademske godine 2022/2023 [PDF]. Available: https://www.fizika.unios.hr/wp-content/uploads/2022/09/Izvedbeni-plan_preddiplomski_2022_2023_prosireni.pdf [Accessed: Jan. 29, 2023].

[4] Sveučilište Josipa Jurja Strossmayera u Osijeku, Odjel za fiziku. (2022). Izvedbeni plan diplomskog studija Fizika akademske godine 2022/2023 [PDF]. Available: https://www.fizika.unios.hr/wp-content/uploads/2022/09/Izvedbeni-plan_diplomski_2022_2023_prosireni.pdf [Accessed: Jan. 29, 2023].

[5] University of Rijeka, Department of Physics, 2022. IZMJENE I DOPUNE PREDDIPLOMSKOG STUDIJA FIZIKA Available: https://www.phy.uniri.hr/files/nastava/preddiplomski_studij/planovi_i_opisi_2022/Preddipl%20Fizika_Izmjene%20i%20dopune_svibanj%202022_prihvaceno%20na%20Vijecu.pdf [Accessed: Feb. 2, 2023].

[6] University of Rijeka, Department of Physics, "Izmjene i dopune Studijskog programa Diplomski studij Fizika - smjer Fizika i informatika" [Online]. Available: https://www.phy.uniri.hr/files/nastava/diplomski_studiji/fizika_informatika/Izmjene_i_dopune/Dipl%20FI_izmjene%20i%20dopune_2018.pdf . [Accessed: Feb. 4, 2023].

[7] University of Rijeka, Department of Physics, "Izmjene i dopune Studijskog programa Diplomski studij Fizika - smjer Fizika i matematike" [Online]. Available: https://www.phy.uniri.hr/files/nastava/diplomski_studiji/fizika_matematika/Izmjene_i_dopune/Dipl_FM_obrazac_izmjene_i_dopune_2018.pdf [Accessed: Feb. 10, 2023].

[8] University of Split, Faculty of Science, Department of Physics, Tekstualni i grafički programi za fizičare Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP071.pdf [Accessed: Jan. 30, 2023].

[9] University of Split, Faculty of Science, Department of Physics, Programiranje u struci Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP073.pdf [Accessed: Jan. 30, 2023].

[10] University of Split, Faculty of Science, Department of Physics, Programski alati u fizici Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP074.pdf [Accessed: Jan. 30, 2023].

[11] University of Split, Faculty of Science, Department of Physics, Praktikum iz opće fizike I Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP011.pdf [Accessed: Jan. 30, 2023].

[12] University of Split, Faculty of Science, Department of Physics, Praktikum iz opće fizike II Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP012.pdf [Accessed: Jan. 30, 2023].

[13] University of Split, Faculty of Science, Department of Physics, Praktikum iz opće fizike III Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP013.pdf [Accessed: Jan. 30, 2023].

[14] University of Split, Faculty of Science, Department of Physics, Matematičke metode fizike III Available: https://www.pmfst.

unist.hr/wp-content/uploads/predmeti/PMP102.pdf [Accessed: Jan. 30, 2023].

[15] University of Split, Faculty of Science, Department of Physics, Praktikum iz opće fizike IV Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP014.pdf [Accessed: Jan. 30, 2023].

[16] University of Split, Faculty of Science, Department of Physics, Metodika nastave fizike I Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP050.pdf [Accessed: Jan. 30, 2023].

[17] University of Split, Faculty of Science, Department of Physics, Metodika nastave fizike II Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP150.pdf [Accessed: Jan. 30, 2023].

[18] University of Split, Faculty of Science, Department of Physics, Sustavi E-učenja Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMIK10.pdf [Accessed: Jan. 30, 2023].

[19] University of Split, Faculty of Science, Department of Physics, Seminar iz metodike fizike s nastavnom praksom Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMP152.pdf [Accessed: Jan. 30, 2023].

[20] University of Split, Faculty of Science, Department of Physics, Metodički informatički seminar s nastavnom praksom II Available: https://www.pmfst.unist.hr/wp-content/uploads/predmeti/PMIK61.pdf [Accessed: Jan. 30, 2023].

[21] University of Zagreb, Faculty of Science. WORD PROCESSING AND SPREAD SHEETS Available: https://www.pmf.unizg.hr/phy/en/course/otpt_b [Accessed: Jan. 14, 2023].

[22] University of Zagreb, Faculty of Science. COMPUTERS AND OPERATING SYSTEMS Available: https://www.pmf.unizg.hr/phy/en/course/ros_b [Accessed: Jan. 14, 2023].

[23] University of Zagreb, Faculty of Science. FUNDAMENTALS OF PHYSICS MEASUREMENTS Available: https://www.pmf.unizg.hr/phy/en/course/sofm [Accessed: Jan. 14, 2023].

[24] University of Zagreb, Faculty of Science. COMPUTING LAB 1 Available: https://www.pmf.unizg.hr/phy/en/course/racpra1 [Accessed: Jan. 14, 2023].

