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VIRTUAL LEARNING – VIRTUAL REALITY

Radu Jugureanu • Grigore Albeanu • Dorin Mircea Popovici
Olimpius Istrate •Adrian Adăscăliței
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Editors:
Radu Jugureanu, ROSE Project
Grigore Albeanu, "Spiru Haret" University
Dorin Mircea Popovici, "Ovidius" University of Constanta
Olimpius Istrate, Bucharest University
Adrian Adăscăliței, "Gheorghe Asachi" Technical University

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All papers were presented during conference according to the schedule.
All papers were checked for plagiarism.
However, there is no perfect software to certify "free of plagiarism".
All papers were reviewed for scientific value and relevance.
The responsibility for the results presented in this book is assumed by authors.

Contents

About ICVL 2021

ICVL Project intends to explore and propose innovations in education in the perspective of the Knowledge Society. The International Conference on Virtual Learning contributes to the development of both theory and practice in the field of Virtual Learning having the following objectives: creating a framework for a large scale introduction of the eLearning approaches in teaching and training activities; assisting the teachers, professors and trainers in the use of innovative teaching technologies both in formal education and life-long learning; stimulating the development of eLearning projects and software for education process and systems; promoting and developing scientific research for eLearning, educational software and virtual reality.

Participation is invited from researchers, teachers, trainers, educational authorities, learners, practitioners, employers, trade unions, and private sector actors and IT industry.

The ICVL committee accepts academically robust papers, topical articles and case studies that contribute to Virtual Environments for Education and Training (VEE&T), Virtual Reality (VR), Computer Vision (CV), Information and Knowledge Processing (I&KP), and presenting, as well, practical results and original applications. The education category includes:

- The use of Web Technologies, Computer Graphics and Virtual Reality / Augmented Reality Applications;
- New tools, methods, pedagogy and psychology;
- Case studies of Web Technologies and Streaming Multimedia Applications in Education;
- Experience in preparation of courseware;
- Design and Development of Massive Open Online Courses (MOOCs).

The main sections and related topics are (http://c3.icvl.eu/):

- **Models & Methodologies (M&M):** Innovative Teaching and Learning Technologies; Web-based Methods and Tools in Traditional, Online Education and Training; Collaborative Virtual Learning, E-Pedagogy; Design and Development of Online Courseware; Information and Knowledge Processing; Knowledge Representation and Ontologism; Cognitive Modelling and Intelligent systems; Algorithms and Programming for Modelling.

- **Technologies & Virtual Laboratory (TECH):** Innovative VR and Web-based Teaching and Learning Technologies; Advanced Distributed Learning (ADL) technologies; Web, Virtual Reality/AR and mixed technologies; Web-based Education (WBE), Web-based Training (WBT); New technologies for e-Learning, e-Training and e-Skills / e-Competences; Educational Technology, Web-Lecturing Technology; Mobile E-Learning, Communication Technology Applications; Computer Graphics and Computational Geometry. Intelligent Virtual Environments.

- **Software Solutions (SOFT):** New software environments for education & training; Software and management for education; Virtual Reality Applications in Web-based Education; Computer Graphics, Web, VR/AR and mixed-based applications for education & training, business, medicine, industry and other sciences; Multi-agent Technology Applications in WBE and WBT; Streaming Multimedia Applications in Learning; Scientific Web-based Laboratories and Virtual Labs; Software Computing in Virtual Reality and Artificial Intelligence; Avatars and Intelligent Agents.

- **Intel® Education - Innovation in education and research (IntelEdu):** Digital Curriculum, collaborative rich-media applications, student software, teacher software; Improved Learning Methods, interactive and collaborative methods to help teachers incorporate technology into their lesson plans and enable students to learn anytime, anywhere; Professional Development, readily available training to help teachers acquire the necessary ICT skills; Connectivity and Technology, group projects and improve communication among teachers, students, parents and administrators.

From the first edition in 2006, ICVL has published 15 volumes (one volume per year), and awarded 13 papers, as shown in the following table (http://c3.icvl.eu/).

Order Number	ICVL edition	ICVL Location	Received papers	Published papers	Awarded papers
1	2006	Bucharest	55	34	--
2	2007	Constantza	45	35	2
3	2008	Constantza	64	44	2
4	2009	Iassy	103	52	2
5	2010	Targu-Mures	134	78	2
6	2011	Cluj-Napoca	145	85	--
7	2012	Brasov	146	67	3
8	2013	Bucharest	104	55	2
9	2014	Bucharest	155	70	--
10	2015	Timisoara	121	69	--
11	2016	Craiova	101	55	--
12	2017	Sibiu	116	74	--
13	2018	Alba iulia	124	82	--
14	2019	Bucharest	144	87	--
15	2020	Bucharest-ONLINE	123	77	--

The 2021 edition of ICVL was planned for October 30, 2021. However, the death of the leader of the ICVL Project, associate professor **Dr. Marin Vlada**, in the last decade of September 2021, led to the postponement of the event for November 20, 2021.

Organized on this day, in two parallel sections, all 28 articles accepted by the program committee have been presented online using the ZOOM platform. This volume contains all these works in the final version for publication after their improvement by the authors following the recommendations submitted by scientific reviewers. Some articles were directly rejected either because of plagiarism, or because of poor contributions to one of the conference's topics, or because of the inappropriate subject for the ICVL.

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First, our thoughts go to **Marin Vlada**, the initiator of the ICVL project, who, year after year, managed not only the electronic platform of the project, but also the coordination of all tasks necessary for the conference, almost every time, in another city in Romania. In parallel with the ICVL, the National Conference on Virtual Education (CNIV) was held with the large participation of teachers and students from the pre-university environment in Romania. Marin Vlada thought of the ICVL and CNIV projects as high-profile events that would bring added value in the field of learning with the help of modern technologies.

The success of a rigorously conference asks for strong efforts of many parties like chairs, reviewers, and contributors. Fair and detailed feedback was sent to authors by the Technical Program Committee based on reviewers' recommendations. Despite the time pressure imposed by the new conference deadlines, authors did their best to supply camera ready version in time before the conference. Finally, the volume has been processed according to the ICVL standards.

We are extremely grateful for efforts of all mentioned parties. Below, the lists of Chairs, Scientific committee/Technical Program Committee/Reviewers and Contributors are given.

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General Chair Associates:

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Dr. Gabriela **MOISE,** *Petroleum-Gas University of Ploiesti*,
Faculty of Letters and Sciences, Ploiesti, Romania

Dr. Mihaela **OPREA,** Petroleum-Gas University of Ploiesti,
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Dr. Zlatin **ZLATEV,** *Trakia University*, Faculty of Technics and Technologies, Yambol, Bulgaria

Contributors

Antoaneta Dimitrova, *Trakia University*, Bulgaria
Avadanei Manuela-Lacramioara, *"Gheorghe Asachi" Technical University*, Iași, Romania
Barna Valentin, *University of Bucharest*, Romania
Berlic Catalin, *University of Bucharest*, Romania
Bogdan Mihai, *"Lucian Blaga" University of Sibiu*, Romania
Burlacu Natalia, *Technical University of Moldova*, Chișinău, Rep. Moldova
Burlan Bogdan, *Petroleum-Gas University of Ploiesti*, Romania
Cernicova-Buca Mariana, *Politehnica University of Timișoara*, Romania
Chiriacescu Bogdan, *University of Bucharest*, Romania
Chiriacescu Fabiola-Sanda, *University of Bucharest*, Romania
Colt Marilena, *University of Bucharest*, Romania
Costache Daniel, *University of Bucharest*, Romania
Crăciunoiu Alexandra, *Tremend Software Consulting*
Curteza Antonela, *"Gheorghe Asachi" Technical University*, Iași, Romania
Dineva Snejana, *Trakia University*, Bulgaria
Dinu Ion Georgian, *Petroleum-Gas University of Ploiesti*, Romania
Dragomir Florentina Loredana, *Carol I National Defence University*, Romania
Dragomir Marilena-Cătălina, *Polytechnic University of Bucharest*, Romania
Dumitru Victor-Tiberiu, *University of Bucharest*, Romania
Fartușnic Ciprian, *National Centre for Educational Policies and Evaluation*, Romania
Gherheș Vasile, *Politehnica University of Timișoara*, Romania
Istrate Olimpius, *University of Bucharest*, Romania
Katerina Despot, *Goce Delchev University*, Stip, R. N. Macedonia
Krum Videnov, *Trakia University*, Bulgaria
Labăr Adrian, *Alexandru Ioan Cuza University*, Iași, Romania
Lotrean Elena, *Finnish Teacher Training Centre*, Sibiu, Romania
Marta Kosturska, *Goce Delchev University*, Stip, R. N. Macedonia
Mihai Aura, *"Gheorghe Asachi" Technical University*, Iași, Romania
Mihăilescu Luca, *University of Bucharest*, Romania
Miron Cristina, *University of Bucharest*, Romania
Miroslav Vasilev, *Trakia University*, Bulgaria
Morcov Stefan, *Tremend Benelux, Katholieke Universiteit Leuven*, Belgium
Moșoiu Oana, *University of Bucharest*, Romania
Nedeva Veselina, *Trakia University*, Bulgaria
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Opriș Edina-Timea, *Babes-Bolyai University*, Romania
Popescu Eleonora, *University of Bucharest*, Romania
Popescu Mihai, "*Ion Luca Caragiale" National College*, Ploiesti, Romania
Pupezescu Valentin, *Polytechnic University of Bucharest*, Romania
Seul Arina, *"Gheorghe Asachi" Technical University*, Iași, Romania
Silviya Dechkova, *Technical University of Sofia*, Bulgaria

Section M&M
Models and Methodologies

Artificial Intelligence Based Approaches for Higher Education Applications

Mihaela Oprea

Petroleum-Gas University of Ploiesti, Department of Automatic Control, Computers and Electronics
Bdul Bucuresti, No 39, Ploiesti, 100680, Romania
E-mail: mihaela[at]upg-ploiesti.ro

Abstract

The paper presents an overview on artificial intelligence based approaches applied in higher education mainly for teaching, learning and student evaluation. Artificial intelligence provides various types of approaches such as knowledge based approach (e.g. knowledge based systems, expert systems, ontologies), computational intelligence approaches (e.g. artificial neural networks, genetic algorithms, fuzzy systems), intelligent agents based approach, machine learning and data mining approaches. A brief presentation of these approaches is made, focusing on selected examples of applications that were reported in the literature.

Keywords: Artificial intelligence, Higher education, Knowledge based approach, Computational intelligence approach, Machine learning, Data mining

1 Introduction

Artificial intelligence and, particularly, machine learning applications have been extended in the last decade more in the higher education institutions. For example, teaching and learning activities in universities can be improved by using artificial intelligence methods and techniques that make use of knowledge derived mainly from experience. Also, administrative activities of university management can benefit from the efficiency of such methods.

An analysis of the specialized literature shows that artificial intelligence (AI) provides various approaches for solving different higher education types of problems such as development of intelligent tutoring systems or e-learning platforms, course scheduling, student examination, student performance prediction etc. Other existing or potential types of applications are solving administrative tasks specific to universities, mostly those related to students (i.e. faculty/university secretariat, university library). The main AI approaches types that have been applied or have the potential to be applied in higher education are: knowledge-based approach, computational intelligence approach, intelligent agents based approach, machine learning and data mining. The main purpose of this research is to present an overview on some applications of AI based approaches in universities highlighting the importance of knowledge modeling in such applications.

The paper is organized as follows. Section 2 presents the main types of artificial intelligence based approaches that are applied or has the potential to be applied for solving

higher education related problems. A selection of some applications that use artificial intelligence techniques and methods for solving such problems, recently reported in the literature, are briefly analyzed in section 3. The final section concludes the paper and highlights some future work.

2 Types of artificial intelligence based approaches

The main types of artificial intelligence based methods that can be applied in higher education are: knowledge based systems and expert systems, case based reasoning, machine learning and data mining, computational intelligence (e.g. artificial neural networks, genetic algorithms, fuzzy systems, and nature-inspired techniques), intelligent agents and multi-agent systems.

All these methods use or can use specialized ontologies that allow knowledge modeling (Mizoguchi, 2004). Figure 1 shows a classification of artificial intelligence based approaches which are applied or have the potential to be applied in higher education.

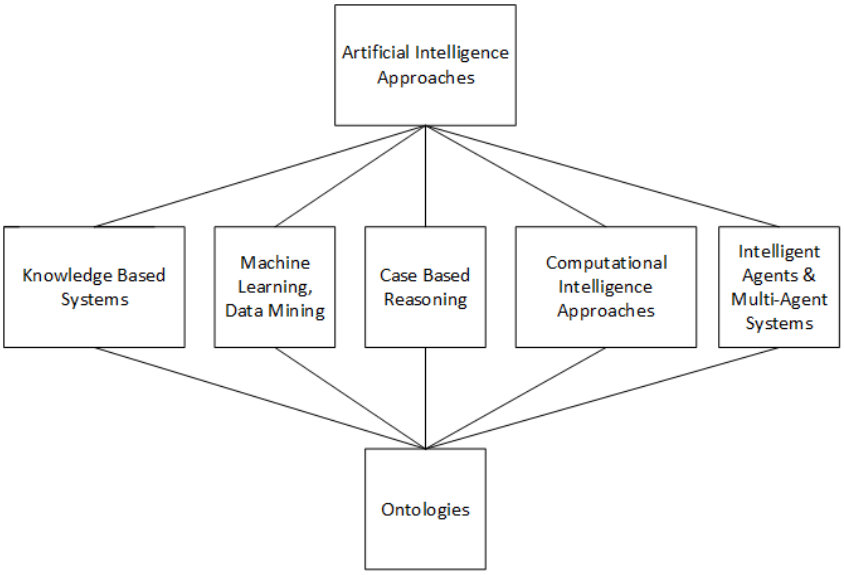

Figure 1. A classification of artificial intelligence based approaches for higher education applications

A brief description of each approach is made as follows.

2.1 Knowledge-based approach

The knowledge-based approach includes knowledge based systems (KBS) and expert systems. Also, case based reasoning can be included in this category, if not considered as a standalone approach (as depicted in Figure 1). The knowledge-based approach makes use of a knowledge base and of an inference engine (Russel and Norvig, 2020). Case based reasoning (CBR) uses a case base and a metric that measure the distance between a new case and the cases existing in the case base for which a solution was found in the past. An expert system is a particular case of knowledge based system that includes heuristic

knowledge from a certain expertise domain and solves problems from that domain at the domain experts' level. Ontologies that are defined as conceptualizations of specific expertise domains can be used for knowledge modeling. In particular, the knowledge base can be generated from an ontology. The knowledge based approach applies methods of inference such as deduction or induction chaining them in more complex reasoning chains that solve problems. The application domain knowledge can be represented by various methods, as for example, production rules, symbolic logic (e.g. first order predicates logic), procedural methods, and frames. In many cases, the knowledge base is a rule base.

2.2 Machine learning and Data mining

Machine learning (ML) provides various methods that allow improvements of intelligent systems performances by learning from experience, by analogy, by induction (Mitchell, 1997). Examples of such methods are: inductive learning, reinforcement learning, and deep learning. There are two types of learning approaches: unsupervised learning (e.g. clustering, association rules) and supervised learning (e.g. statistical methods, artificial neural networks). Data mining (DM) searches patterns in large data bases allowing knowledge discovery, usually, under the form of rules. Examples of data mining algorithms are decision trees, rule algorithm, various regression algorithms (Cios et al., 2007). It is important to highlight that most of the methods used by data mining are actually, machine learning methods. Ontologies can be used for knowledge modeling in both cases, machine learning and data mining. For example, the knowledge discovered by data mining can be represented with concepts and relationships defined in the application domain ontology.

2.3 Computational intelligence approach

In contrast with traditional artificial intelligence that is based on symbolic logic, computational intelligence (CI) applies mathematical formalisms specific to the computational models that are used. Examples of computational intelligence methods and techniques are: fuzzy logic and fuzzy inference systems, artificial neural networks, genetic algorithms, nature-inspired methods such as ant colony optimization (ACO), particle swarm (PSO) and artificial bee colony (ABC) (Konar, 2005). Also, various hybrid methods are part of computational intelligence (e.g. adaptive neuro-fuzzy inference system - ANFIS). Ontologies might be used by computational intelligence approach for the conceptualization of the application domain focusing on the computational model.

2.4 Intelligent agents and multi-agent systems

Intelligent agents (IA) are physical or virtual entities that have autonomy, reactivity, pro-activity and social ability (i.e. communication ability) which are embedded in a certain environment that they perceive and where they perform actions (Russel and Norvig, 2020). More capabilities can be added to intelligent agents such as: learning, adaptability, benevolence. Multi-agent systems (MAS) are (geographically) distributed systems composed of intelligent agents that have a common goal they need to solve, usually, by collaboration. Ontologies have a fundamental role in multi-agent systems as inter-agent communication is based on them. Intelligent agents can communicate by using terms from a common ontology.

3 Applications of artificial intelligence based methods in higher education

Various applications of AI based methods in higher education were developed. Examples are intelligent tutoring systems, e-learning platforms, student assessment, automatic scoring, student performance prediction, student learning paths analysis, personalized teaching, course scheduling, exams timetabling etc. There are some recent studies that analyze the scientific production on artificial intelligence in higher education, as for example, in (Hinojo-Lucena et al., 2019) are analyzed 132 papers published in the period 2007-2017 and indexed in Web of Science and Scopus databases, in (Zawacki-Richter et al., 2019) are reviewed 146 papers published on AI applications in higher education in the period 2007-2018, in (Guan et al., 2020) are analyzed 400 papers published in twenty years of educational research that applied AI in the period 2000-2019, and in (Zhai et al., 2021) are analyzed 100 papers published in the period 2010-2020 on AI in education from which 63 were empirical papers and 37 were analytic papers.

A selection of some papers that we have studied are analyzed as follows.

3.1 Intelligent tutoring systems

One of the applications of AI in higher education is intelligent tutoring systems (ITS) development. Such systems can use all the approaches discussed in section 2. There are several intelligent tutoring systems that were implemented so far. We have selected for this overview two recent examples. RadarMath (Lu et al., 2021) is a novel ITS developed for math education which can support personalized learning guidance and provides services for automatic grading. The authors applied two automatic grading models for scoring: the text answer (i.e. Deep Learning based grading model)), the formula-answer questions. Another intelligent tutoring system is described in (Castro-Schez et al., 2021): and supports active learning. An education-oriented knowledge graph is used as a key tool for guiding the personalized learning process.

Some extended studies were reported in the literature. An analysis of 1173 relevant publications from Web of Science is described in (Guo et al., 2021).The authors analyzed interactive learning environments, student modelling, teaching and learning strategies and machine learning potential applications. A review of intelligent tutoring systems in e-learning is described in (Dašic et al., 2016) from their applicability point of view and student level of knowledge.

The AI approaches that were applied more often for intelligent tutoring systems development are: machine learning, multi-agent systems and knowledge based systems. Also, ontologies, data mining and deep learning proved to be efficient when used in the intelligent tutoring systems that were reported in the literature and the current trends in the area of higher education software applications show that more researchers are using them for new ITS applications.

3.2 E-learning systems

A variety of e-learning systems are available, most of them combing the traditional learning and teaching models into a blended learning approach.

An e-learning system was introduced in (Tzouveli et al., 2007) that applies an e-learning schema adapted to the learner's ICT. The approach is based on electronic questionnaire (i.e. e-questionnaire) that were designed by a group of experts. Different learner profilers

were used. A combination of a multi-agent system and dynamic content manager is proposed in (Kristensen, 2016). An ontology-based tool, developed under the Semantic Web framework and described in (Tane et al., 2004) was implemented as a guide that help students working with an e-learning platform to find and organize the distributed courseware educational resources.

The AI approaches that are currently applied for the development of intelligent e-learning systems are intelligent agents and multi-agent systems, knowledge based systems and machine learning. Other AI approaches that can bring more efficiency are data mining, case based reasoning, more researchers starting to apply them. An extensive use of ontologies as educational resources are also increasing the efficiency of higher education software tools based on AI for teaching, learning and student examination.

3.3 Personalized learning

A recent study on the potential impact of educational AI applications in personalized learning is described in (van der Torst and Tommy, 2019). The authors proposed the use of machine learning for personalized learning and they realized an analysis in Netherlands from a socio-technical perspective related to the impact of educational AI in the context of personalized learning applications. Another research study that discusses personalized learning is presented in (Joshi et al., 2020). The authors conclude that an intelligent system tutoring or adaptive tutor involves personalized learning via some techniques such as student's dialogue and feedback of student learning process. Also, the study revealed that one of the current trends in artificial intelligence based education is given by the application of machine learning techniques. Another research work tackling personalized learning is presented in (Zaporozhko et al., 2018). The authors performed online courses personalization via genetic algorithms that allow to form an optimal learning route. An example of applying case based reasoning for personalized learning is discussed in (Mamcenko et al., 2019). The proposed solution was integrated in a recommending system that help learners to create learning scenarios that are most suitable for them.

Discovering student's learning paths can be realized by data mining techniques, i.e. by analyzing past behaviors of the students working with the virtual learning environment. This issue is important for recommending personalized learning paths.

3.4 Student assessment and student's performance prediction

Monitoring and analyzing the student's activity especially the learning progress made for a certain course can be performed efficiently with AI tools. In this sense, the use of machine learning or AI techniques can enhance the efficiency of the educational process (see e.g. (Popenici and Kerr, 2017)). A systematic review on student assessment performed with AI approaches is described in (González-Calatayud et al., 2021). The authors analyzed 22 papers selected from a total of 454 papers found in Web of Science and Scopus databases.

An ANFIS model was developed in (Taylan and Karagözoglu, 2009) for student's academic performance prediction. Different AI techniques can be applied for student's evaluation. Some examples are artificial neural networks, genetic algorithm and knowledge based systems (see e. g. (Oprea, 2014)). An important problem for the university management is predicting student's results. A neural network approach is described in (Oancea et al., 2013).

Artificial intelligence use for student assessment proved to be one of the applications with higher relevance and innovation, especially when integrated in intelligent tutoring systems or intelligent e-learning systems.

3.5 Course and exams timetabling

Timetable scheduling problems are common to higher education. This involves mainly two types of problems: lecture/course scheduling and examination scheduling. There are several methods that were applied for such problems. We have selected some examples that are briefly described.

One of the algorithms that was applied for scheduling exams timetables is particle swarm optimization (PSO), a population-based evolutionary computation technique. An example of application is given in (Chu et al., 2006). The solution quality is measured by the quality of the examination timetable and by the time spent to generate the timetable. Different hybrid solutions based on PSO were also proposed, as in (Thepphakorn et al., 2021) where the authors proposed a hybrid PSO-based timetabling. Another method that was successfully applied for timetabling is genetic algorithm, either alone or in combination with other techniques (see e.g. (Son and Jaafar, 2021)). A multi-agent system for university course timetable scheduling is described in (Oprea, 2007). The proposed solution is based on the communication and negotiation between the intelligent agents involved in the higher education process (i.e. teachers of different university courses).

University course and exams timetabling can be solved with different methods or techniques of the computational intelligence approach, as e.g. genetic algorithms, particle swarm intelligence, and artificial bee colony (ABC), sometimes in combination with other techniques, as iterated local search or simulated annealing.

Table 1. Overview synthesis – AI based approaches and higher education applications

AI-based approach / **Higher education application**	**KBS & CBR**	**ML & DM**	**CI**	**IA & MAS**
Intelligent tutoring systems	X *ontologies*	X	X	X *ontologies*
E-learning systems	X *ontologies*	X	X	X *ontologies*
Personalized learning	X	X	X	
Student assessment		X	X	
Course/Exam timetabling	X	X	X	X

3.6 Overview synthesis

We have synthesized the overview presented in section 2 and in the previous sub-sections of section 3 in Table 1. For each type of application it is given a set of possible

approaches/techniques based on AI that can offer a good solution. As we can see, machine learning, data mining and computational intelligence are the most used approaches, while knowledge modeling with ontologies is a good (potential) option for the implementation in each case that was studied. However, so far educational ontologies are not fully integrated in intelligent tutoring systems nor in intelligent e-learning systems. This issue needs more attention from higher education experts as knowledge modeling can be easily performed with ontologies considered as educational resources of university courses and labs.

4 Conclusion and Future Work

The paper presented an overview on some AI based approaches applied in higher education, knowledge based systems, case based reasoning, computational intelligence, machine learning, data mining, intelligent agents and multi-agent systems. A brief discussion on knowledge modeling (i.e. ontology use) was presented for each approach. A number of papers reporting AI-based applications developed for higher education were reviewed, focusing on the following types of applications: intelligent tutoring systems, intelligent e-learning, personalized learning, student assessment and course/exam timetabling. Current trends in the development of higher education applications is to apply some AI methods such as machine learning (including deep learning), data mining, computational intelligence techniques (e.g. PSO, ACO, ABC), intelligent agents and multi-agent systems, for solving different types of problems related to higher education (mainly for the activities of teaching, learning and examination).

Future work involves a more detailed analysis of the research reported in the area of AI based approaches for each higher education application type.

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Digitalization of University Courses in the Focus of Educational Management

Natalia Burlacu

Technical University of Moldova,
Faculty of Computers, Informatics and Microelectronics,
9/7 Studentilor street, Chișinău city, Rep. Moldova, MD-2020
E-mail: natalia.burlacu[at]iis.utm.md

Abstract

The given article is on the intersection of two research domains, such as the field of Educational Management and the Implementation of Information and Communication Technology in Education. The material contains the analysis of the scientific literature related to the study topic and also describes the managerial strategy of the Technical University of Moldova in the context of the imperative of digitizing the courses to ensure a qualitative didactic process. From the perspective of finality, this study is a comparative descriptive one that capitalizes on the applied experience of major academic centers around the world in terms of digitizing university courses kept in the hybrid and / or online format for both teachers and the administrative staff of educational institutions.

Keywords: Digitalization strategy, educational management, lessons' video recording, video formats of university courses

1 Introduction

In view of the epidemiological situation around the world and the Republic of Moldova, starting from March 2020, the Technical University of Moldova (TUM), especially the teaching staff, students, members of the administration, and representatives of the engineering department, thousands of people already have an educational experience in a regime that could be called conventional, hybrid didactic format, in the during of over one year and six-month, even better.

The notion of hybrid didactic format has acquired wider applicability, but also a more operationalization in the TUM university at the beginning of the 2020-2021 academic year, after an entire online semester of the 2019-2020 academic year (second (spring) semester), when the population of our country had already formed a behavior corresponding to the level of epidemiologic risk. Then TUM managers decided that the new academic year would go on with the hybrid educational process.

The hybrid didactic format meant that theoretical lessons, consultations, and evaluations will be in an online environment, predominantly in a synchronous manner, and practical lessons, such as seminars and laboratories, will be done in a traditional, synchronous manner in the classroom, obviously, respecting sanitary norms regulated by the Commission for Exceptional Situations of the Ministry of Health of the Republic of Moldova.

Of the total number of hours in the courses of the TUM study programs, it was expected that by default about 40% would be spent in virtual format, and the other lessons, such as seminar and / or laboratory hours in case of low epidemiological risk, would be conducted in the traditional educational format, in the classroom, didactic communication teacher-student (students) "face to face".

Thus, it became necessary to solve immediately the problem of digitizing courses for both the TUM administration and for university teachers.

2 Analysis Of The Literature Related To The Study

Voices that support education management constructively focus on innovative technologies, including digital ones, that have existed still before a state of emergency needs to be introduced because of the epidemiologic situation in which we all found ourselves with the advent of COVID-19.

Significant, in our opinion, would be the scientific papers published long before the pandemic that could serve as confirmatory evidence as to the pro-digitization visions of educational management as follows:

USA: Idalene F. Kesner actively advocates for technology-supported strategic management solutions in solving emerging problems in institutions and companies of various types. Moreover, the author is also concerned with the transfer of knowledge on this subject and proposes, in one of her basic works, the analysis, and description of the concept of a strategic management course from the perspective of tools, techniques, and teaching methods used so that it is a successful one (Kesner, 2005).

There are studies that since the pre-pandemic period expressed for digital integration in the field of educational management in **France & Spain**. Thus, some researchers (Bronfman and Pelegrín, 2018) argue that digital is the reason for revolutionary changes in the size of executive educational management in their investigations on the implications of digital in "blended teaching". They consider "Executive Education" has a special effect because in customized programs technology has a profound impact because of the extremely dynamic environment in which companies and organizations operate. In the opinion of the authors [ibidem] the given transformations, being applied both on the concept of training and on the approach of training, affect the content of management, management models for training, and the importance of the learning experience concept, and digitalization, in this conjuncture, are causing the cost efficiency and return on investment of the given study programs.

The trend of digital integrating into the institutional teaching process becomes more pronounced in the spring of 2020 when politicians, researchers, academics, methodologies, and pre-university teachers around the world set out in search of clever ways to reduce the chaos produced by COVID - 19 in the vast majority of spheres of human life. Definitely, the people concerned about the field of vocational and continuing education and training have spoken out on the development of educative and managerial strategies aimed at different periods of time, like duration, able to solve various general and the particular institutional situations; elaboration and implementation of didactic and managerial methods that would support the constructive continuation of the emerging educational process either in distance learning format or in hybrid learning conditions.

Germany: Numerous experiences, related to the management of the teaching process, have been collected, in order to support the educational system from the perspective of institutional strategic management. The given collections included quality tips starting with the management of the educational institution, the management of the number of trainees (classes or groups of students from various levels of study programs like undergraduate, master's, doctoral, continuing education, etc.), finalizing with the management of the didactic activity (considering the lesson either in a lecture format, seminary, laboratory, evaluation activity, etc., or in a standard format, specific to pre-university education institutions).

In this sense, we consider significant the works that accumulate and disseminate teaching experiences. This type of research (Baumann, 2020) is exposed to learning from teaching failures to achieve didactic success; teaching strategies that don't teach strategies; strategic management applied to online and hybrid courses, etc.

Although most of the recommendations are aimed at improving the strategic management of various types of institutions, some methods and techniques have been customized and may be adapted to the educational environment and use, respectively.

Sweden: Based on her previous research, scientist Fanny Pettersson states that digitization processes are often limited to the implementation of digital technologies, without pedagogical and organizational changes (Pettersson, 2021). Thus, the author holds "a broader perspective on the concept" of digitization in one of her most recent studies. She identifies it as a process that involves "change and transformation" into "different stages and several organizational levels" [ibidem] in one of her most recent studies. Referring to the empirical way of incorporating CHAT theory into various "levels of learning" (Bateson and Engeström, 1987), Fanny Pettersson states that the given principles could be implemented to discuss digitization and transformation into schools [ibidem].

Given that in the 21st century, the continuation of the teaching process in conditions of acute pandemic crisis is absolutely impossible without the full intervention of digital. The opinion expressed by many studies and initiatives aimed at solving the problems was based on the analysis and/or description of a broad spectrum of various methods and procedures for the implementation of digital. In order to continue the distance learning process, pandemic remedies of institutional transformation (these have the potential to be modified into post-pandemic solutions one day) most often represented the alloy between management methods and techniques, including educational technologies, mediated by the digital.

These management methods and technologies include management tools, ranging from traditional tools to modern procedures and strategies that focus on digital investigation, planning, and organization.

Republic of Moldova: TUM reacted to the call for consolidation of efforts addressed to public law organizations in the fields of research and innovation to register projects that would come with proposals for ways to overcome the COVID-19 pandemic, and also to adjust national actions to European actions provided in the ERAvsCorona Action Plan (European Commission, 2020) launched by the Ministry of Education, Culture and Research and the National Agency for Research and Development. Thus, TUM's response was focused on research and implementation of anti-pandemic solutions applied in

engineering university education, applying to various state projects, and also developing concepts of projects fully funded from its own institutional sources.

3 TUM Educational Management In Solving The Problem Of Digitalization Of Courses

In order to ensure a successful transition of the teaching process from the face-to-face to the online and / or hybrid format of studies, TUM has moved on several dimensions, among which (see Figure 1):

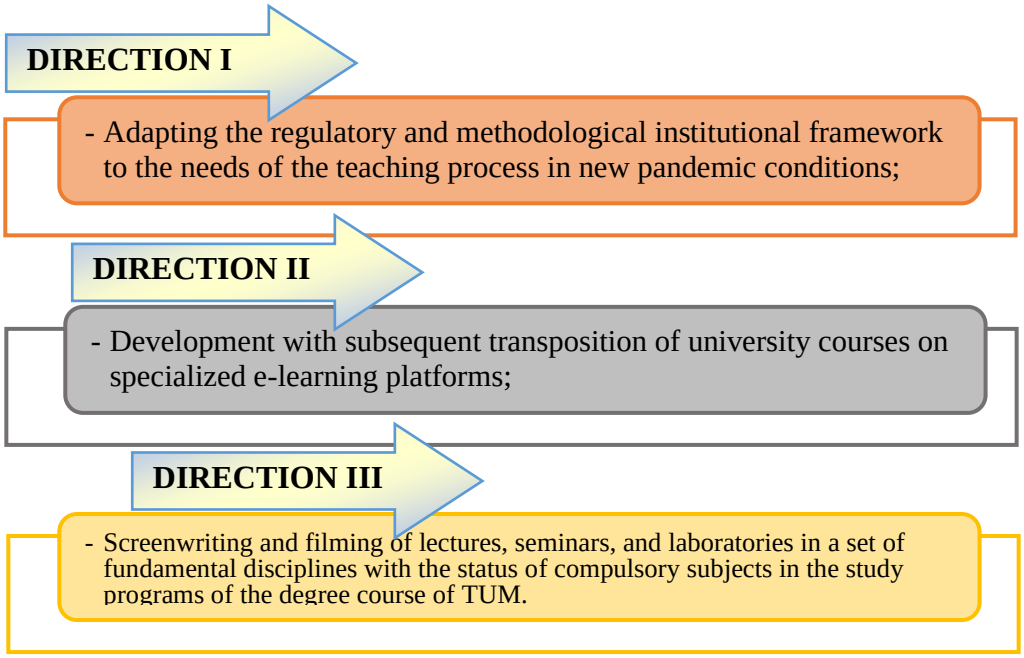

Figure 1. TUM strategic directions for digitalization of courses

Regarding the **first dimension**, the representatives of the rectory together with the faculties administration were involved here. Also, the heads of departments acted under the coordination of the Academic Management and Quality Assurance Directorate of TUM in developing and implementing an institutional framework adapted to pandemic conditions.

Because of the circumstances, regarding **the second dimension**, it was decided that for the transposition of the courses in digital format TUM will use the Moodle platform (Moodle means an abbreviated title from the *Modular Object-Oriented Dynamic Learning Environment*). We have to mention that TUM's teaching process is supported by two Moodle platforms that serve various faculties.

The platforms work autonomously and there are installed various versions of Moodle there. Thus, the given platforms are:

– http://moodle.utm.md - 8 faculties, the TUM's Doctoral Schools, the TUM's continuing education center, are served on this platform.

– https://else.fcim.utm.md/ - is the property of the Faculty of Computer Science and Microelectronics (FCIM), the largest faculty of TUM, in both terms by the number of beneficiaries and teachers, as well for its physical surface, and also its academic visibility.

In this sense, the TUM administration, as well as the dean of FCIM, organized training for own and foreign university teachers in order to familiarize them with the facilities of e-Learning platforms and numerous master classes that developed and strengthened the digital skills of the teaching staff so that its representatives could later apply the knowledge and skills acquired in order to carry out a qualitative teaching process, including in the format of distance learning.

In addition to familiarizing teachers with Moodle, also the MS Teams video conferencing platform was used to support online lessons at TUM (Burlacu, 2021a; 2021b). To this end, some teacher training has been organized. Teachers, FCIM representatives, who have experience in applied research in education and the implementation of ICT tools, were recruited as trainers for these training courses.

If the first and second dimensions are common to most educational institutions in the world during the pandemic and pre-pandemic stages of the didactic process, then **the third dimension** is unique. The filming of the lessons from the basic courses studied at TUM has been organized by the rector's decision. This idea came from famous universities: *Massachusetts Institute of Technology* and *Stanford University*. Both reviewed universities have their own platforms with the educational content of filmed lessons, displayed in the virtual space with open access for the interested public.

Predominantly the number of lessons filmed and exhibited on the dedicated platforms also have coverage for the compulsory subjects in various study programs (see Figures 2 from Table 1 & Figure 3-4 from Table 2).

The above two universities have their own platforms, which contain educational content of video courses, which are displayed in a virtual space and are open to the interested public. Mainly, the number of courses shot and displayed on the dedicated platform also covers the compulsory subjects of each degree course (see Figures 2 from Table 1 & Figure 3-4 from Table 2).

The described ideas' ability to inspire prompted TUM's members to develop their own platform, which will host filming courses with the participation of life-long teachers. This process begins in the summer of 2020. As for the financial coverage for the development of the project to convert the course into a video format, this is assured entirely by TUM.

3.1 Development Of University Courses In The Format Of E-Learning Platforms

The development of the process of digitizing the courses on the second dimension involved the familiarization with the built-in set of tools of e-Learning platforms, as well as the training/development of prominent skills of the TUM teaching staff in the digital design of teaching content to be placed on Moodle.

Teachers, researchers, developers of IT products in the area of interest whose aspects of applying of the Moodle platform, from the perspective of its use in education and training, note that the development of this platform is based on principles such as cooperation between stakeholders, collaboration's activities, the participatory work of the actors who want to come up with efficient contributions in the development of the teaching process.

No.	The name of the platform	The address of the filmed courses	Owner
1.	MIT OpenCourseWare | Free Online Course Materials	**https://ocw.mit.edu/**	USA, Massachusetts Institute of Technology

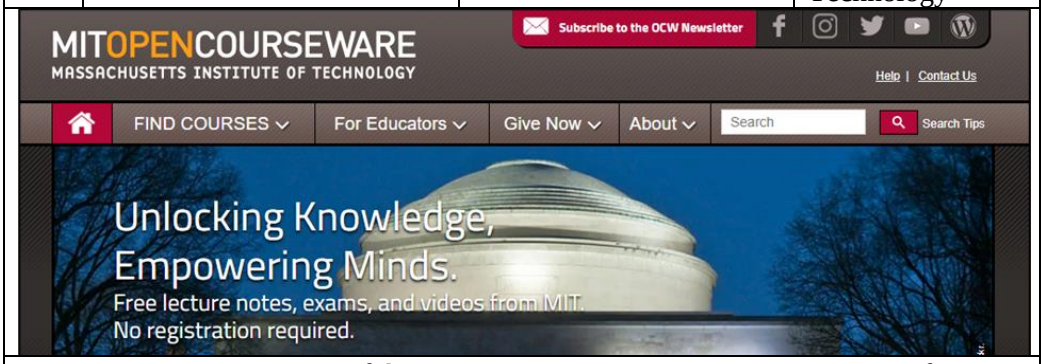

Figure 2. Screen Print of the MIT OpenCourseWare course access interface

Table 1. Details and interface of Massachusetts Institute of Technology Open Course Platform

2.	**Stanford University | Stanford Engineering Everywhere (SEE)** supported by Stanford Center for Professional Development	**https://see.stanford.edu/**	USA, Stanford University, Stanford, California 94305

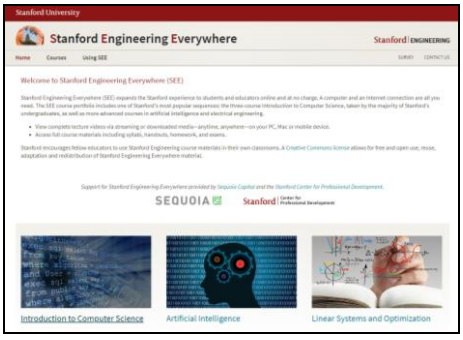

Figure 3. Presentation page of the platform with the SEE's course set

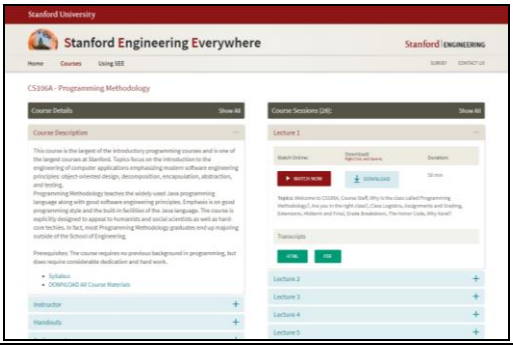

Figure 4. Access to the video format of SEE's lessons

Table 2. Details and interface of Stanford University platform with filmed lessons

Depending on how the e-Learning platform is used (form, frequency, complexity, etc.), in our case Moodle, certain types of ICT-mediated teaching processes can be specified as follows:

I. The traditional ("face-to-face") ICT-mediated teaching process (broadly assisted by information and communication technology products) is characterized by a role assigned to the e-Learning platform, namely, to serve in a static mode as:

I.1. An interactive teaching tool that provides a set of computer facilities for educational purposes, which can be perfectly adjusted according to the content and objectives of learning, and can diversify the traditional teaching-learning-assessment process.

I.2. Space for storing/exchanging digital teaching resources, (A.) whether these are selected / elaborated / systematized / organized teaching content according to a certain didactic approach by the teacher, (B.) whether these are products of the teaching activity of students (elaborated / organized / presented), ideally, depending on the teacher's requirements.

In view of the applicability of courses delivered through Moodle-type apps, we distinguish between the synchronous and asynchronous operation of the e-learning platform by participants in the didactic process.

II. Now, in the 21st century, the ICT-mediated distance learning process is organized and run exclusively online and is characterized by an imperative role of the e-Learning platform, which, in particular, offers the possibility of a permanent interaction between the actors of the teaching-learning-assessment process to each other / through others through the tools incorporated in the system.

III. The hybrid didactic process, which is a symbiosis of traditional and online formats or, more precisely, of an ICT-mediated format.

In all three cases mentioned above, the content and quality of the courses developed on the e-learning platform are critical.

Given the fact that TUM is extremely interested in the development of valuable courses by the course holders and their assistants, the university administration came up with the idea to organize a biannual edition of the Digital Courses Contest (DCC) where the authors of the courses this guy to compete with each other for distinct places, noted with a series of prizes. For the mentioned DCC, the university courses placed on one of the Moodle platforms of TUM that are currently taught during the semester in which the DCC edition is organized are eligible. DCC runs in accordance with the provisions of the TUM regulation on the aspects of organization and development; evaluation of digital courses; how to set up the winners, the activity of the Competition Commission, etc. (Burlacu, 2020a; 2020b).