[25] University of Zagreb, Faculty of Science. COMPUTING LAB 2 Available: https://www.pmf.unizg.hr/phy/en/course/racpra2 [Accessed: Jan. 14, 2023].

[26] University of Zagreb, Faculty of Science. PHYSICS LAB 2 Available: https://www.pmf.unizg.hr/phy/en/course/fizpra2 [Accessed: Jan. 14, 2023].

[27] University of Zagreb, Faculty of Science. PHYSICS LAB 3 Available: https://www.pmf.unizg.hr/phy/en/course/fizpra3 [Accessed: Jan. 14, 2023].

[28] University of Zagreb, Faculty of Science. FUNDAMENTALS OF ELECTRONICS Available: https://www.pmf.unizg.hr/phy/en/course/osnele_a [Accessed: Jan. 14, 2023].

[29] University of Zagreb, Faculty of Science. LABORATORY IN PHYSICS EDUCATION 1 Available: https://www.pmf.unizg.hr/phy/en/course/pienf1 [Accessed: Jan. 14, 2023].

[30] University of Zagreb, Faculty of Science. LABORATORY IN PHYSICS EDUCATION 2 Available: https://www.pmf.unizg.hr/phy/en/course/pienf2_b [Accessed: Jan. 14, 2023].

[31] University of Zagreb, Faculty of Science. COMPUTERS IN EDUCATION Available: https://www.pmf.unizg.hr/phy/en/course/urun_b [Accessed: Jan. 14, 2023].

[32] University of Zagreb, Faculty of Science. TEACHING PRACTICE IN PHYSICS 1 Available: https://www.pmf.unizg.hr/phy/en/course/mpif1_b [Accessed: Jan. 14, 2023].

[33] University of Zagreb, Faculty of Science. LABORATORY IN PHYSICS EDUCATION 3 Available: https://www.pmf.unizg.hr/phy/en/course/pienf3 [Accessed: Jan. 14, 2023].

[34] University of Zagreb, Faculty of Science. TEACHING PRACTICE IN PHYSICS 2 Available: https://www.pmf.unizg.hr/phy/en/course/mpif2_a [Accessed: Jan. 14, 2023].

[35] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Computational physics Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Racunska_fizika.pdf [Accessed: Feb. 12, 2023].

[36] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Mechanics Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZOB_FIZ_PU_mehanika-maj2022_popravljeno.pdf [Accessed: Feb. 12, 2023].

[37] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, hysics experiments 1 Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZOB_FIZ_Fizikalni-Eksperimenti-1-EMAG-nova-verzija-AD.pdf [Accessed: Feb. 12, 2023].

[38] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Physics experiments 2 Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Fizikalni_eksperimenti_2.pdf [Accessed: Feb. 12, 2023].

[39] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Physics experiments 3 Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Fizikalni_eksperimenti_3.pdf [Accessed: Feb. 12, 2023].

[40] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Thermodynamics Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Termodinamika.pdf [Accessed: Feb. 12, 2023].

[41] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Physics experiments 4 Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Fizikalni_eksperimenti_4.pdf [Accessed: Feb. 12, 2023].

[42] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Didactics of physics 1 with practicum Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZOB_FIZ_Didaktika_fizike_1_s_praktikumom-nov.pdf [Accessed: Feb. 12, 2023].

[43] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Didactics of Astronomy Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZOB_FIZ_Didaktika_astronomije-EMAG.pdf [Accessed: Feb. 12, 2023].

[44] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Didactics of physics 2 with practicum Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZOB_FIZ_Didaktika_fizike_2_s_praktikumom-nov.pdf [Accessed: Feb. 12, 2023].

[45] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Measurements in Physics Available: https://www.fnm.um.si/wpcontent/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Fizikalna_merjenja.pdf [Accessed: Feb. 12, 2023].

[46] Univerza v Mariboru, Fakulteta za naravoslovje in matematiko, Astronomical observations Available: https://www.fnm.um.si/wp-content/uploads/predmetniki/1_stopnja/predmetni-ucitelj/izofiz/2022-2023/EMAG_IZO-FIZ_Astronomska_opazovanja.pdf [Accessed: Feb. 12, 2023].

[47] R. Repnik, "Using physics simulation environment for better students' performance," 2018 41st International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, Croatia, 2018, pp. 0819-0824, doi: 10.23919/MIPRO.2018.8400151.

[48] PhET Interactive Simulations, Circuit Construction Kit DC Simulation Available: https://phet.colorado.edu/hr/simulations/circuit-construction-kit-dc [Accessed: 1-Feb-2023].

[49] S. Babić, S. Križan Sučić, and G. Sinković, "Understanding the factors that influence secondary school teachers' intention to use e-learning technologies for teaching after the COVID-19 pandemic," in Proceedings of the 43rd International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, Croatia, 2020, pp. 938-943, doi:10.23919/MIPRO49410.2020.92