Although the regulatory document reviews both the criteria to be evaluated in the competition, and the score offered for each component evaluated, and also the obligation of the presence of certain types of materials and / or activities, design, sequence, the content of materials, dislocation, the digital resources developed by the teacher, the author of DCC and/or the external location of some teaching resources selected / taken over by the author is at the discretion of the person (s) who develops the course on Moodle [ibidem].

3.2 Transposition Of University Courses In Video Format For The Lectii.utm.md Platform

The **lectii.utm.md** project came to life from the mutual desire of the administration and the representatives of the academic community of TUM to support the educative process, the

teachers, and the students of the institution in the new epidemiologic conditions. Thus, being interested in developing a flexible platform, equipped with a multitude of film lessons for most core courses that are taught at TUM faculties, the administration came up with several interesting ideas, some of which were inspired by the experience of the most famous university centers in the world. Eventually, the concept of developing an online platform was accepted. The platform dedicated to hosting basic courses in video format to meet the needs of TUM.

Hence, when it was launched on September 1, 2020, the lectii.utm.md project already contained around 1000 hours of videos, which were reflected in theory courses, seminars, and laboratories in the field of science such as Mathematics; Physics; Chemistry; Biology; Mechanics; Programming, security, and computers; Technical drawing. The entire set of filmed lessons, presented on **lecții.utm.md**, was produced by the extensive and dedicated team of TUM with the aim of assisting online engineering and technology education; diversification of the methodological and scientific support of the subjects taught at TUM for both traditional and online education; ensuring the continuity of the distance teaching process in exceptional situations (quarantine; as the case may be, physical impossibility to teach/attend lessons in the class room, etc.).

Figure 5. Platform home page

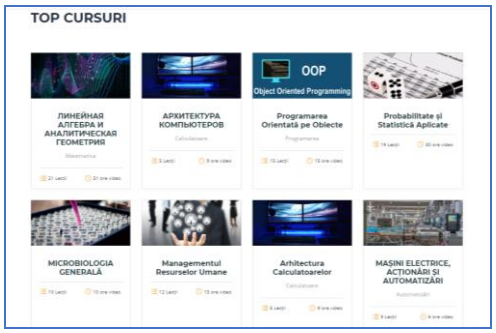

Figure 6. Displaying of the platform's top courses

Table 3. Interface of lecții.utm.md platform

The content shot in the **lectii.utm.md** project (see Figure 5-6 from Table 3) will serve as additional material for the students of the TUM faculties, as follows: Architecture and Urban Planning (FAUP); Computers, Informatics and Microelectronics (FCIM); Constructions, Geodesy and Cadaster (FCGC); Economic Engineering and Business (FEEB); Electronics and Telecommunications (FET); Energetics and Electrical Engineering (FEE); Food Technology (FT); Mechanical Engineering and Transport (FMET); Textile and Polygraphy (FTP).

In the current calendar year 2021, the filming of the courses continues, with the second edition of the courses being filmed for the new courses approved in the spring of 2021. Here, you can find about 1000 hours of video lessons in curricular areas, such as Computer Architecture; Object-oriented programming; IT essentials (Python); Probability and applied statistics; Human resource management; Differential equations; Linear Algebra and Analytic Geometry; Organic chemistry; General microbiology, etc.

Most of the courses listed are filmed in two languages: Romanian and Russian. The organization on the platform of the filmed lessons is performed according to a concept elaborated by the filming team and includes the description of the course, with the indication of the modules and faculties where it is studied; curriculum in the course where each item is correlated with a certain filmed lesson; distribution of lessons right to their typology: lectures, seminars, laboratories; knowledge verification tests, accessible to both TUM students; as well as for those interested in the presented didactic content outside of TUM. The filming of the courses takes place on a permanent basis, and the **lecții.utm.md** platform is in continuous development.

4 Conclusions

Since the pre-pandemic period, the need to convert university courses into digital formats has become an indisputable fact. In this way, the demand to achieve this has grown even faster with the advent of the pandemic. Or will humanity always need a crisis to progress?

Certainly, it is impossible to promote innovation in education and academic environments without the merger of the management and execution forces of institutions interested in transformation; in our case, we are referring to the digital field. In our age of digitalization, many innovative forms of learning, teaching, and pedagogical experiences are available for educational institutions. This requires a shift from transmission-oriented teaching to a new form of learner training and guidance in the learning process based on a digital learning environment.

Academic teachers are no longer only well-versed researchers and experts and / or good role models, but also mentors. Owing to the digitization of didactic content, the educational tandem between the teacher and student will get the opportunity to move from the transmission of basic knowledge to the concept of research-led teaching, able to familiarize students with current developments, research results, and expertise.

This means that the digitization of university courses is a step that would ensure the necessary transformation, and institutional policies and strategies must be an objective for the management of educational institutions of all levels, and also to be in the sights of educational management as a science.

5 Acknowledgments

We extend our heartfelt thanks to Professor **Marin Vlada** (posthumously) and to the scientific committee of the International Conference on Virtual Learning (ICVL) for their support over the last 12 years of collaboration.

We express our sincere condolences to the grieving family and the entire ICVL/NCVL (CNIV) community (authors, evaluators, teachers, students, specialists, researchers, etc.) for the passing away of the remarkable creator of ICVL/ NCVL (CNIV) Professor **Marin Vlada**.

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Supporting Teachers' Motivation and Preparedness for Online Education: A Case Study – CRED Large-Scale Programme

Olimpius Istrate [1], Ciprian Fartușnic [2], Adrian Labăr [3]

(1) University of Bucharest, Teacher Training Department,
90 Panduri str., Bucharest, Romania
E-mail: olimpius.istrate[at]unibuc.ro
(2) National Centre for Educational Policies and Evaluation,
37 Stirbei Voda str., Bucharest, Romania
E-mail: ciprian.fartusnic[at]ise.ro
(3) Alexandru Ioan Cuza University, Teacher Training Department,
11 Carol I blv., Iasi, Romania
E-mail: adrian.labar[at]uaic.ro

Abstract

During the suspension of face-to-face courses in the Romanian education system, a large part of teachers used digital technologies to continue teaching activities. In the absence of a systematic preparation for this role, teachers were aware to a different extent of the implications of online learning for the design, development and evaluation of the learning path, as well as of psychological effects. Furthermore, access to equipment and internet connectivity have raised many equity issues and digital platforms, applications and resources have been to a varying extent recognized and incorporated into learning activities.

More or less prepared for the new challenges, teachers received different forms of ad-hoc support from colleagues, students, parents, management teams, companies and NGOs. During the "home school", they received institutional support through specific programs, projects and initiatives developed by the Ministry of Education and subordinate institutions.

The article summarizes the results of an investigation carried out in two stages, at the beginning and end of the period of suspension of face-to-face courses (March 2020 and February 2021), with samples consisting of 3418 and 6062 teachers in primary and secondary education. It presents an analysis of the differences and the evolution of teachers' perceptions on the organization of learning, teaching strategies and classroom management in online learning situations. The article focuses in particular on the preparedness role of the project "Relevant curriculum, education open to all - CRED" and its impact on teachers' competencies, self-confidence, motivation and attitudes. Thus, the article provides a documented perspective on important intervention areas at the level of educational policies.

Keywords: distance education, online learning, teachers, continuous professional development, education policies, digital competences

1 Introduction

Distance education during the suspension of courses in Romania, from March 2020 to February 2021, marked progresses, innovations, but also a syncope in several aspects. In some cases, prior training within various initiatives, projects and programs has been a supporting preparedness element whose value has been underestimated in the dedicated literature.

"Relevant Curriculum – Education Open to All" (CRED- "*Curriculum relevant – educație deschisă pentru toți*") is a large-scale program, initiated in 2018, with a series of innovations regarding the blended-learning way of running teacher training, the creation of educational resources in digital format, the development of methodological guides for the implementation of the national curriculum in the context and with the resources of the 21st century[1]. Focusing on curricular empowerment and integrating aspects from the fields of school counselling and use of new technologies, **the training of teachers in primary and secondary education carried out within the CRED project proved its relevance in this atypical period of suspension of face-to-face courses**, both in terms of skills for managing educational situations at a distance and as well regarding the attitudinal level. Responsibility towards students and the school, the ability to adapt, confidence in teacher's own possibilities to mitigate the negative impact of the discomfort felt by students and to continue activities in an unfavourable context were aspects that the present investigation points out, often noting differences between CRED training program graduates and teachers who had not participated in the program.

For the research, data from two large investigations were used, one conducted in March 2020, to which 3,418 primary and secondary school teachers responded [2], and the other conducted a year later, in February 2021, with 6,062 teachers from primary and secondary education, of which 3,254 (54%) teachers who participated in the CRED training program.

2 Teaching activity

The experience of the period of face-to-face courses suspension was, for many teachers, an opportunity to reconsider the dimensions of designing and carrying out effective teaching activities. In developing new, *distance learning* situations, significantly based on digital technologies, teachers recalibrated the importance of the three main components: technical, pedagogical, and content-related aspects. If, at the beginning of the period, the technical dimension was the most prominent, generating the most difficulties, after a year of educational activities with digital support, its significance for carrying out effective learning activities was reduced from 59% to 37%.

Table 1. Competences needed to carry out distance learning activities (2020, N = 3418; 2021, N = 6062)

	2020	2021
Technical aspects specific to the use of new technologies (for example: accounts creation, software installation, synchronous session initiation - video conferencing / webinar / chat)	59.1%	37.2%
Pedagogical aspects (for example: learning situation management, didactic communication, choosing the appropriate methods and tools for interactions and assessment, providing feedback, monitoring progress, and providing learning support)	36.5%	59.8%
Content-related aspects of the discipline (for example: knowledge in the field of specialization, thorough mastery of the subject)	4.4%	3.1%

The resizing of the three types of areas of competence placed pedagogical expertise in the first place, increasing from 37% in March 2020 to 60% in February 2021.

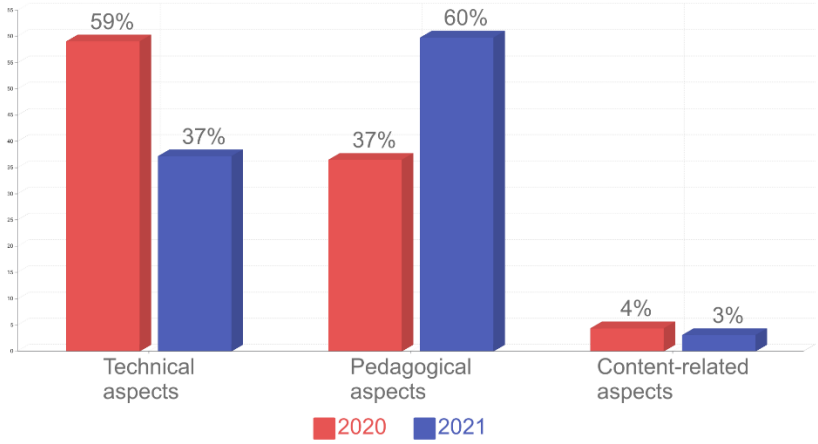

Figure 1. Proportion of skills needed to carry out distance learning activities (2020, N = 3418; 2021, N = 6062)

Regarding the support and guidance received during this period, the teachers consider that the technical aspects were the favoured ones, to the detriment of the pedagogical ones and that belong to the domain of the discipline.

Table 2. Type of support for distance learning activities (2021, N = 6062)

	Not at all	To a small extent	To an average extent	To a great extent
Technical aspects	13.2 %	29.0 %	32.7 %	25.1 %
Pedagogical aspects	31.7 %	30.3 %	24.7 %	13.3 %
Content-related aspects	33.4 %	28.8 %	24.5 %	13.3 %

By comparing the teachers who went through the CRED training program (N = 3,254; 54%) and the teachers who did not participate in the program (N = 2,808; 46%), significant differences appear. Teachers who have completed CRED training score significantly higher on all three support components compared to those who have not passed the CRED program.

Table 3. Support and guidance, differentiated according to CRED training (Averages on scale 1-4, 2021, N = 6062)

	CRED training		
	Yes (N=3254)	**No** (N=2808)	**t***
Technical aspects	2.83	2.55	11.07**
Pedagogical aspects	2.40	1.96	16.95**
Content-related aspects	2.36	1.96	15.15**

** Results obtained by applying the independent-samples t-test; . **p < 0.001*

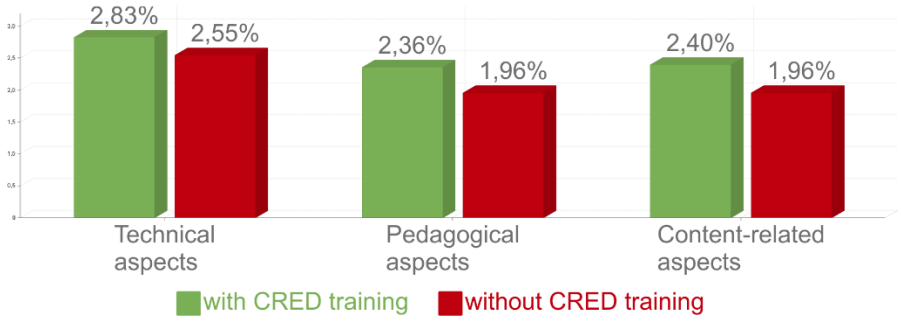

Figure 2. Support and guidance, differentiated according to CRED training (Averages on scale 1-4, 2021, N = 6062)

Within the CRED project, the training offered through the program for teachers had, to a large extent, the role of preparing the participating teachers in the use of tools for synchronous online meetings (through Google Meet), thanks to the series of webinars organized for each training group. The program also included from the beginning a module dedicated to the development of digital educational resources.

In addition, two direct support measures were launched in March 2020 for all teachers in the country – a webpage with concrete suggestions on teaching, learning and assessment with digital support, as well as a series of workshops dedicated to the use of new technologies for teaching activities.

The 6,062 teachers included in the sample, out of which 3,254 (54%) were participants in the training and 2,808 (46%), had not participated in the CRED program, indicated the usefulness of the support measures offered by the project, positively appreciating the help offered for their teaching activity from March 2020 to February 2021:

Table 4. The usefulness of support and training measures for conducting distance learning activities (Percentages, 2021, N = 6062)

	Not at all/ NA	To a small extent	To an average extent	To a great extent
Training through the CRED curricular empowerment program	46.3 %	**17.3 %**	**17.5 %**	**18.8 %**
Suggestion webpages opened by the Ministry of Education on digital.educred.ro and educatiacontinua.edu.ro	24.2 %	33.1 %	26.4 %	16.3 %
CRED workshops conducted by videoconference / Recordings of CRED workshops	37.5 %	23.4 %	22.0 %	17.1 %

Teachers who have completed the CRED training program have significantly lower difficulties in a number of important components of distance teaching activity, compared to those who did not participate in CRED training, which brings forth the project's added value not only in terms of training for the use of new technologies, but also regarding the psycho-pedagogical training regarding the design of significant, efficient learning situations, methodologically connected to the new school curriculum.

Table 5. Difficulties in carrying out distance teaching activities, differentiation according to CRED training (Averages on scale 1-4, 2021, N = 6062)

	CRED training		t*
	Yes (N=3254)	**No** (N=2808)	
Lack of an adequate methodological framework for the preparation, guidance and conduct of online activities	2.31	2.44	5.18**
Lack of educational content (digital resources) in the field of discipline	2.10	2.19	3.51**
Lack of pedagogical support for carrying out sufficiently effective and / or attractive learning activities for all students	2.11	2.18	2.90**
Lack of appropriate tools for teaching-learning-assessment in my discipline	2.10	2.17	2.83**
Limits due to the specifics of the discipline (learning activities my disciplines cannot be easily translated into distance activities)	2.07	2.14	2.80**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

The continuation of the CRED project, with training activities that have been given a new perspective following this experience in which distance education has been carried out accompanied by new digital technologies, proves to be an opportune, useful, necessary step for teachers.

The difficulties of the period of suspension of face-to-face courses were significant, with negative repercussions on the entire teaching staff, and one of the main lessons learned

is in the area of educators' training and the establishment of authentic collaborative communities for them. In this context, an interesting aspect highlighted by the investigation concerns the variation of motivation for the teaching profession.

Table 6. Motivation towards the teaching profession (%, 2021, N=10246)

Motivation towards the teaching profession:	Raised	Remained the same	Lowered	I don't know/ Cannot say
Pre-university education teachers (N=10246)	30.5 %	54.1 %	10.3 %	5.1 %

During online schooling, motivation for the profession increased for 30% of pre-university teachers and decreased for 10%.

Primary education teachers and those who teach in lower secondary education (the target group of the CRED program) show a slight positive difference (31.2% compared to 30.5%), and a comparative analysis between the samples of graduate teachers of the program CRED and those who did not participate in the program, we find that this difference is explained by the opportunities and perspectives offered by the program.

Table 7. Motivation towards the teaching profession - comparisons according to the level of education and participation in the CRED program (%, 2021)

Motivation for teaching profession:	Raised	Remained the same	Lowered	I don't know/ Cannot say
Teachers in primary and lower secondary education (N=6062)	**31.2 %**	**54.2 %**	**9.5 %**	**5.1 %**
Primary and secondary education teachers who did not participate in the CRED program (N=2808)	27.7 %	55.2 %	12.1 %	4.9 %
Primary and secondary education teachers who participated in the CRED program (N=3254)	34.3 %	53.3 %	7.2 %	5.2 %

The challenges of the period led to an increase in motivation for 34.3% of CRED teachers and a decrease of 7.2%, compared to 27.7% increase (significantly lower than the general average of 30.5%) and 12.1% decrease - percentages of teachers in primary and secondary education who had not taken part in the professional development activities offered by the CRED project.

3 Students' activity

A major objective of the CRED program is to train teachers to be able to design and use various teaching-learning-assessment strategies, which allow the adaptation of the educational approach to the needs of students.

In this perspective, the investigation reveals that **the teachers who participated in the CRED training program are more able to manage the learning situations that make use of the new digital technologies**, capitalising upon their own distance learning

experiences offered by the project, on one hand, and on the other hand putting into practice the knowledge acquired and the skills formed within the Open educational resources' module.

Table 8. Teachers' opinions on specific issues of the period, differentiated according to participation in CRED training (Averages on a scale from 1=disagree, to 3=agree; 2021, N=6062)

	CRED training		t*
	Yes (N=3254)	**No** (N=2808)	
My students like to learn using digital tools and resources	2.21	2.14	3.73**
Too many applications and platforms confuse students	1.91	1.97	2.98**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

The learning community formed within the program, supported by direct communication between graduates (Whatsapp for the training group, Facebook, and the project platform for the whole group of graduates), provided a way in which information, approach ideas, good practices were disseminated quickly and with visible effects. It is a plausible explanation, which partly explains the differences between the results observed by CRED graduates and teachers who had not participated in the program.

Similarly, at the level of learning, the research shows that the approaches of CRED teachers have results, their observations indicating that students manage to work independently – an essential aspect in the period of distance education. In addition, the fact that CRED teachers moved faster to digital teaching activities, organized collaborative learning opportunities and a cohesive climate, like the one in the classroom, can be a good explanation for the significant differences in socio-emotional development noted by CRED teachers by comparison with teachers who had not gone through the professional development experiences offered by the project.

Table 9. Teachers' opinions on some aspects of learning, differentiated according to participation in CRED training (Averages on a scale from 1=disagree, to 3=agree; 2021, N=6062)

	CRED training		t*
	Yes (N=3254)	**No** (N=2808)	
My students manage, to a large extent, to work independently	2.04	1.96	4.19**
Socio-emotional development of children is negatively influenced in this distance education period	2.27	2.33	3.13**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

These are part of the set of conditions for educational progress, both in "normal" situations and (especially) in atypical situations. We find that **teachers who participated in the CRED training program are more confident that students can complete the common**

core curriculum as planned, to a significantly better extent than teachers who did not participate in CRED project activities.

Table 10. Students' progress, by level groups, differentiated according to the participation of teachers in the CRED program (Averages on scale 1-4. 2021, N=6062)

	CRED training		
	Yes (N=3254)	**No** (N=2808)	t*
Students with good and very good school results	3.39	3.33	4.07**
Students with average school results	2.79	2.73	3.60**
Students with poor school results	2.07	1.98	4.58**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

4 Perspective on changes in the teaching process and educational management

Teachers participating in the CRED training program give more significance to digital skills and their value for teaching, learning and assessment. They consider to a greater extent that **the acquisitions of this period are useful for the didactic activity of the next period** and are more willing to consider the incorporation of digital tools and resources in conventional (face-to-face) training situations.

Table 11. Teachers' opinions on specific aspects of the period, differentiated according to CRED training (Averages on a scale from 1=disagree, to 3=agree; 2021, N=6062)

	CRED training		
	Yes (N=3254)	**No** (N=2808)	t*
The digital skills acquired by teachers during this period are useful acquisitions for future teaching activity	2.70	2.65	3.65**
I will continue to use in the face-to-face teaching activity (some of) the digital tools and resources that I started to use during this period.	2.65	2.60	3.43**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

Also, the perspective of CRED participants is slightly different in terms of three aspects of the investigation, related to the role of the teacher and the model of action in special situations of crisis or of "opportunity". Direct contact with students is considered more important by CRED teachers for learning success – even if a learning activity is well designed, the lack of "human contact" (at least in the long run) cannot be compensated and may result in decreased interest, motivation, learning performance. Distance education requires more efforts from teachers –CRED teachers believe to a greater extent that they are responsible for supporting students' motivation. The approach in a crisis, for the teachers participating in the CRED project, must be different from that of the normal situations, consisting in a reconsideration of the meaning and importance of the learning contents.

Table 12. Teachers' opinions on specific aspects of the period, differentiated according to CRED training (Averages on a scale from 1=disagree, to 3=agree; 2021, N=6062)

	CRED training		
	Yes (N=3254)	**No** (N=2808)	t*
Lack of human contact can be compensated by well-designed remote activities	1.94	1.84	5.11**
The period of suspension of face-to-face courses allows teachers and students to focus on the essential, the qualitative, the skills and competences	2.17	2.08	4.68**
In the current situation, supporting the motivation for learning depends exclusively on the teacher	1.82	1.78	2.44**

** Results obtained by applying the independent-samples t-test; **p < 0.01*

Beyond the experience of a year of face-to-face courses suspension, these aspects denote a type of attitude that supports and stimulates the success of educational endeavours. An adequate perspective regarding the role of the teacher, their possibilities, and the relationship with the students is definitory for the ”natural” educational paths as well as for the success of the interventions in any ”atypical” situation and in any possible circumstances at school and class level – risk of dropout school, remedial education, inclusive education, unfavourable external conditions (e.g. lack of facilities, lack of adequate space, low socio-economic status, inappropriate learning climate) or challenging circumstances (e.g. opportunities for collaborative distance learning projects, gifted students, new programs and initiatives/ teaching innovations).

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Comparison of the Functionalities of Video Conferencing Platforms Used in Education

Tanya Pehlivanova

Trakia University - Stara Zagora, Faculty of Technics and Technologies - Yambol, 38 “Graf Ignatiev” str, Yambol - 8602, Bulgaria
e-mail: tanya.pehlivanova[at]trakia-uni.bg

Abstract

The use of video conferencing platforms is constantly increasing. During the COVID-19 pandemic the universities were able to continue the educational process thanks to the developed powerful software tools for video conferencing. This paper examines the functionalities provided by video conferencing systems in terms of their application for training engineers. The aim of the paper is to make a comparative analysis of the realization of these features in BigBlueButton, Google Meet and Zoom, which are widely used in Bulgaria. This comparison is not intended to arrange the platforms and determine which the best is, but to help lecturers to use more fully the capabilities of video conferencing systems. The analysis performed can make the software selection easier. As a result of the analysis, recommendations have been made for the application of the various functionalities in training in technical disciplines. Predictions for the development of the video conferencing platforms are described.

Keywords: Video conferencing platforms, Distance learning, Functionalities

1 Introduction

The COVID-19 pandemic has accelerated the process of digitalization of education. It forced all higher education institutions in Bulgaria to immediately switch to distance learning. This posed many challenges for lecturers. First, they had to choose the way the classes were conducted - synchronously, asynchronously or in combination. Then - the most appropriate technology. Finally, they had to fully explore the capabilities of the chosen software and apply them in the most appropriate way in the training. Synchronous learning is closest to traditional face-to-face learning. Its realization is possible thanks to the developed video conferencing platforms.

The mass application of these platforms and the competition between them makes their creators constantly improve their capabilities. Currently, the services offered by the various systems are very close. However, each software has specifics that make it preferred in different situations.

At the Trakia University, the most used platforms are Google meet and BigBlueButton and less often Zoom. They are among the most used worldwide as well. A study at the

University of Warsaw in Poland (Pacholak, 2021) shows that the largest number of lectures was conducted with Zoom, followed by Google meet, BigBlueButton and MS Teams.

BigBlueButton (BBB) is an open-source tool for video conferencing. It is integrated with Moodle and other learning management systems (LMS). This allows students to access study materials and the virtual classroom from one place. Google Meet (GM) is a video conferencing platform developed by Google. GM can be used easily with all Google applications. For example, using Google Calendar, you can create a new meeting, set the meeting title, date, time, duration, and guests. Zoom is widely used video conferencing platform. It is very convenient for application in education, because it is easy to use and have good presentation and other features.

A comparison of the capabilities of the various platforms has been made in many scientific papers and Internet resources. The comparisons are made for different purposes, so they cover different elements of the systems - price, number of participants, functions, different technical aspects. Zoom and BBB, which are applied at the Technical University of Latvia are compared in (Chaiko at al, 2020).

A number of advantages and disadvantages of both software have been identified. In (Azlan at al, 2020), eleven functionalities of GM, Cisco WebEx, MS Teams, Zoom, Skype, BBB, and Jitsi have been compared. Review of various available online platforms, namely Zoom, GM, Google Classroom, Microsoft Teams, Cisco Webex, GoToMeet, and Say Namaste and comparing their essential features and their benefits was done in (Dash at al, 2021).

Most scientific papers look for the advantages of one platform over another. Price and technical parameters are compared. No publications have been found that examine the functionalities provided by the systems in terms of their usefulness in application for training engineers.

The aim of this paper is to make a comparative analysis of the realization of certain functionalities in BigBlueButton, Google meet and Zoom, which are widely used in Bulgaria.

This comparison is not intended to arrange the platforms and determine which the best is, but to help lecturers to use more fully the capabilities of video conferencing systems. Recommendations have been made for the application of the various functionalities in training in technical disciplines. The analysis performed can make the software selection easier for users.

2 Functionalities of Video Conferencing Platforms

After the pandemic forced lecturers to move to online learning, they had to find a way to attract and retain students' attention, to provoke their activity and cooperation. The best way to do this is by using interactive teaching. The key to this teaching are technologies. Video conferencing systems bring a whole new dimension to the classroom. They provide a number of functionalities that give an advantage of online training over face-to-face training. For example, content sharing, recording of lectures, interaction and collaboration. The benefits of video conferencing, however, depend on how well lecturers know and use these technologies effectively.

Based on the author's many years of experience as a lecturer in various technical disciplines, surveys and interviews with students and colleagues are defined twenty-five functionalities of video conferencing software that are most beneficial in technical education. They are grouped into five categories: Integration and access opportunities; Opportunities for presentation; Cooperation; Communication between the participants; Administrative functions. In the next section a comparative, theoretical analysis of the realization of the selected functionalities in Google meet, BigBlueButton and Zoom is made.

3 Comparison of the Functionalities of Video Conferencing Platforms

- Integration and access opportunities
  - *LMS integration* – The students give a very high assessment of the availability of this functionality, as it allows them a combination of synchronous and asynchronous learning. BBB is integrated with several LMS and is available as a plugin for others (BBB integrations, 2021). It also has integration with LMS Moodle, which is used at the Trakia University. GM and Zoom have not integration with LMS. Students can join the pre-established meeting created in GM or Zoom from a course in Moodle if the lecturer has provided a link.
  - *Opportunities for access from mobile devices* - All considered software allows work from mobile devices. In the virtual meeting organized with BBB you can enter from the course in the LMS and use the full capabilities of the product. Meetings in GM and Zoom are available via mobile devices after installing an application. Almost all product functionalities are available in the mobile versions.
  - *Recording the meeting* - This is a very useful feature, as it allows multiple viewing of the lecture at a time convenient for the student. BBB makes a record, which is stored in the course in the LMS, in which the meeting was created. In Zoom, the recording is stored on the computer of the meeting host. The recording of the GM meeting is stored in a Google drive and sent to the host's mail. The advantage is that technical problems with the server on which the e-learning platform is located do not affect the recording. In order for students to have access to the recording, the host must share the file with them.
  - *Access to the meeting* - In BBB, the creator of the meeting can include in it all students enrolled in the course, as well as add them by name or role in the course. There is a possibility to introduce various restrictions on access, such as success (grades), location, etc. Anyone who has a link to a meeting at the GM can join it. When quick access is not allowed, the host must first be involved and then the other participants. If the participant is not from the organization or is from the organization, but there is no invitation, an application for joining is sent and permission is awaited. To participate in a meeting in Zoom, you need to install an application. To create a meeting you need an account. Joining a meeting is by clicking on the link or by opening the software, entering the number and password of the meeting. The creator can set the waiting room function, which requires confirmation from him to join the meeting.

- Opportunities for presentation
  - *Upload a Presentation* - This feature is available in BBB. The lecturer can upload any office documents and pdf files in advance (pdf is recommended for best results). During the presentation, he selects and switches the desired file. The presence of a presentation area allows the lecturer to observe the meeting - participants, chat and more. In Zoom and GM, displaying a presentation or text file is done by sharing the screen - full screen or a specific window. This way the presenter sees the shared file on his window. To see both the presentation and the participants, he can reduce the size of the presentation window and open a separate window through which he can see and manage the participants (in Zoom) or to adjust the screen layout in the sidebar (in GM).
  - *Notes of the lecturers on the presentation* - Students find this functionality very useful in teaching technical disciplines. When the presentation is open on the built-in board of BBB on the file you can make notes and draw figures. If the presentation is done by sharing a screen or window, it cannot be edited. In Zoom, when sharing a screen or window, a toolbar opens that provide rich options for making notes on the presentation - writing text, drawing shapes, placing stamps, and more (Figure 1). GM does not have built-in annotation tools. The presenter cannot write on the shared file.

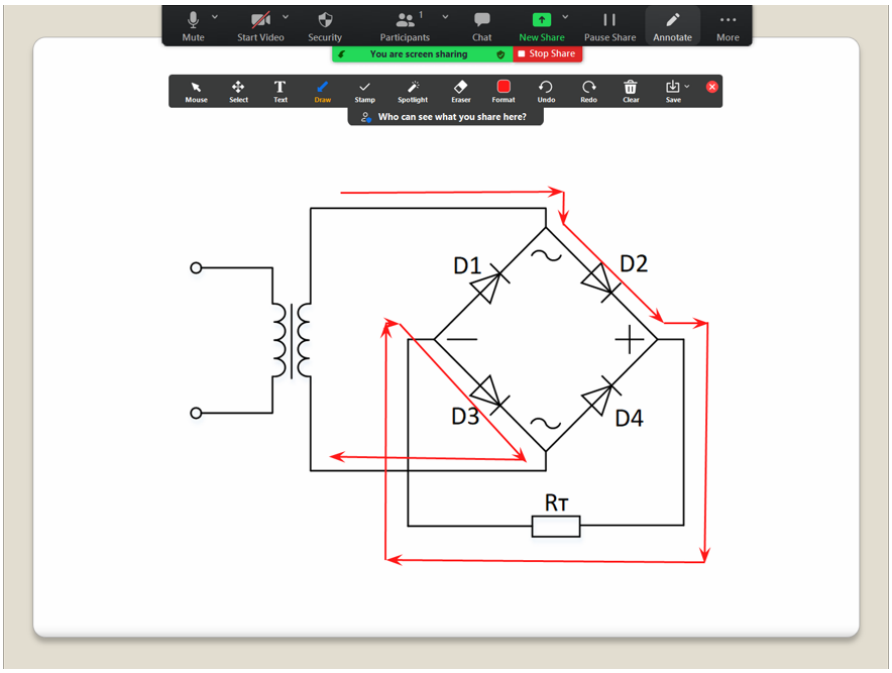

Figure 1. Notes of the lecturers on the presentation in Zoom

  - *Notes of the participants on the presentation* - In BBB if the moderator turns on the multi-user whiteboard function from the toolbar, all participants can make notes on the presentation area, no matter if there is a presentation or a whiteboard. Zoom allows all

meeting participants to make notes on the shared screen. Google meet does not have an editing feature on the shared screen.

- *Using a whiteboard* - BBB has a built-in whiteboard. The downside is that the whiteboard cannot be saved as a separate file and loaded in a new meeting. To activate a whiteboard in Zoom, the screen sharing function must be started and whiteboard sharing must be selected. The contents of the board can be saved on the computer in png or pdf format. The file can be viewed after the meeting is over, and reloaded when a new meeting is started. In GM the whiteboard is a separate application Jamboard that is shared with meeting participants (Figure 2). Everyone can write on the whiteboard. The whiteboard is automatically saved in the cloud in Google Drive. The recordings on the boards are available at any time and can be shared at a new meeting.
- *Rich editing tools* - BBB and Zoom allow editing on both the presentation and the whiteboard, and GM only on the whiteboard. All three platforms support the ability to write in different colors and different pen thicknesses, to insert text boxes, lines and shapes. BBB has weaker editing functions - it does not allow editing and deleting selected elements. Zoom has rich editing capabilities. Images from the Internet or a computer can be placed on the board in the GM. The Jamboard app for Android and iOS allows students and lecturers to join from their mobile devices. So they can paint with a stylus and erase with their finger. In teaching technical disciplines, where it is often necessary to discuss schemes, diagrams and formulas, these functionalities are highly valued by lecturers and students.

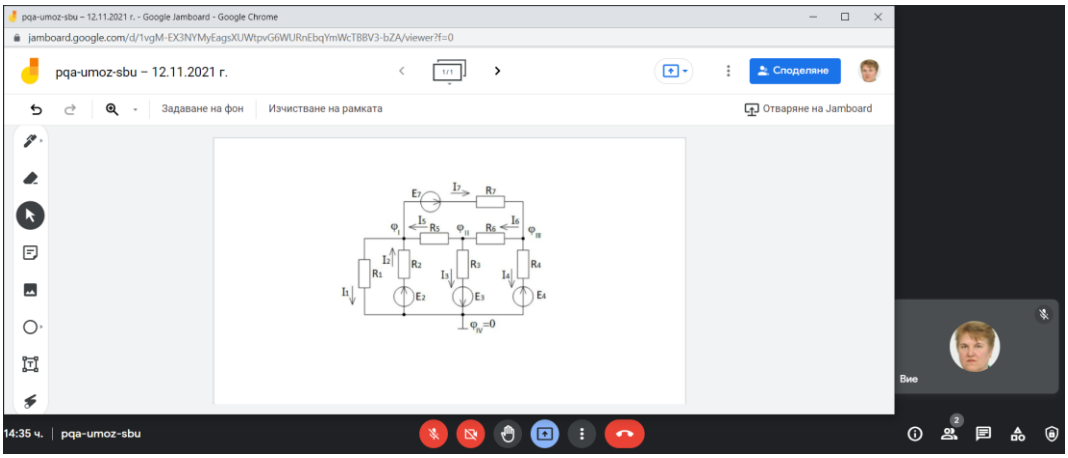

Figure 2. Whiteboard in GM (Jamboard)

- Cooperation
  - *Sharing of the screen* - Most often in video conferencing the screen is shared by the presenter, but sometimes the other participants have to do the same. In GM, the host allows or does not allow sharing the screens of the participants in the meeting. Anyone can share an entire screen, a window, or tab in Chrome. Zoom allows participants to share on screen all types of files, even an audio-visual file. Portion of the screen can also be shared.

The screens in GM and Zoom can be shared even in the mobile version. In BBB, a participant can share his screen only if the host makes him a presenter.

- *Screens sharing from several participants at the same time* - This feature is very useful when conducting online exams in small groups. The examiner can see both the image from the camera of the student and everything he does on the screen. This largely prevents attempts at fraud and dishonest behavior in the testing. In GM, if the host has enabled the screen sharing feature in the meeting settings (this is the default), all meeting participants can share their screens at the same time. Zoom also has the ability to share simultaneously. The host must select the "Multiple participants can share simultaneously" option. Only one screen can be shared in BBB.
- *File sharing* - When creating a meeting in GM scheduled with Google Calendar, documents, spreadsheets, and other files can be added directly to the event. Thus, the guests have all the necessary information before the meeting. There are various options for sharing. The participants cannot exchange files during the meeting. This can be done with the help of other Google applications (mail, chat, drive). No files can be sent in BBB. It is possible for the moderator to allow the presentation, which is uploaded to the built-in board to be downloaded. Zoom allows you to send files up to 512 MB in size and there is no limit to the expiration of download links.
- *Sharing of video and audio* - Sharing high-quality video and audio in presentations makes sense when the lecturer uses the videos as part of the lesson or to present slides with embedded videos or GIFs or with animated transitions between slides. BBB has functionality for uploading video from the Internet. This is done in the same way that presentations are uploaded to the built-in board by setting the URL. Sharing video with higher quality audio content in a GM is done by selecting the tab sharing feature. In Zoom, to share the sound of the video with all participants in the meeting, in the screen sharing mode, you have to click the check box that says "Share computer sound".
- *Transmission from two cameras* - Zoom offers functionality not included in the other video conferencing platforms. It allows you to share content from a second camera. This can be very useful in synchronous training in technical disciplines. For example, you can include a camera that captures: demonstration of laboratory exercises, monitoring the operation of a specific machine, and more.
- *Annotations on the whiteboard by all participants* - All three software allow all participants to edit on the whiteboard. In BBB, when the "Multi-user whiteboard" function is activated, all participants can use the full editing capabilities. When sharing a Jamboard in a meeting in GM, the host must choose the access of the participants - for viewing only or editing. In Zoom, anyone with whom the whiteboard is shared can edit on it.
- *Breakout rooms* - All considered software allow the lecturer to divide the students into groups in separate virtual rooms for joint work. In Zoom, groups can be created by splitting participants automatically, manually, or by choice. In the BBB, participants can also be divided into groups at random, manually or at the choice of the participants. You can also set the duration of work in groups. In the GM, participants are distributed manually. It is possible to stir or stop the rooms after a set period of time. Rooms can also be created in advance of the meeting scheduled with Google Calendar.

- Communication between the participants
  - *Emoticons* - During videoconferencing, it is common practice to mute the participants' microphones, except for the speaker microphone. This is done to avoid distractions from background noise. However, this can make the meeting boring and the speaker will not hear any feedback from the other participants. That's why platform creators include feature emoticons for reaction. Participants can send emoticons with applause, smiles, etc. This shows that they listen and participate carefully in the meeting. Zoom and BBB provide this feature. So far, GM does not include sending emoticons. Another way to react is to use the raise hand feature. It shows the host that the participant wants to say something. All three software provide this functionality.
  - *Chat options* - BBB and Zoom allow both private and public chat options during meetings. GM supports public chat, but no private channel. BBB has a function for saving the chat in text format, as well as copying to the clipboard. Zoom chat can be saved to a text file on the participants' computer. GM does not have a chat recording function.
  - *Polls* - This functionality serves to study the opinion of the participants in the meeting. In the GM, the host must enter the questions and options for answers. In Zoom, the polling feature must be activated in the host's account in order to conduct polls. It allows you to create single choice or multiple choice polling questions. It is possible to download a report of polling, which shows what each participant has chosen. Polls can also be conducted anonymously. The results of the survey can be shared with the participants in the meeting. In BBB, questions must be written on the slides or asked orally. With one click the lecturer can choose to start a survey. Pre-configured choices and Custom Choices are available.

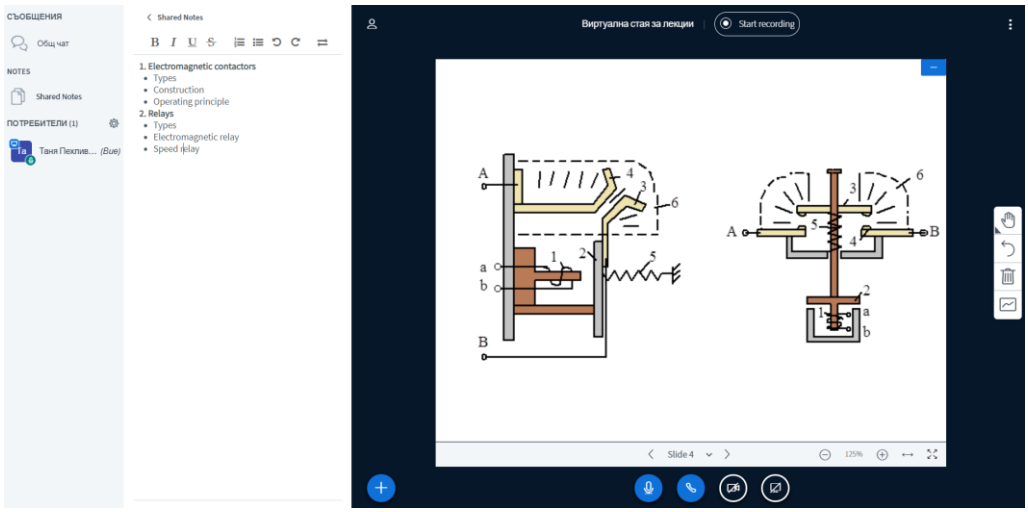

Figure 3. Shared notes in BBB

  - *Shared notes* - It is recommended to use this functionality to emphasize the main points in the lecture, as well as for additional explanations. BBB has a separate Shared Notes feature. It opens an additional field in which the lecturer can write and format text in an appropriate way (Figure 3). Students can also download this text. GM doesn't have a

separate note-taking feature. It is easiest to use the whiteboard function. Zoom does not have a separate section for writing notes. Notes can be written on the shared files or on the whiteboard, both by the teacher and by the others.

- *Questions* - GM has a special section for asking questions. All participants can ask questions and answer verbally in the meeting or add their reply in the meeting chat. After the meeting, information about the questions is stored in Google drive and sent to the host's mail. There is no such section in BBB and Zoom.

- Administrative functions
  - *Host rights* - Everyone who schedules or starts a meeting is its host (moderator). He can control various aspects of the meeting, such as managing the participants. The rights of a moderator of a pre-scheduled meeting in Google Calendar can be transferred to another person. This is not possible during the meeting. Each participant during a meeting in BBB can be promoted to moderator. When scheduling a meeting in Zoom, the host can designate another user as an alternate host. Zoom also offers a shared host feature.
  - *Chat control* - BBB does not have the opportunity to stop the chat by the moderator. In GM, the host can allow or prohibit participants from sending chat messages. In Zoom, the host can disable chat completely, allow chat only with it, allow only public chat or public and direct (private) chat.
  - *Management of the participants' microphones and cameras* - In GM, the host can simultaneously and individually turn off the participants' microphones. After switching off, he cannot switch them on again. In Zoom the host can set when joining, all microphones to be muted, may prohibit participants from turning on their microphones, mute all participants simultaneously or individually, turn off participants' cameras, send a request to participants to turn on their cameras or microphones.
  - *Captions* - This can be used to allow participants to easily monitor conversations or meet accessibility requirements. Zoom has a variety of options for creating captions. During meetings, the host or other participant in the meeting assigned by the host can provide manual captioning. An integrated third-party closed captioning service may be used in which a third-party streams text from their closed captioning software to the Zoom meeting. The third option is to use the Zoom's live transcription feature, which can automatically provide captions. GM has a Live Captions feature during meetings. Automatic live captions provided by Google's speech recognition technology are appearing in real time. BBB has no automatic captions. There is only a function for manual captioning (closed captions).

4 Future Development of Video Conferencing Systems

Video conferencing platforms will continue to evolve in the future. Their creators will add more and more features that will make their use even more convenient and efficient.

According to (Correia at al, 2020), future work will focus on: Improving security; Improving the work with touch screens; expand the systems to incorporate social media features; applications that allow the use of filters, image manipulation, animated virtual backgrounds; Support 3D augmented reality and more. In (Mendes at al, 2020), the use of artificial intelligence is proposed to add the following new features to video conferencing

systems: Stop sharing inappropriate content; Audience Counting; Identity Verification; Automatic Layout; Automatic Accessibility; Participant Anonymization; Video Summarization; User Attention/Engagement Detection and others.

Artificial intelligence (AI), machine learning (ML), natural language processing (NLP) tools and computer vision (CV) are expected to become more widespread in video conferencing systems. They will make possible:

- Voice activation and end of meetings;
- Voice virtual assistants;
- Real-time translations;
- Automatic voice quality adjustment;
- Automatic jamming;
- Entering a meeting by recognizing faces;
- Automatic detection of visual problems;
- Background control; Eye correction;
- Automating meeting scheduling;
- Greater security and confidentiality of meetings and much more.

Work is already underway to replace video conferencing platforms with AR / VR platforms. This is a new mode of communication that uses holograms in augmented reality, via a smartphone or AR glasses. So the people who are talking will appear in a hologram in the other's space.

5 Conclusions

Video conferencing platforms are widely used in higher education. Lecturers at the Trakia University usually use GM and BBB and less often Zoom. The creators of these systems are constantly improving them and currently they offer approximately the same functionalities. Therefore, the decisive factor for successful learning is not the technological factor, but the human one - the extent to which lecturers know and use these technologies effectively. The paper compares the realization of twenty-five functionalities in some of the most used in education platforms for video conferencing GM, BBB and Zoom. This comparison is not intended to arrange the platforms and determine which is the best, but to help lecturers to use more fuller their features. The analysis performed can also make the software selection easier for users. It is recommended to use all the considered functionalities in the teaching of technical disciplines.

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Psychological Aspects of Online Assessment

Tanya Pehlivanova

Trakia University–Stara Zagora, Faculty Technics and Technologies-Yambol, 38, Graf Ignatiev Str. Yambol - 8602, Bulgaria
E-mail: tanya.pehlivanova[at]trakia-uni.bg

Abstract

This paper discusses topics related to the psychological state of students during online assessment. The results of a study among students from Trakia University - Stara Zagora, Bulgaria are presented. It aims to check how students feel during online exams, whether this way of testing affects their concentration and results and which are the most preferred forms of online assessment. It is concluded that electronic exams do not cause additional stress in the students being assessed. On the contrary, many of them feel more comfortable with online assessment. Students do not have the feeling that their online grade will be lower than what they would get in an attendance exam. Their biggest concerns in electronic assessment are related to the possibilities for technical problems. Of all the types of online exams used for assessment in technical disciplines, the quizzes in the e-learning system are listed as causing the least stress. Next is a defense in a conference call of pre-developed projects, tasks, etc. After analyzing the results of the study, the main factors leading to stress were defined and measures were offered to improve the mental state of students during electronic assessment.

Keywords: Psychological aspects, Online assessment, Stress

1 Introduction

At the beginning of 2020 due to the epidemic situation, the world has completely changed its way of life. This inevitably affected education as well. Training and assessment began to be conducted remotely. The development of computer technology and digitalization has made this process possible.

Despite the enormous opportunities provided by computer technology, higher education institutions face a number of challenges related to both teaching and student assessment.

The main challenges in conducting distance online exams are: “Possible student academic dishonesty; Assessing and certifying practical knowledge and skills; Ensuring fairness; Risk of technical failure”, according to (OECD, 2020)

Assessment is the most important step in the educational process. Done incorrectly assessment can be “a source of dissatisfaction, frustration and anxiety” (Jisc, 2020). Effective learning assessment provides students with feedback and encourages them to improve. It helps lecturers to understand whether students have achieved the learning objectives of the course and to adapt their teaching methods to ensure the most effective learning.

The widespread use of online assessment during the epidemic requires research and analysis of students' attitudes towards it. Almost all research on e-evaluation discuss questions related to its acceptance. Questions related to stress and concentration during the e-exam are partially considered. The results obtained are contradictory. Factors that are considered as possible causes of stress are: speaking in front of a camera, unreliable technological infrastructure, technological incompetence of students and lecturers, objectivity of assessment, dishonest behavior on the part of some students, limitations in assessment by technical disciplines, fears that the answers will not be obtained and that time will not be enough, impossibility of students to explain their answers, etc.

A study at the Polytechnic University of Rijeka, Croatia among 133 students shows that students do not think e-assessment adds stress, it is not difficult for them to concentrate during the evaluation and would like computers to be used for assessment. It is considered that the e-assessment is suitable for technical disciplines, does not create problems for health and safety. It is as reliable as paper-based assessment (Tomljanovic and Polic, 2015).

A survey of 93 students in Jordan shows that the e-exam is an effective method of assessing knowledge. The e-exam has been found to make students feel less stressed and allow them to concentrate better. In addition, the electronic exam reduces the degree of fraud committed by students. (Elsalem et al, 2020)

A study in the UAE (Khan and Khan, 2019) shows that students have a number of concerns during e-assessment: about the unreliable technological infrastructure; for the technological incompetence of students and lecturers, for the fact that they will not be able to write fast enough; that their questions will not be sent. They have the feeling that their grades are falling due to online grading and that online exams are restrictive for some disciplines that require drawings and calculations.

In (Yoestara et al, 2020) it was found that 59.3% of students believe that online assessment reduces exam stress. It is more interesting than the traditional one, it can facilitate the evaluation process and it does not facilitate fraud.

The purpose of this paper is to examine the impact of electronic assessment on students' stress and concentration during the exam and students' perception of e-assessment. After analyzing the results of the study, the main factors leading to stress are identified and measures are proposed to improve the mental state of students during online assessment.

2 Methods

To achieve the goals of the paper, a survey was conducted with 70 students from the Trakia university – Stara Zagora, Bulgaria, Faculty of Technics and Technologies-Yambol, studying in different technical programs in the professional fields of Electrical Engineering, Electronics and Automation, Mechanical Engineering and Energy. Twenty-two were first year students, thirty-seven were second year students, and eleven were fourth year students. Forty-six students were in full-time education and twenty-four in part-time form. The survey was published in three e-courses - "Electrical Engineering and Electronics" and "Theoretical Electrical Engineering" and "Lighting and Installation Equipment" in the learning management system Moodle. The surveyed students have experience with different ways of online assessment using video conferencing software and e-learning system and can express a competent opinion.

The survey includes fourteen questions. They are related to the preferences to different ways of online assessment, general mental condition and the reasons that cause stress in the assessed - speaking in front of a camera and other students, the emergence of technological problems, the need for specific technological equipment and specific computer skills, objectivity of assessment, etc. The questions were compiled on the basis of the studied literature, the author's experience and preliminary conversations with students. A frequency analysis of the obtained results was made. The results are shown graphically in relative units. The factors that have the greatest impact on the mental state of students during online assessment have been identified and stress reduction measures have been proposed.

3 Results

Trakia University – Stara Zagora has a Moodle learning management system (LMS) and therefore most distance exams after the emergency situation with COVID-19 are conducted using this system. Most often, these are quizzes generated individually for each student by a large bank of questions. Other lecturers prefer to evaluate students by developing topics controlled by video link. These topics are uploaded to the courses in the discipline in a specially created assignment. Sometimes there is an oral interview with students. It is also possible to conduct a full oral exam. A common form of assessment is the preliminary development of projects, course assignments, essays and other independent work with or without defense. For the technical disciplines it is possible to evaluate by performing practical tasks, controlled by video link.

In order to obtain better results in assessment and teaching, it is necessary to know the preferences of students and lecturers to comply with them.

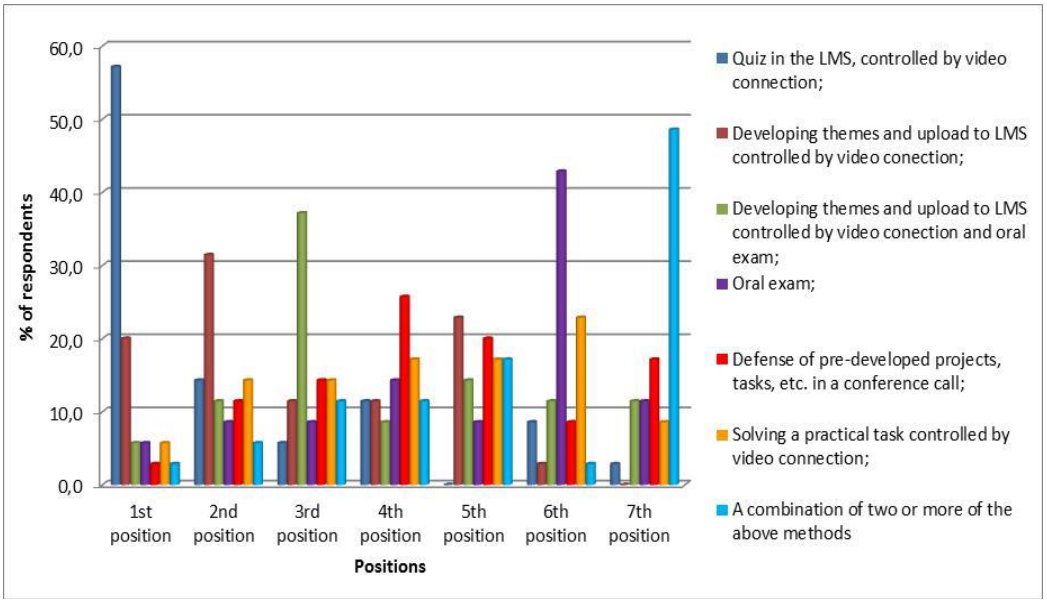

Figure 1. Student preferences for electronic assessment methods

The results of the survey show that the most preferred form of assessment by students is the quiz in LMS. 57.1% of the respondents put the quizzes in the first place and 14.3% in the second place (Figure 1). In order to prevent fraud, these tests are conducted controlled by a video connection and using a secure browser.

Students were asked to arrange the different forms of assessment in ascending order according to the stress they caused. It turns out that students do not always prefer those forms of assessment that they believe cause the least stress (Figure 2). Most first places (least stress) were given again to the quizzes in LMS (54.3%). After that, the defense of pre-developed projects, tasks, essays, etc. is placed. The reason for this is that the preparation of the materials takes place at a convenient time and everyone can spend as much time as needed. Although it causes less stress, this form is not among the most preferred, because requires a lot of time and effort. The combination of several assessment methods, the oral interview and the development of practical tasks during the assessment are most stressful.

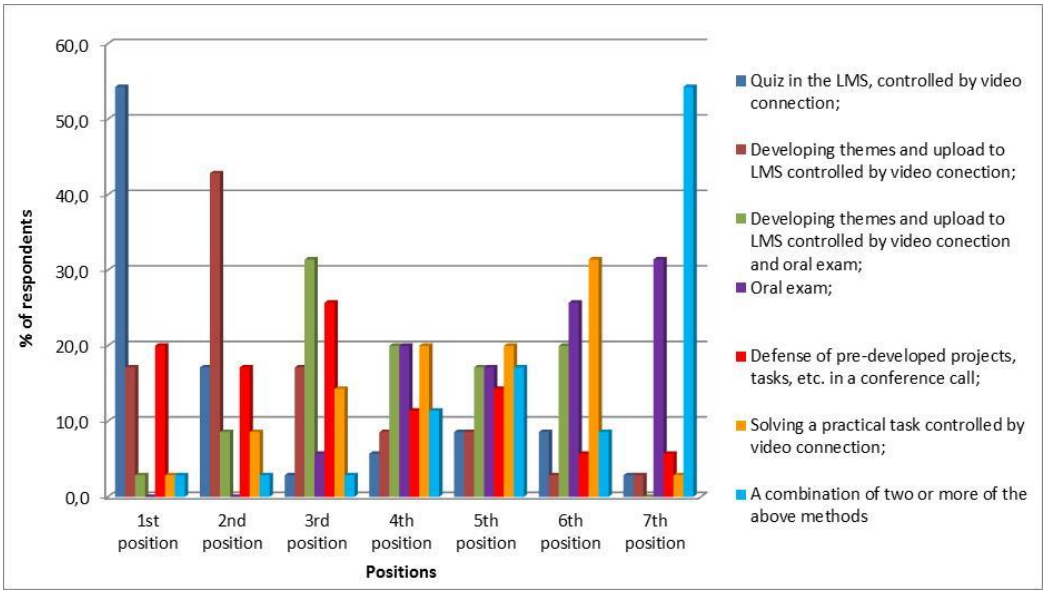

Figure 2. Which assessment method causes the least stress in learners

As a result of the study, it was determined to what extent different factors affect the assessment and the mental state of the evaluated. A small part of the students, 14.3%, say they feel more anxious when the examiner watches them with a camera than in person in the classroom. Almost all surveyed students believe that they have the necessary specific computer skills (85.7%), have the necessary equipment, software and network connectivity (71.5%). The biggest concerns of students in electronic assessment are related to the possibility for technological problems (poor connection, power outage, computer shutdown, etc.) (71.4%). 31.4% of the respondents feel worried when speaking before a large number of students participating in the video conference during the exam. 17.1% are more worried talking in front of a camera than in person with the lecturer (Figure 3).

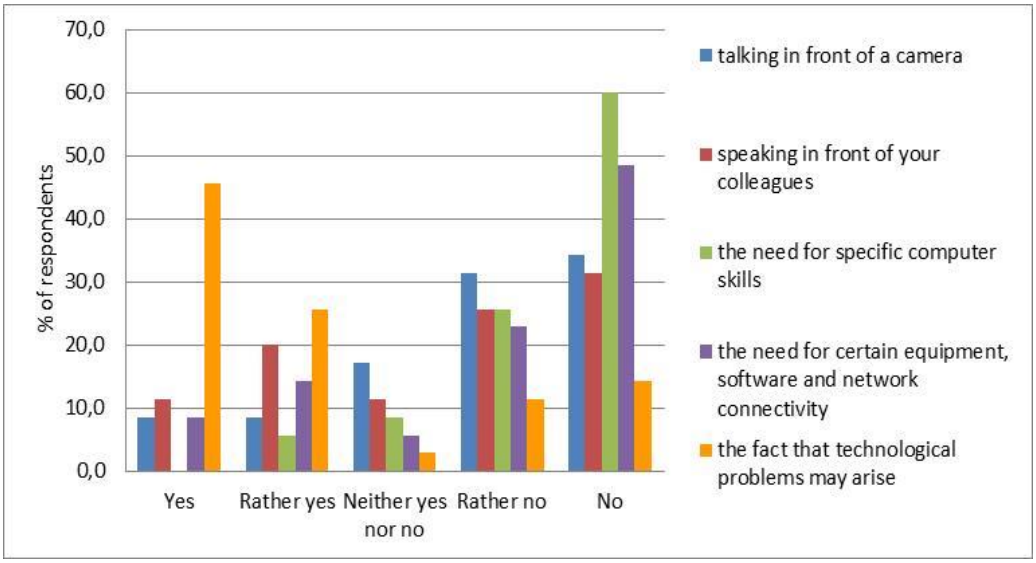

Figure 3. Influence of various factors on the mental state of the evaluated

Students do not put under suspicion the objectivity of online exams compared to face-to-face exams. Only 14.3% believe that distance exams create preconditions for an increase in fraud and plagiarism.

To the question "Do you have a feeling that your online grade will be lower than you would get in a face-to-face exam?" only 5.8% answered yes or rather yes (Figure 4).

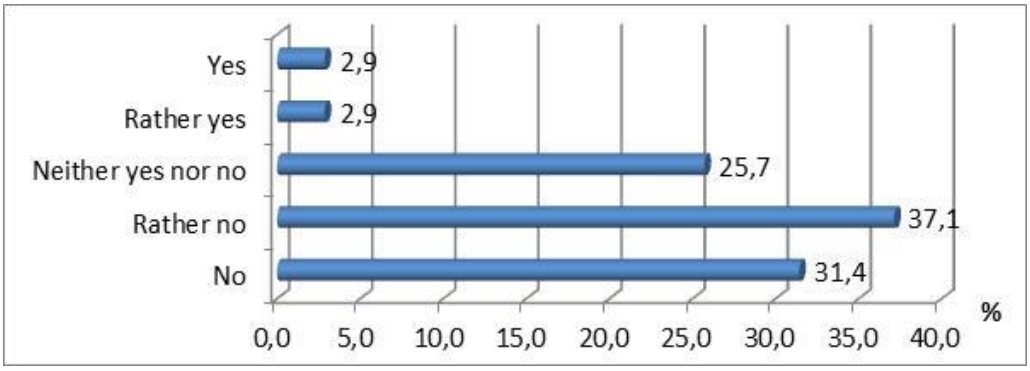

Figure 4. Feeling that the online grade will be lower than in a face-to-face exam

More than half of the respondents rate that their general mental state when conducting online exams is better than in the face-to-face exams. Many others feel equally calm with both types of assessment (Figure 5). Nevertheless, students say that measures can be implemented to reduce the impact of stressors in online assessment.

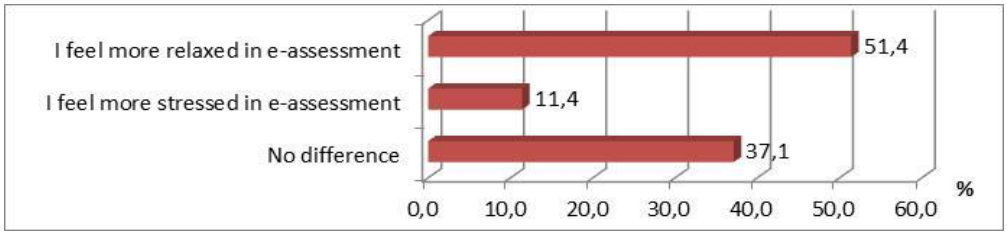

Figure 5. General mental state during online assessment compared to face-to-face assessment

4 Measures for Improving the Mental State of Students during Online Assessment.

- Inform students in detail about the way of conducting the exam - time for preparation of the written materials, format and way of presenting the written materials (if any), time for oral interview (if any). When assessing with quizzes, provide students with trial tests containing all types of questions, so that they do not waste time unraveling how to answer, but to focus on completing the task;
- Make previously trial examinations in the form in which the assessment will be conducted. Thus, students will check whether their equipment and software work well and will feel prepared and relaxed for the exam;
- Before starting the test, after making a live connection, allow enough time to set up the computers.
- Create an emergency plan. Inform students in detail about the consequences of technological problems - opportunities to second taking the exam, to re-solve the test, to continue the test after a short disconnection, the ability to continue video surveillance over the phone when the video connection from the computer is interrupted, the possibility to continue the exam over the phone in case of disconnection from the computer, etc.;
- Provide a telephone or other channel for communication with the examiner - so, in case of a technological problem, students will be able to connect and receive guidance for further action;
- Take measures to prevent cheating (Pehlivanova, 2019);
- Allow more than one quiz attempt. Naturally, this is possible when generating test questions from a large question bank, where the repetition of the questions in the second option is unlikely. In this case, turn off the correct answer review feature after solving the quiz. Experience shows that in most cases, students get better results on the second attempt;
- Conduct oral exams in small groups. Do not test students orally in front of all their colleagues;
- Do not announce the grades publicly. 85.7% of respondents are not worried about the fact that the grades are announced publicly to all participants in the online exam, and not in person, as is usual in the face to face exams. Some even want to see their colleagues' grades as a way to improve the transparency of evaluation. But there are also those who do not want their colleagues to learn their assessment. Their rights and dignity must be respected;

- Provide individual feedback to students. Regardless of the way you conduct it, always finish the exam by talking to the students. This will allow you to rule out any unnoticed problems during the exam, ask additional questions and the opportunity to increase the grade.
- Consider the time for solving the quizzes with the number of questions and the fact that they are solved online. Do not ask a very large number of questions in a short time, because if the connection is not good enough, there is no time to solve all the questions.

5 Conclusion

This paper presents the results of a survey among students from the Traka University - Stara Zagora, Faculty of Technics and Technologies-Yambol on topics related to the psychological state of students during online assessment.

As a result of the study, it was found that online assessment does not add additional stress to the students. More than half of the respondents answered that their general mental state is better when conducting online exams compared to face-to-face exams. Many of them feel equally relaxed with both types of assessment. The biggest concerns of students in electronic assessment relate to the possibilities for technical problems. Some of the respondents are worried when speaking to a large number of students participating in the video conference during an oral interview with the lecturer. There are those who are more worried about speaking in front of a camera than in person with the lecturer.

The paper proposes measures to reduce stress and improve the mental state of students during online assessment. The most important of them are related to conducting trial exams in the same format, more detailed preliminary information about the consequences of technological problems, conducting oral exams in small groups and individualized feedback.

They believe that they have the necessary technological equipment and network connectivity and the necessary computer skills. They have no worries about the objectivity of online exams. They have already gained experience in conducting online exams and this form of assessment has become a preferred form of assessment.

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Challenges in Education During the Second Year of Pandemic

Dineva Snejana

Trakia University, Faculty of Technics and Technologies,
Food Technology, Yambol, Bulgaria;
e-mail: snezhana.dineva@trakia-uni.bg

Abstract

The assessment quality of education during the second year of a pandemic was carried out. Under continuous social isolation, the maintains of students' motivation to study appears as a major problem with all consequences – lower attention to virtual lectures; lower virtual practice; and over 50 % drop of students in some specialties. Trakia University, including the Faculty of Technics and Technologies, had an online well-developed virtual learning environment on Moodle, since 2008. Up to pandemic closure, the mixed methods of learning were applied with great success. The first wave of pandemics passes without a strong negative effect on the quality of education. Even more, it has given the students and teachers new opportunities for implementing innovative methods of learning at a vast rate. Students, teachers, and administration stuff got adapted to the new circumstances and cope well. Nevertheless, the influence of the global health crisis triggered insecurity for the human future well-being and increased the chronic stress that deteriorate the authority of institutions and rearranged the human priorities. In the field of education, that process of 'pandemic fatigue' was remarked as undermining the attendance of on-lectures, lower motivation of learning, and drop of students during the second year.

Keywords: *e-learning, COVID-19, pandemic fatigue, quality of education*

1 Introduction

Education undoubtedly is a major key for a society's growth and progress, creating more employment opportunities, improving the economy, giving mental agility to make the right decisions, securing a higher income, bridging the borders, and creating a modern society with equal opportunities for a prosperous and happy life (Abdulghani Al-Shuaibi 2014; Blog 2020; Olufemi et al. 2018). The innovative technologies with the existing online platforms, transformed education during the last decades, allowing teachers easily to connect with the students, and facilitate collaborative experiences with the opportunity to create content (Jacobsen 2021). One of the government priorities is to promote and spread adequate measures to retain and improve the quality of education because that ensures well-being and further posterity for the next generation and, as well as an economic growth for all.

The pandemic situation has broad an enormous deleterious impact on all spheres of human life. The hidden negative effects on education caused by pandemics start to appear

in the second year after the applied strict restrictions for social isolation. The lockdown that closed the institutions all over the world broke the most important part of education, the personal interactions in teach community, the direct connection between the educator and the students, and interconnections inside the students' group. That unprecedented situation distinct the partners involved in the educational process and made learning progress less effective in all aspects. According to McKinley (2019), "class participation leads to increased learning for the entire class". Traditional class communication benefits both the student and the teacher, as a teacher receive continually student feedback. On other hand the student confidence increases also by feeling that the thoughts or ideas are appreciated, it generates an overall positive experience, makes learning easier, reinforced the connection student - teacher, and increases opportunities for expanded and prolonged learning (McKinley 2019).

The aim of the article is to describe the experience obtained during the second year of the pandemic and the strategies that were applied to preserve and continue delivering high-quality education.

2 First year of pandemic - enhancement of innovations

With the COVID-19 pandemic, teachers were challenged to teach in virtual and hybrid environments (Summer 2021). First-year of COVID-19 pandemic restrictions enhanced online delivery and new methods of teaching and assessment in Trakia University. The education was transmitted through the virtual learning environment using the possibilities of Moodle, Google Meet, and BigBlueButton. On 13 March 2020, Trakia University closed and transformed all communications and learning processes in all possible distant forms synchronous and asynchronous, following the published framework of OECD to guide education responses to the COVID-19 pandemic, in a period of social isolation.

In the period 01.03.2020 to 31.01.2021, the commission of quality and accreditation in the Faculty of Technics and Technologies, carried out inspections for classes conducting in the virtual learning environment using TrEU platform and in the virtual classrooms of the academic staff during the first pandemic year. The check-ups included the way of conducting the classes - synchronous/asynchronous, remote, and other variants of lectures, seminars, practical and laboratory exercises, etc. The conclusion noticed that in the new conditions of absentee classes the main problem is the attendance of classes by students, regardless of the way they are conducted (Dimova E. 2021).

The effects of pandemic on education, after first year of pandemic was deeply analysed in the Joint Research Centre technical report of European Commission's science and knowledge service. According to that technical report students are, on average, likely to experience a learning loss during the second lockdown, caused by:

- *less time spent in learning* - compared to when schools are open;
- *receiving more stress* - students confined at home may feel stressed and anxious that negatively affect the ability to concentrate on schoolwork;
- *lack of learning motivation* – during social isolation students are less externally motivated to engage in learning activities.

3 Second year of pandemic – pandemic fatigue and learning loss

During second COVID19 pandemic year, still two-thirds of the global student population is affected by full or partial school closures. The gained knowledge's and experience from previous first year of lockdown were successfully implemented in the study process, but nevertheless, the second pandemic year had different pattern and influences on education process. All participants included in training had their already online experience, so there were less tension regarding unknown procedure or requirements. Nevertheless, amazingly, to organize and work with students during second pandemic year were remarkable problematic and more difficult than the first year. Students were less motivated, or more stressed, registered as low participation in virtual meetings from the beginning of second pandemic year and increased dropout after the first half of the study year. The claim reasons for their fall were different as lack of time, low income, broken techniques, low-quality Wi-Fi connection, including illness.

Table 1 showed students' attendance in the main education activities for teaching the subject Ecology. In fig.1 are the results from the end exam of the subject.

Table 1. The learning activities of students on study subject Ecology

Date of attendance	Total	period 2020-2021 summer semester
30 June 2020	65	4
31 May 2020	13401	1656
30 April 2020	51446	7258
31 March 2020	20220	2594
29 February 2020	0	0
28 February 2020	6622	865

Figure 1 Results of Ecology exam

Undeniably, COVID-19 epidemic affected all aspects of human activities globally, the entire world was in distress because of COVID-19 threats, and the education sector were one of the most concerned (Onyema et al 2020).

Figure 2 shows the conceptual framework that included some of the spheres, which may affect education during Coronavirus lockdown (Onyema et al 2020).

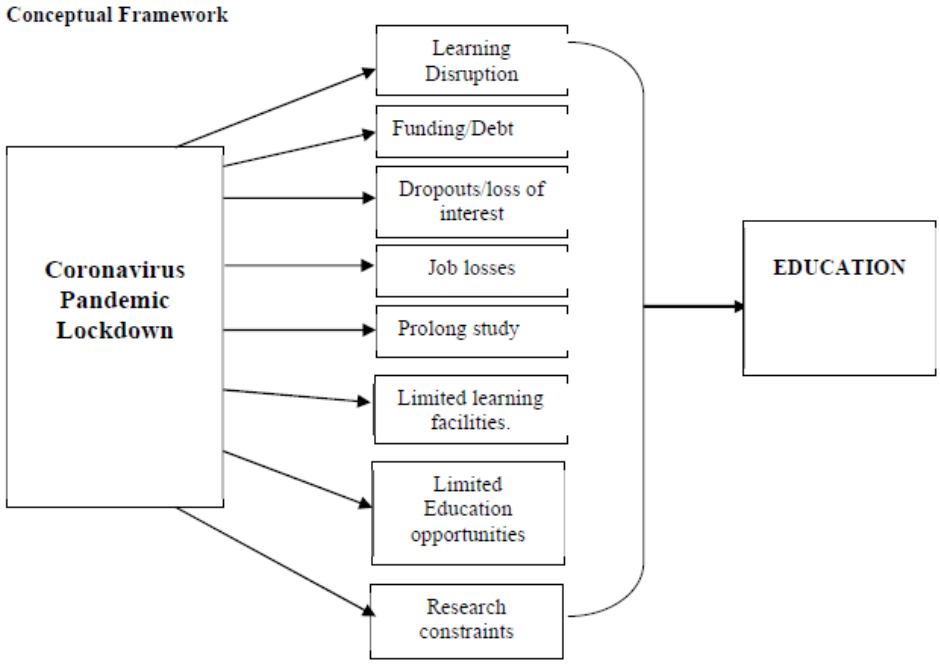

Figure 2 Conceptual Framework of the Study (Source: Onyema et al 2020)

The transition to distance learning and teaching is expected to cause greater inequalities in cognitive skills, emotional well-being, and student motivation. Isolating students from friends and teachers can lead to different distributions of behavioural and psychological problems. Students with less favourable backgrounds are more likely to be exposed to a stressful environment at home (for example, by sharing limited space and a limited number of digital devices with other family members). In addition, parents in these households, who may be under pressure due to financial and job security problems due to the covid-19 crisis, are probably not in the best position to support their children in these circumstances (Pietro et al. 2020).

Thoughtful, that the pandemic has no definitive end, causes widespread a ’pandemic fatigue’, i.e., the ability to cope with the problems lowered naturally because of long-term chronic stress, which led to less motivation to do efforts for positive and constructive work, even to the inability to manage growing negative feelings (Millard 2021). According to Pietro et al. (2020), the negative influence on education will grip both cognitive and non-cognitive skills acquisition and learning loss will not affect students equally, is probably it will have important long-term consequences in addition to the short-term ones.

4 Pandemic fatigue – and how to cope with erasing problems

On 5 October 2020, high-level public health experts from over 30 countries and partner organizations in the WHO European Region connected remotely to reinforce understanding of pandemic fatigue and share experiences in how to address it, many countries have been reporting an increase in "pandemic fatigue" (WHO 2020).

UNESCO found the Global Education Coalition (GEC) that counts 160 members mobilized to support learning continuity (Guttman 2021). On 29.03.2021, from Paris were transmitted the VII Seminar and training provided from Global Skills Academy (GSA) that reviewed arisen topics as concerns in every country:

- *Keeping schools open, prioritizing and supporting teachers;*
- *School dropout & learning loss;*
- *Digital transformation and the future of education;*

UNESCO informed that over 800 million students, more than half the world's student population encounter important interferences to their education, ranging from full school closures in 31 countries to reduced or part-time academic schedules in another 48 countries (UN News 2021).

Pandemic fatigue is accepted and determined as a natural and expected reaction to sustained and unresolved adversity in people's lives, evolves gradually over time, affected by the cultural, social, structural and legislative environment.

The pandemic fatigue is a serious problem and the experts from WHO described the main strategies and ways how to cope with the erasing problems and its consequences:

- **Understand people**: *collect and use evidence for targeted, tailored and effective policies, interventions and communication*;
- **Engage people as part of the solution**: *find ways to meaningfully involve individuals and communities at every level*;
- **Help people to reduce risk while doing the things that make them happy**: *wide-ranging restrictions may not be feasible for everyone in the long run*;
- **Acknowledge and address the hardship people experience**, and the profound impact the pandemic has had on their lives.

The five crosscutting principles for any initiative, policy or communication must be *transparency, fairness, consistency, coordination and predictability* (WHO 2020).

5 Conclusion

The main challenges in front of the academic community during the second year of the pandemic were keeping going students' motivation, reducing and relieving stress, increasing the participation in virtual meetings, diminishing dropout, and giving emotional support. The main reasons for bad performance were diverse as

lack of time, low income, broken techniques, low-quality Wi-Fi connection, including sickness and healthy disorders.

Despite enormous difficulties and observed pandemic fatigue among learners and academic staff during the restriction regime, most of the students adapt quickly to the challenges and showed success in their education. Many of them even received higher marks on the final exams.

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Assessment of Students During COVID-19 Case Experience

Dineva Snejana[1], Nedeva Veselina[2]

(1) Trakia University, Faculty of Technics and Technologies, Food Technology, Yambol, Bulgaria; E-mail: snezhana.dineva@trakia-uni.bg

(2) Trakia University, Faculty of Technics and Technologies, Department Electrical Engineering, Electronics and Automation, Yambol, Bulgaria. E-mail: veselina.nedeva@trakia-uni.bg

Abstract

The assessment of knowledge is the most difficult task for the education system in the absolute social isolation during COVID-19 pandemic. The education system has not had such experience never before, so it is essential to share our practice with all the pros and cons. Trakia University, Faculty of Technics and Technologies had an online assessment system as quizzes for self-training and final exam developed in the virtual learning environment on Moodle, since 2008. Ordinarily, by the schedule published for the exam session, students attended traditional computer classrooms and pass their exams. In that case, during quarantine, it was not possible. The Trakia University rector gave order how is acceptable the learning process to be continued. Teachers had different options from which they can choose how to inspect the learning process of students, like synchronous or asynchronous online assessment, assignment or course assignment, tests, quizzes, multiple tasks, developing a thesis or presentation. The learning process did not stop. Most students complained that they have more homework than before. The synchronous online exams were arranged using BigBlueButton in Moodle, or Google meets. The difficulty encountered include lack of proper devices for video connection, not always high-speed internet or WiFi, and not adequate techniques. Due to many obstacles that arose as slow or weak internet, or overloaded study platforms, some of the students disappear from the monitor during conducting the assessments. In the case of using a safe - browser as "Lock Down", the students were not able to open the quiz, or when was used the option "window with JavaScript" in Moodle - the marks did not appear in the assessment reports on the end. Hence, to be sure that the cheating will be minimized the tests were restricted in time approximately 40%.

Keywords: e-learning, COVID-19, student assessment, online assessment

1 Introduction

The very vital part of any education process is the evaluation of achieving knowledge. It gives feedback to both teachers and learners, how the study material is equated and understanding, where student drop confidence, what in addition, should learn, what must be repeated, or it is purely an opportunity to learn from errors.

The assessment is an educational tool and offer a snapshot of student comprehension at a specific time in the learning process (Tookoian 2018). The formative assessment takes place during the process of teaching and learning, helps to clarify students' understanding, gives lecturers insights into their students' learning and their own teaching practice, and it permits the learner to take allegation of their own learning (Connell 2021). Furthermore, no one acquiring knowledge can proceed without tracing the study process and check of the training state, which give self-esteem and motivation for self-improvement to the students, show weak points and gaps in their understanding. The definitive purpose of education is understanding (Briggs 2020), and most of the used approaches effectively can be applied in distance learning as quizzes both synchronous and asynchronous, the reflection of students at the end of the lesson, checking for understanding during the lecture, etc.

The aim of the article is to describe the experience gained during the remote learning applied because of the COVID-19 pandemic and particularly the process of assessment.

2 Different types of assessment and evaluation applying in FTT-Yambol

The authority of the Trakia University (TrU) guides in a proper manner the faculty members during all extreme situations of pandemics. Prior exam session the definitions and options on how is acceptable to inspect students were immediately given with the links to workshops, video instructions, and seminars. There were also available support teachers ready to help if someone needed it. The leading lectors had different options from which they can choose how to review the learning process of students, like synchronous or asynchronous online assessment, assignment or course assignment, tests, quizzes, multiple tasks, developing a thesis or presentation.

The examination report used by each lecturer and by the Head of the Department for the report of the department was contained the procedures for conducting the current assessment and semester exams described as follows:

- Test in the e-course in the discipline in TrEU (Trakia e-University), controlled, with video connection via Google Meet or similar software;
- Test in the e-course in the discipline in TrEU;
- Test sent by email to students with limited time to solve;
- Development of papers or presentations - recommended to present them to the teacher through the form "Assignment" in the e-course in the discipline at TrEU. They can also be presented via video link, if the teacher does not use TrEU, also an e-mail can be used.
- Solving practical tasks - recommended to be presented to the teacher through the form "Assignment" in the e-course in the subject in TrEU. Sending decisions by e-mail can also be used when the teacher is not using TrEU.

- Development and sending of course assignments, term papers, and projects through the form "Assignment" in the e-course in the subject in TrEU. Also sending the works by e-mail, when the teacher does not use TrEU, with defense by video link.
- Defense of protocols from practical/laboratory classes via video link. The protocols are presented to the teacher through the form "Assignment" in the e-course in the discipline at TrEU. If the teacher does not use TrEU, an e-mail can be used to link with the students.

Other forms are also admissible, in accordance with order № 825/31.03.2020 of the Rector of TrU, but it is necessary to agree in advance with the Head of Department and the Deputy Dean for Academic Affairs. The faculty members used all types of mentioned above methods to check the state of knowledge and move forward with their students, following the content of curriculum. Students' assessment during a pandemic was conducted using different methods, depending on the nature of the discipline.

In Computer Programming and Web Programming, students have tasks for which they write program code as an independent work with a certain deadline, which is evaluated by the teacher, after this period. The grade that students received from these assignments is a part of the ongoing control, which gives a maximum of 30% of the final grade for the semester. Depending on how many tasks they have solved and presented, students received points corresponding to this number - in this case 3% for each correctly solved task, with the presented code and a screenshot of the solution. In a similar way students are evaluated during the semester of Web Programming (Java Script) - with independent tasks during online learning. Students received separate assignments for independent work from the teacher leading the lectures and from the teacher who lead s the practical exercises.

A different approach is applied in the discipline "E-business and e-government". The students' independent work was to study three e-shops according to certain criteria and to evaluate the design, content and functionalities. The results had to be described in an abstract and uploaded to TrElUni. Then they had to create a working e-shop site using the Shopiko platform. The instructions received by the students, in addition to online lectures, were recorded on 6 videos - for each stage of the implementation of the e-shop.

The results of the implementation were impressive for e-shops. There was a variety of themes, designs and products for women's fashion; Herbal honey; Table lamps; Photographic services; Cars and service, etc. (Fig.1). It is likely that some students will create their own e-business in a similar way. During the exam, each student presents his e-shop and explains how certain elements of it are created. This takes place in a virtual room, in front of the teacher and the students from the same group. Students receive a grade for the paper and for the creation of the e-shop, and the final grade is average, but depends on the performance of the work.

The third method of assessment was in the form of an online test with video surveillance via Google meet, in which a record is kept. Students are required to stay with a camera and microphone constantly on and be alone in the room. For this purpose, two secure browsers were used, according to the preference of the teachers: Safe Exam Browser and LockDown. This method of assessment is applied for both current control and semester exam. The main advantage of using these two browsers is that both are used on Moodle platform.

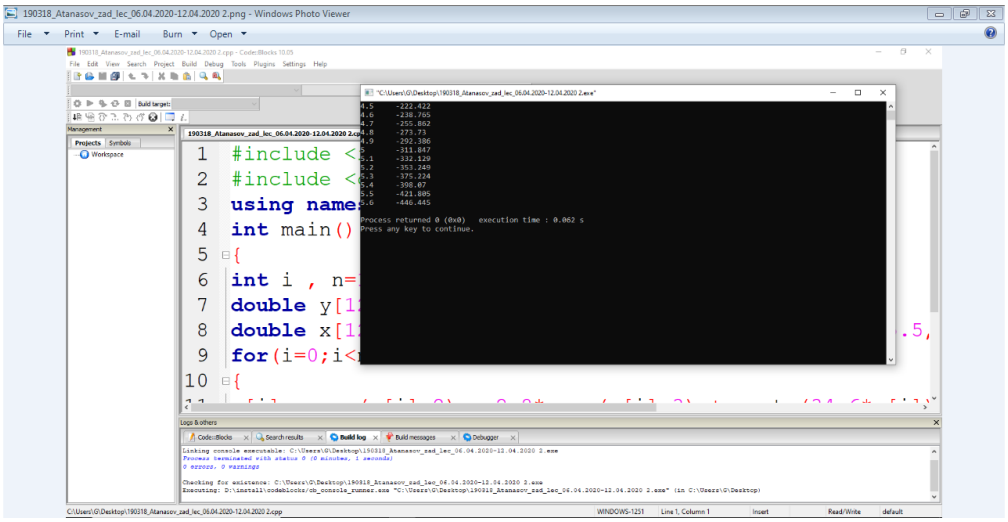

Figure 1 Screenshot of program code execution for a task

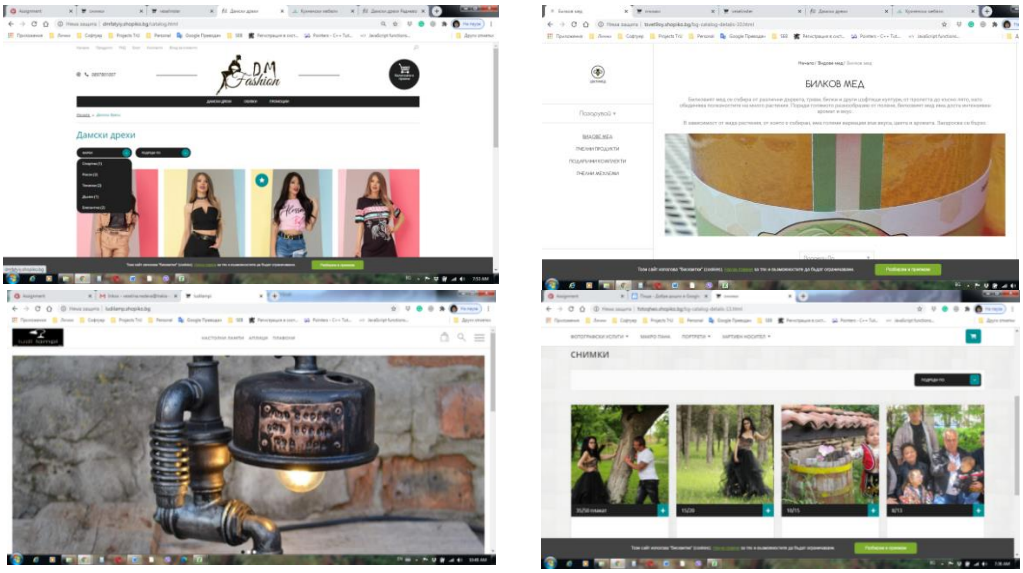

Figure 2 Screenshot from several e-shops of students

What is the difference between the application of Safe Exam Browser © 2010-2019 ETH Zurich, Educational Development and Technology (LET), based on the original idea of Safe Exam Browser by Stefan Schneider, University of Giessen Project concept; it is freeware) and Respondus LockDown Browser (Respondus, StudyMate, LockDown Browser and Respondus Monitor are registered trademarks of Respondus, Inc .; It is paid). Safe Exam Browser made administrative setting in the browser itself; a code is generated that is entered during the settings of the test with Extra restrictions; a key file is created from Safe Exam Browser, which must be made available to the students who will solve the test; an additional password for the secure browser can be entered, regardless of the test

password in Moodle. With LockDown Browser, a setting is made for the test whether LockDown Browser or Respondus Monitor will be used; no additional codes or key file are required. Respondus Monitor is a browser module that allows you to take an exam without supervision by a teacher or conservator - this is online web proctored exam; it prevents students cheating during proctored online exams. In its application, students follow 7 steps of Respondus: the entire exam is recorded on video; 5 sec is recorded at the beginning. Video with the voice of the person; a photo is taken; identifies with an identity document; requires crawling the environment in the room with the camera of the device; acquaints the student with the instructions on what is not allowed during the exam and starts the exam itself. After the exam, Respondus Monitor offers an analysis of the exam and an assessment of the probability that it did not pass the rules. The teacher can review the record and determine whether the exam will be recognized or not.

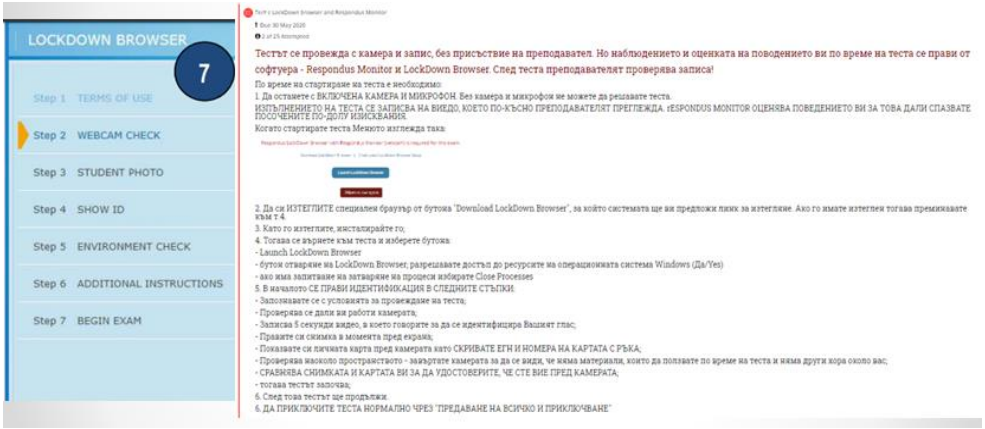

Figure 3 Instructions for students to use Respondus Monitor

What is the difference between the application of Safe Exam Browser © 2010-2019 ETH Zurich, Educational Development and Technology (LET), based on the original idea of Safe Exam Browser by Stefan Schneider, University of Giessen Project concept; it is freeware) and Respondus LockDown Browser (Respondus, StudyMate, LockDown Browser and Respondus Monitor are registered trademarks of Respondus, Inc .; It is paid). Safe Exam Browser made administrative setting in the browser itself; a code is generated that is entered during the settings of the test with Extra restrictions; a key file is created from Safe Exam Browser, which must be made available to the students who will solve the test; an additional password for the secure browser can be entered, regardless of the test password in Moodle. With LockDown Browser, a setting is made for the test whether LockDown Browser or Respondus Monitor will be used; no additional codes or key file are required. Respondus Monitor is a browser module that allows you to take an exam without supervision by a teacher or conservator - this is online web proctored exam; it prevents students cheating during proctored online exams. In its application, students follow 7 steps of Respondus: the entire exam is recorded on video; 5 sec is recorded at the beginning. Video with the voice of the person; a photo is taken; identifies with an identity document; requires crawling the environment in the room with the camera of the device;

acquaints the student with the instructions on what is not allowed during the exam and starts the exam itself. After the exam, Respondus Monitor offers an analysis of the exam and an assessment of the probability that it did not pass the rules. The teacher has the opportunity to review the record and determine whether the exam will be recognized or not.

In pandemic, the learning process did not stop in TrU; even students complained that they had more homework than before. The synchronous online exam was arrange using video connections of virtual classroom created with BigBlueButton, or Google meet. The difficulty that encountered include lack of proper device for video connection, not always high-speed internet or WiFi, and not adequate techniques. Due to slow or weak internet some of students disappeared from the monitor, or the internet joining often broke, trying to use safe browser as lockdown, or window with Java script, the marks did not appears in the assessment reports on the end, or some of students were not able to open the quiz. Hence, to be sure that the cheating will be minimize the tests were restricted in time, approximately 40%.

3 Impact of COVID-19 on education and further trends

The impact of COVID-19 on education is still unknown. By the way, at that moment all countries reported that they successfully cope with the situation, even the performance of students increased (Crawford et al. 2020; Basilaia & Kvavadze 2020; Sintema 2020).

According to Sintema (2020), the results of national examinations at Grade 12 registered growth of pupils' performance. Comparing 2018 and 2019 academic year, the results show enhancement in computer science and mathematics with 32.7 % and 13.9% rise, while pure chemistry, design, and technology maintained the same with a 100% pass rate. However, science recorded a small percentage drop in performance with pure physics posting quite a significant drop.

In higher education, the universities and colleges replaced traditional exams with online assessment tools (Burgess&Sievertsen 2020). The universities with adequate infrastructure and experience successfully moved toward virtual learning, if disturbances appeared according to Ahmady et al. (2020), the main reasons were:

(1) *cultural and social contexts;*
(2) *lack of teachers' preparation for virtual teaching;*
(3) *lack of access to all infrastructures and equipment;*
(4) *willingness to hold presence classes (ie, in-person);*
(5) *impossibility of using mobile-based training for all age groups;*
(6) *lack of access to smartphones;*
(7) *insufficient literacy and technological capabilities;*
(8) *inability to virtualize all courses; and*
(9) *large number of learners and the limited time to prepare online courses*.

As was mentioned by Sahu (2020), successful education further will demand the proper re-investment of funds to upgrade the technical infrastructure of schools and universities to make virtual a core aspect of teaching and learning. The financial aids for improving the tech equipment will allow the spreading high quality online learning and will support the

development of new methods for advanced delivery of education with increasing distance online training and examination. Faculty members should embrace technology and pay careful attention to student experiences to make learning-rich and effective.

4 Conclusions

Our experience gained from the pandemic situation showed that all assessment types as diagnostic, formative, interim, and summative, could be applied in remoteness learning. The conclusions arose from the outcome of students' performance on exams. The success of students was approximately the same or even with higher grades. However, students often complained of social communication missing.

There were listed many problems that arose from the internet or overloaded study platforms. To ensure adequate evaluation of the study process with minimum cheating, the duration of exam tests was restricted in time to approximately 40%. On that stage, consequently, we are prepared for new quarantine, we gained experience, technical equipment, but the social isolation influence on the human health and that really can be with big consequences**.**

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Students' Perception about University / Faculty Support for Adapting to The Online Learning Environment

Carmen Tiță

Gheorghe Asachi Technical University of Iaşi,
Faculty of Design Industrial and Business Management
address: Iași, Romania
E-mail: carmen.tita@academic.tuiasi.ro

Abstract

Influenced by the COVID 19 pandemic, higher education has engaged in the last year in a significant change in the teaching-learning-testing process. The transition from the classic face-to-face system to the exclusively online or hybrid system required a series of changes to which both the teacher and the student had to adapt. The article is based on research conducted between April and May 2020, on a sample of students from the Gheorghe Asachi Technical University of Iasi on how the university tried to adapt to the new form of education. I specify that the analysis will be based on the answers to the open question in the questionnaire: "How would you like the University / Faculty to support you during this period to adapt to the online learning environment?". The answers will be analysed with the help of a software program for qualitative data analysis. Support from the university could be: good informational infrastructure (server, e-learning platform, video-conference applications), the help of the teachers, administrative staff and colleagues, quality of the delivered content, and evaluation methods applied. Studying these aspects regarding students' perception can help the institution in developing effective strategies for improving the teaching process in the online environment. Student feedback should be an important aspect during this period that universities should consider and some researchers in this field consider that user experience is „worst experiences with online education come from the lack of a dedicated learning space". The results of the study are included in the analysis of the answers and conclusions.

Keywords*:* pandemic period; e-learning; perception; students; qualitative method

1 E-learning in the pandemic period

Professional context has changed a lot in the early days of the COVID-19 virus pandemic starts. If before most students worked only a few days a month at home, now remote learning has become the standard, including laboratories, where regular meetings have even been replaced by video presentations or simulations. The courses are held virtually through webinars and an e-learning platform which leads to more time available for online courses.

A few years ago, an American businessman said, "Physical offices will soon become a thing of the past." Although many were sceptical at the time, most employees now work remotely, and students attend online courses and labs using online tools such as video conferencing, live video feeds, applications.

"Online learning is not the next big thing, it is the now big thing." [8]. E-learning, also referred to as online learning or electronic learning, is the acquisition of knowledge which takes place through electronic technologies and media. In simple language, e-learning is defined as "learning that is enabled electronically". Typically, e-learning is conducted on the Internet, where students can access their learning materials online at any place and time. "E-Learning most often takes place in the form of online courses, online degrees, or online programs" [8]. Online learning can be termed as a tool that can make the teaching–learning process more student-centred, more innovative, and even more flexible. Online learning is defined as "learning experiences in synchronous or asynchronous environments using different devices (e.g., mobile phones, laptops, etc.) with internet access. In these environments, students can be anywhere (independent) to learn and interact with instructors and other students" [3].

The sudden shift from the face-to-face classical form of learning, in which the emphasis was on the teacher-student or student-student connection, to the online form has generated several behavioural changes at teachers and students. If in the first part of the last year the feeling was one of insecurity, or how we will manage, with the further of the period some aspects such as: the infrastructure used, the students' ability to have or the possibility to identify the acquisition of the devices necessary to participate in these activities are in almost all cases solved at the level of higher education. Probably the main advantage was that many of the platforms used can be installed on smartphones, devices that most students have. The major difficulty was in the case of students from specializations that depend on laboratories for understanding and applying specific notions, which is why universities / faculties, teachers have made considerable efforts to adapt.

Romanian top universities transitioned to eLearning very easily, having a strong infrastructure. Primary, secondary, and high schools, and also small universities have been confronted with the same challenge: to adapt the education system from a classical education system to an online education system based on eLearning. [3].

2 Students perception about e-learning

Adoption technology in higher education could "include relative advantage, the degree to which an innovation is perceived as better than the comparable product it supersedes; compatibility, the degree of consistency with existing values, past habits, and experiences of the target recipients of the innovation; and complexity, the degree to which an innovation is perceived as difficult to understand and use" [7].

For this reason, universities were, during the pandemic, in a position to take a series of decisions to improve the quality of: technical infrastructure, teaching methods, content of courses and seminars, as well as adding or creating new support services, to help the process. The efforts of all, namely teachers, students and institutional administrators were "for the optimal use of the technology and efficient learning process".[5]

According with Khan at al, "the preferences of students for e-learning as it provides them much freedom to connect with their teachers, fellow students and engage with their study materials at the comfort and flexibility of space and time" [6].

Keller and Cernerud after studying the student's perception about e-learning conclude that "the strategy of implementing the e-leaming system at the university was more

important in influencing students' perceptions than the individual background variables. Students did not regard access to e-learning on campus as a benefit" [2].

Ease of access to educational materials and the ability to choose the time and place to study were shown as the strongest advantages of online learning among respondents in our survey. Remote access is of particular importance during the COVID–19 pandemic, but it can also reduce the cost of accommodation and transportation in other settings.

According with Bashitialshaaer, R. at all the main obstacles for achieving the quality of distance learning and applying electronic exams under the coronavirus pandemic are: i) *Personal obstacles,* could be: weak motivation of students to adapt to distance learning; lack of willingness to implement; some of the faculty members have a negative perception toward the e-learning system *ii)Pedagogical obstacles*, the lack of: clarity of the methods of remote evaluation from distance learning that was similar among students from electronic exams; preparation of the university community (administration, professors, etc.); some teachers do not have sufficient experience to prepare and apply the test in the online environment; *iii) Technical obstacles* at slow internet, security and confidentiality of data and information transfer and the professor may not be able to guarantee that the student is not cheating and is not able to prove the student's identity; *iv) Financial and organizational obstacles* the lack of capabilities to communicate remotely (devices, internet, Apps, etc.) was compared to the lack of financial and technical capabilities of some students. [8]

3 Research methodology and results

The research carried out on a group of 360 students from different faculties within the Gheorghe Asachi Technical University of Iaşi is of quantitative as well as qualitative type. The questionnaire was applied to the target group between April and May 2020, at the beginning of the COVID 19 pandemic, following several aspects, including students' perceptions of how the university was trying to adapt to the new form of online education. This article will qualitatively analyze students' answers to the open-ended question in the quantitative questionnaire: "How would you like the University / Faculty to support you during this period to adapt to the online learning environment?". The answers to this question were significantly less than the number of participants being 158, it will be analyzed through the software specific to the qualitative methods Atlas.ti. The quantitative analysis using the SPSS 21 software product includes the answers to the questions regarding the students' access to e-learning platforms offered by Gheorghe Asachi Technical University as well as whether the learning modalities adopted by the educational institution facilitate a good school performance.

Compared to the qualitative part where only those who wanted to answer the open question, the quantitative analysis includes 360 answers specific to the technical problems section and the relationship with the teachers.

Distribution of students according to the coding made in Atlas.ti. Figure 1 points out that most are in the final years of bachelor studies, aged between 20 and 22, female 77 and male 87. The difference compared to the total number of responses appears from the coding because in the initial data female was coded with "-F" and male with "-M" because there is the possibility that among the answers to the automatic coding to appear specified the presented abbreviation.

```
CODES-PRIMARY-DOCUMENTS-TABLE (CELL=Q-FREQ)
Report created by Super - 05.03.21 06:35:42
Code-Filter: All [53]
PD-Filter: All [1]
Quotation-Filter: All [860]

---------------------------------
                          PRIMARY DOCS
CODES                      1 Totals
---------------------------------
19                        11     11
20                        34     34
21                        39     39
22                        51     51
23                        18     18
An 1 - Bachelor           17     17
An 1 - Master              9      9
An 2 - Bachelor           39     39
An 3 - Bachelor           46     46
An 4 - Bachelor           48     48
Male                      87     87
Female                    77     77
```

Figure no. 1. Atlas.ti. Distribution of respondent students by age, gender and years of study

The qualitative analysis of the 158 answers includes in the first stage the frequency of the appearance of some words in order to identify the importance that the students give to some relevant aspects in the university education. Applying the “word cruncher” tool, the answers have a total of 5356 words, among which there are also prepositions and for the analysis over 700 specific to the proposed research were selected. Table 1 shows the words that have a high number of occurrences and the percentage of occurrence. We can see the case of the word teacher highlighted in various forms such as (teacher, teachers, professors, teacher, etc.), but "online" appears 48 times.

The responses received from students were subjected to a coding system using the hermeneutics unit codes and the main results are presented in Figure 2. It can be seen that the main problem reported by students is related to adapting courses and seminars to online requirements, related to how online interaction between students and teachers. Compared to the first aspect with high frequency is a second coded in the form "the maximum possible has been achieved" represents the fact that students understood and perceived as such the efforts of Gheorghe Asachi Technical University to adapt to the new conditions of online education. A third relevant aspect for students is the "task load" by teachers, who believe that by going online, students have more time and can be loaded with additional homework and labs without many explanation or was cases when teachers send students to learn the material from tutorials posted on youtube.

Words	number of occurrences	Percentage in total occurrences
online	48	0,896%
teachers	33	0,616%
professors	21	0,392%
courses	18	0,336%
hours	16	0,299%
themes	15	0,280%
material	14	0,261%
courses	13	0,243%
professor	13	0,243%
laboratory	12	0,224%
project	12	0,224%
technique	12	0,224%
want	11	0,205%
laboratories	11	0,205%
course	10	0,187%
students	10	0,187%
time	10	0,187%
laboratory	9	0,168%
hours	9	0,168%

Table 1. Relevant words in students' perception

```
CODES-PRIMARY-DOCUMENTS-TABLE (CELL=Q-FREQ)
Report created by Super - 28.02.21 23:28:33

Code-Filter: All [37]
PD-Filter: All [1]
Quotation-Filter: All [222]

---------------------------------
PRIMARY                          DOCS CODES
1 Totals
---------------------------------
adaptation to online requirements   29    29
maximum possible                    23    23
asset loading                       23    23
staff indulgence                    18    18
I prefer face-to-face               13    13
lack of technology on               13    13
teacher communication               11    11
lack of soft licenses               10    10
additional materials                9     9
```

Changing the teaching method d	8	8
we don't get bored at home	7	7
adapted explanations	7	7
course registration	6	6
we are sent to yo	6	6
lack of knowledge	5	5
nothing was done i	5	5
low interest from professors	4	4
quality not quantity	4	4
limit adaptation	3	3
forum with "questions	3	3
connection problems	3	3
division of groups	2	2
emphasis on materials	2	2
Restructuring courses	2	2
Compliance with the schedule	2	2
recovery program	2	2
disposal of materials	1	1
face to face evaluation	1	1
it has also become possible	1	1
a single platform	1	1
not to take the exam	1	1
Make the right decisions	1	1
we are not to blame	1	1
more examples	1	1
learning gaps	1	1
I don't know	1	1
injustices on the part of	1	1
Totals	231	231

Figure 2. Atlas.ti. Output for the main codes

In these conditions, we consider relevant the coded aspect "teachers' indulgence" where there was a formula such as "we hoped to be permissive in exams or to understand their difficult situation and this way of learning." Another aspect that we can identify from figure 1 is that many of the codes related to the way teachers adapt to the new form of education such as: "changing the teaching method", adapted explanations, course registration, additional materials. The results using Query Tools from Atlas.ti for code "*adapt to online requirements*" the all 29 results are represented in output and for illustrate in Figure no. 3 to be extracted first 5 answers from the selected code.

Query Report (Extract)

HU: Student perception analysis_stepl 1
Edited by: Super
Date/Time: 07.03.21 18:52:23

Global selection criteria:
All

1 Primary Doc in query:
29 quotation(s) found for Query (Infix-Notation):
P 1: Answer.rtf - 1:20 [presenting in another way cour..] (52:52) (Super)
presenting in another way the courses, not read from the slides, understanding the situation not to involve so many tasks for students at home, without having the necessary
P 1: Answer.rtf - 1:29 [More video presentations..] (76:76) (Super)
More video presentations than writing
P 1: Answer.rtf - 1:31 [The problem is that for lack of a..] (82:82) (Super)
The problem is that in the absence of a blackboard on which a schematic description can be made to understand the course, most of us do not remember many things
P 1: Answer.rtf - 1:41 [First of all it would help me if..] (100:100) (Super)
First of all, it would help me if they would at least send us the courses, most of the professors do not answer our questions until after 2 weeks and the organization leaves much to be desired.

Figure no. 3. Atlas.ti. Output for the main code [[adapt to online requirements]

The questionnaire was answered by a number of 360 students from the Gheorghe Asachi Technical University of Iasi, and the frequency distribution of respondents according to the year of study is highlighted in table 4.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Year 1	87	24,2	24,2	24,2
	Year 2	95	26,4	26,4	50,6
	Year 3	79	21,9	21,9	72,5
	Year 4	99	27,5	27,5	100,0
	Total	360	100,0	100,0	

Table 4 – Students distribution by study_year

Depending on the form of education, bachelor's or master's studies, the respondents are 93.6% in the bachelor's degree and 6.4% in the master's (Table 5).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	337	93,6	93,6	93,6
	Master	23	6,4	6,4	100,0
	Total	360	100,0	100,0	

Table 5 – Students distribution by study_degree

From a quantitative point of view, the correlation analysis aims to identify statistical links between variables on student access to e-learning platforms provided by teachers of Gheorghe Asachi University in Iasi and whether young people believe that the e-learning method will affect their performance school. In table 6 were considered variables such as: technical problems with equipment, connection to the learning platform, internet speed,

platform failures and the performance of connection devices (phone, computer, tablet, etc.) and the value of grades.

Correlations

		technical_problem	connection_problem	internet_problem	e_learning_platf_problem	computer_perf	grades_value
technical_problem	Pearson Correlation	1	,473**	,179**	,232**	,269**	-,016
	Sig. (2-tailed)		,000	,001	,000	,000	,769
	N	360	360	360	360	360	360
connection_problem	Pearson Correlation	,473**	1	,256**	,214**	,225**	,034
	Sig. (2-tailed)	,000		,000	,000	,000	,515
	N	360	360	360	360	360	360
internet_problem	Pearson Correlation	,179**	,256**	1	,315**	,328**	-,055
	Sig. (2-tailed)	,001	,000		,000	,000	,301
	N	360	360	360	360	360	360
e_learning_platf_problem	Pearson Correlation	,232**	,214**	,315**	1	,387**	-,190**
	Sig. (2-tailed)	,000	,000	,000		,000	,000
	N	360	360	360	360	360	360
computer_perf	Pearson Correlation	,269**	,225**	,328**	,387**	1	-,201**
	Sig. (2-tailed)	,000	,000	,000	,000		,000
	N	360	360	360	360	360	360
grades_value	Pearson Correlation	-,016	,034	-,055	-,190**	-,201**	1
	Sig. (2-tailed)	,769	,515	,301	,000	,000	
	N	360	360	360	360	360	360

**. Correlation is significant at the 0.01 level (2-tailed).

Table no. 6. Correlation between connection variable and academic results

The results presented in the previous table, highlight the fact that the students consider that the school results / performances will not be influenced by technical or technological problems during the classes in online format. From a statistical point of view, the links between the considered variables and grades_value show inverse or very weak correlation, the *Sig* values being of *-, 016,, 034, -, 055, -, 190, -, 201*.

Testing statistical correlation by using the Pearson test between the variables grades_value and teacher-specific such as: student-teacher communication, teacher involvement during course and seminar activities, usefulness of teaching materials used, compliance with the planned program teacher and materials adapted to criteria e-learning. The aim was to measure students' opinion on how their results will be influenced by the specified variables (Table 7).

Correlations

		grades_value	teacher_student_communication	teacher_involved_online	course_material_usefulness	teacher_respect_schedule	adapted_material
grades_value	Pearson Correlation	1	,330**	,250**	,465**	,164**	,408**
	Sig. (2-tailed)		,000	,000	,000	,002	,000
	N	360	360	360	360	360	360
teacher_student_communication	Pearson Correlation	,330**	1	,706**	,523**	,535**	,459**
	Sig. (2-tailed)	,000		,000	,000	,000	,000
	N	360	360	360	360	360	360
teacher_involved_online	Pearson Correlation	,250**	,706**	1	,465**	,547**	,399**
	Sig. (2-tailed)	,000	,000		,000	,000	,000
	N	360	360	360	360	360	360
course_material_usefulness	Pearson Correlation	,465**	,523**	,465**	1	,361**	,689**
	Sig. (2-tailed)	,000	,000	,000		,000	,000
	N	360	360	360	360	360	360
teacher_respect_schedule	Pearson Correlation	,164**	,535**	,547**	,361**	1	,297**
	Sig. (2-tailed)	,002	,000	,000	,000		,000
	N	360	360	360	360	360	360
adapted_material	Pearson Correlation	,408**	,459**	,399**	,689**	,297**	1
	Sig. (2-tailed)	,000	,000	,000	,000	,000	
	N	360	360	360	360	360	360

**. Correlation is significant at the 0.01 level (2-tailed).

Table no. 7. Correlation between teaching quality and academic results

The results presented in table 4 highlight the fact that Sig value can be considered as significant in this case the correlation between grades_value and course_material_usefulness with value, 465 and grades_value and adapted materials, 408. It can be seen that the only statistically significant link is between the variables teacher_involved_online and teacher_student communication with a Sig, 706, which means that the students in the sample are satisfied with the communication with the teachers.

In many cases, students are accustomed to the idea of easy adaptation because the lives of current generations of students are intensely influenced by technology that is difficult to change in peoples of a certain age such as teachers. I believe that we cannot generalize that everyone has adapted perfectly, there are many situations in which adaptation has been easy in which the students' perception has been a positive one, but there are also teachers who change the form of education from face-to-face to online has generated a resistance to change. Positive feedback is related with capacity for university is about “maximum possible”, because they understood the new situation and noticed to attempt of the university to finish the year, but their minds was always when “return to school”.

4 Conclusions

The perception of the students of the Gheorghe Asachi Technical University regarding the online learning system can be considered as an understanding of the efforts that the higher education entity makes in order to carry out its activity in good conditions. In addition,

there are a number of obstacles: i) technology such as lack of dedicated platforms developed by the university, lack of licenses for software products used and lack of reaction from the institution to offer a series of free licenses for students, some connection problems to applications but many consider that from a technical point of view there are no problems of adapting them to the online environment; ii) the teacher-student relationship appears in different forms, the indulgence in evaluations, access to the recordings of courses or seminars, as well as the load with many tasks; iii) the quality of the contents and their adaptation to the online environment are other relevant aspects that the students consider that the teachers still have work to do because "online does not mean in their opinion to read a series of slides on the computer."

According with the results of the study, “students confirmed and expanded upon the findings from much of the previous research that suggested students have definite perceptions about online education and what they believe to be the necessary components for their success in this environment” [9].

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Technology of Essential Oils - a Comparative Analysis Between Training in Companies and Universities

Zlatin Zlatev, Stanka Baycheva

Trakia University – Stara Zagora,
Faculty of Technics and Technologies,
38 Graf Ignatiev str., 8602, Yambol, Bulgaria
E-mail: tania.gt@abv.bg

Abstract

The application of modern teaching tools in disciplines related to the technology of essential oils requires constant updating of the curriculum. This is because new technological equipment as well as technological methods are constantly being introduced in the production. Based on an in-depth study, guidelines for updating the curriculum in Essential Oil Technology disciplines have been proposed. A comparative analysis of the topics was made, from courses taught at Universities in Bulgaria and abroad, as well as in companies, with subject of activity production and trade of essential oils, which also conduct such courses in the form of company training. The obtained results can be used in the training of engineers in the subject area.

Keywords: Essential oils, Aromatic herbs, Food technology, Innovative techniques, Science and education

1 Introduction

Modern training in the field of obtaining, analysis and application of essential oils includes the acquisition of competencies derived from practical and laboratory exercises.

The fact that the industry seeks to introduce newer technological lines and equipment, requires universities to constantly update their curriculum, as well as to introduce new and innovative methods in the training of essential oil analysis.

With the development of modern science and technology, the requirements for technical and technological means necessary for the acquisition of this knowledge are also increasing (Shivacheva et al., 2016).

The application of modern teaching tools during lectures and exercises in disciplines related to the technology of essential oils, aims to convince those present in a scientific projects or to teach certain knowledge in this area. This is because it is in this area that it is important to absorb knowledge well and effectively and to use newer and more useful ways of teaching (Yordanova et al., 2019). In support of what has been said so far, Bulgaria has been working for several years on the National Strategy for Research Development 2017-2030 (Stamatovska et al., 2016; NSRDRB, 2020). It includes universities and research organizations in Bulgaria and is aimed at turning science into a factor in the development of an economy based on knowledge and innovation.

Hence, the purpose of the present work is to make a comparative analysis of the curriculum in the technology of essential oils, which is taught in universities and companies producing aromatic products. Through this update and the implementation of scientific achievements in the education of students, the objectives of the National Strategy for the Development of Scientific Research and in particular in the subject area of the present work can be partially achieved.

2 Material and methods

A study has been conducted among companies and universities that study the technologies of essential oils and essential oils. 5 universities from Great Britain, India, Greece, the United States and Bulgaria were compared. Also compared are 5 companies that offer online courses on the Internet, available from anywhere in the world with network access.

Based on the research, a proposal was made to update the curriculum in the field of Essential Oil Technology.

The "Correspondence Analysis" method was used to process the obtained data. This method is applied in the software product Statistica 12 (Stat Soft Inc.). In the software product Statistica, the method of Correspondence Analysis (Kazlacheva, 2019; Uzunov et al., 2021) is implemented in the sequence (NCSS, 2021) presented in Table 1.

Table 1. Stages of Correspondence Analysis

Stage	Description
A	Enter the input matrix K with dimension mxn. The elements in the matrix are positive. The sum of the values in each row and each column must not be zero
B	The matrix of proportions P is calculated by dividing the elements in K by the total number of elements in it. The number of rows is i and the number of columns is j
C	Calculate the totals for each row and each column of P. The results obtained are entered in the vectors r and c
D	The vectors r and c are converted into diagonal matrices and the reciprocal of the resulting square matrices is assumed. Calculate the scaled matrix A
E	A singular value decomposition (SVD) of A values is calculated
F	The coordinate matrices F and G are determined
G	Eigenvalues of V are calculated
H	The distances between the elements in the rows d_i and those in the columns d_j are calculated
I	The values of the weights in rows and columns w_i and w_j are obtained from the vectors r and c

The following criteria were used in the analysis of the results obtained from the Correspondence Analysis method: data inertia, eigenvalue, chi-squared (χ^2), p-value. Inertia is defined by [1]:

$$[1] \quad I = \frac{w_i {d_i}^2}{\sum_k {w_k}^2 {d_k}^2}$$

where w are weights; d are distances.

The eigenvalue (Mladenov et al., 2015) is the scale of the eigenvector when converting the data from the input matrix processed by the Correspondence Analysis method.

The hypotheses are: H_0 - there is NO statistically significant difference between the groups; H_1 - there is a statistically significant difference between the groups.

In the chi-squared method, the obtained value of χ^2 is compared with the critical χ^2_{cr}, taken from a table (Karapetkov et al., 2019; Suresh, 2019), at the determined degrees of freedom df. If $\chi^2<\chi^2_{cr}$, hypothesis H_0 is accepted.

All data were processed at a level of significance $\alpha=0,05$. If p-value$<\alpha$, the null hypothesis (H_0) is rejected.

3 Results and discussion

A summary of the topics that are taught both in company training and in universities. These topics are related to: extraction, chemical analysis, antimicrobial and antioxidant activity of essential oils and other aromatic products; application of aromatic products in food and cosmetic products; improvement of technologies for production and processing of essential oils.

After the detailed analysis, selection and summaries, the topics related to the Technology of Essential Oils, which are included in the curriculum of companies and universities, are presented in Table 2.

Table 2. Training topics in Essential Oil Technology

№	Topic (T)	№	Topic (T)
T1	Essential oil raw materials - sources of aromatic substances	T9	Determination of impurity content in aromatic products
T2	Raw materials with free and bound essential oil. Essential oil containers	T10	Processing of essential oil raw materials by distillation
T3	Qualitative characteristics of essential oil raw materials	T11	Processing of essential oil raw materials by extraction
T4	Determination of moisture content of essential oil raw materials - by azeotropic distillation and drying to constant weight	T12	Processing of distillation waters - by distillation and extraction
T5	Determination of essential oil content	T13	Processing of aromatic products. Rectification
T6	Qualification of aromatic products - organoleptic characteristics	T14	Properties of aromatic products
T7	Physical characteristics of aromatic products. Relative density, refractive index, solubility in ethyl alcohol, water content	T15	Possibilities for applications of aromatic products
T8	Chemical parameters of aromatic products. Acid value. Ester number	-	-

They can be divided into the following groups:

- ✓ G1 Basic information about essential oils. Includes topics T1 and T2;
- ✓ G2 Quality assessment of essential oils. Includes topics T3, T4, T5, T6, T7, T8, T9;
- ✓ G3 Methods for processing essential oil plants. Includes topics T10, T11, T12, T13;
- ✓ G4 Properties and application of aromatic products. Includes topics T14 and T15.

The results of the analysis of the topics in G1, related to the basic information about essential oils, at eigenvalues of 0,002, which describe the dispersion (inertia) in the experimental data by up to 100%, can be projected on one axis.

At χ^2=0,17<χ^2_{cr}=3,74 and p=0,07>0,05, it can be considered that there is a minimal statistically significant difference between university and company studies on these topics. T2 issues related to the botanical characteristics of essential oils are more strongly addressed in universities. Companies are concerned with more T1-related materials on general information about the use of essential oils in perfume production and their healing properties.

Figure 1 shows the results of analysis topics in G2 related to the evaluation of the quality of essential oils. It can be seen that at an eigenvalue of 0.18, the inertia in the experimental data is described by up to 100%, they can be projected on one axis.

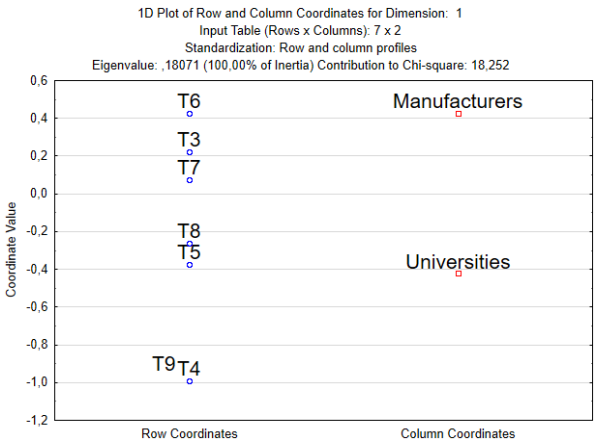

Figure 1. Results of analysis of G2

At χ^2=11,67<χ^2_{cr}=16,92 and p=0,23>0,05 it can be considered that there is a minimal statistically significant difference between the training in universities and companies on these topics. The difference is that the companies emphasize training related to the general composition and organoleptic properties of aromatic products and their physical properties. In addition, universities are focusing on training related to the chemical analysis of oils. Only universities offer training in determining humidity and detecting impurities, which in company training is embedded to a much lesser extent.

Figure 2 shows the results of an analysis of the topics in G3 related to the processing methods of essential oil plants. It can be seen that at eigenvalues of 0.02, the inertia in the experimental data is described by up to 100%, they can be projected on one axis.

At χ^2=1,33<χ^2_{cr}=3,84 and p=0,25>0,05, it can be considered that there is a minimal statistically significant difference between the training in universities and companies on these topics. As can be seen from the figure, the universities cover topics related to the study of various technological methods for extraction and purification of essential oils such as distillation, extraction, rectification. In the company training, in addition to presenting the basic methods for obtaining essential oils, the emphasis is mainly on the ways of using distillation water.

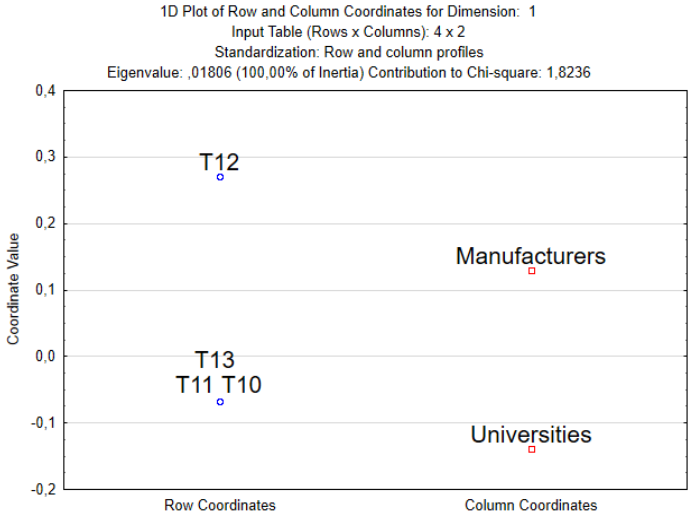

Figure 2. Results of analysis of G3

Results from the analysis of the topics in G4 show that at χ^2<<χ^2_{cr}=3,74 and p>>0,05, on these topics there is no statistically significant difference between the two groups - universities and manufacturers. In both groups, training related to the properties and application of essential oil products is equally affected.

A generalized comparative analysis has been made between companies (manufacturers) and universities, which study the technologies of essential oils and essential oil crops. Figure 3 presents a comparative analysis of the disciplines studied in the training courses related to the technologies for the production, processing and application of essential oils. The comparison is between universities and companies that conduct training courses.

It was found that the coincidence of the disciplines with those studied at universities is 50-80% (average 58%), and that with companies is 40-60% (average 42%). From the analysis it can be considered that the reason for the greater number of disciplines studied at universities is the fact that in addition to the practical tasks covering the technology of essential oils, serious attention is paid to the theoretical training in this field. This is their main difference with the courses held in companies, where the main emphasis is on the practical training of students.

The comparative analysis shows that it is necessary to update the curriculum, as well as to introduce new and innovative methods in the training of analysis of essential oils. In this way, a greater correspondence of the studied topics in the discipline "Technology of

essential oils" can be achieved, both with the universities in Bulgaria and abroad, as well as with the companies that conduct training courses in this field.

The successful implementation of a course in Essential Oil Technology requires joint work between the trainer and the trainees. It is necessary to keep notes, prepare laboratory reports and implement course projects (Shivacheva et al., 2016). Last but not least is the definition of criteria for assessing the knowledge and skills of learners (Yordanova et al., 2019).

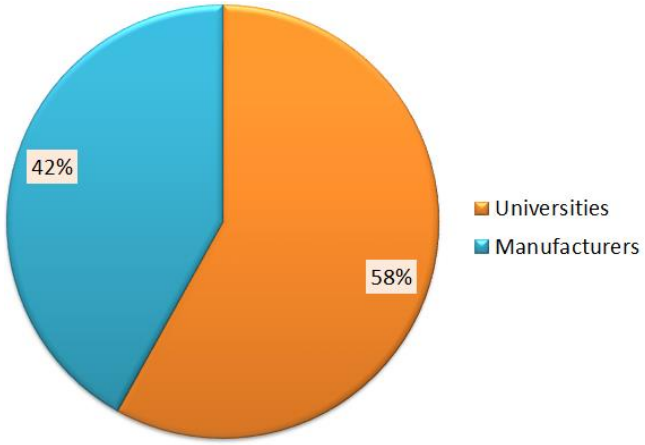

Figure 3. Comparative analysis for the study of essential oil technologies

Effective training on individual topics requires the laboratory report to be completed from the beginning of the implementation of the respective topic and submitted for verification after the completion of each experiment (Indrie et al., 2019). In order to successfully conduct the training on a given topic, the learner must constantly keep detailed notes for each stage of the presentation of the theoretical part and in the performance of practical tasks. In this way, in his future work, in real production, he will easily be able to reproduce what he has learned through the experiment without requiring additional instructions.

The assessments of the trainees from the training course will be formed depending on their level of preparation, the ability to independently and safely conduct each experiment, the implementation of projects.

In Bulgaria, for years It have been working on research projects and training engineers in the field of technologies for obtaining, processing and application of essential oils (Dimov et al., 2018a) from white oregano, dill (Dimov et al., 2018b), coriander (Dobreva, 2005). The results obtained in the present work can be useful in compiling training content for training of engineering personnel in the subject area.

4 Conclusion

The introduction of new technological equipment, as well as technological methods in production, requires universities and companies producing essential oils to constantly update their curriculum.

It has been established that the topics related to the basic information, properties and application of essential oils and essential oil plants are equally affected in the training in companies and universities.

It has been proven that the general composition and organoleptic characteristics of essential oils are studied during training in companies. In universities, in addition to these topics, methods for determining the chemical composition and physical properties of essential oils are also studied in detail.

A comparative analysis of the correspondence between the topics of Essential Oils Technology offered as company training and those in universities has been made. From this analysis it was found that the coincidence between the topics studied at universities in Bulgaria and abroad is up to 80%, and those in companies is up to 60%. This is because in companies the solution of practical tasks is mainly considered, and in the universities theoretical training in this field is obligatorily included.

From the comparative analysis it was established that it is necessary to update the curriculum, as well as to introduce new and innovative methods in the training of analysis of essential oils, both in universities in Bulgaria and abroad, and in companies that conduct training courses in this area.

The results of the present work are in accordance with the National Strategy for Development of Scientific Research in the Republic of Bulgaria. They can be used in the training of engineers in the subject area, taking into account the current and future needs of enterprises in the industry.

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Design Strategy – Art, Education and Functions

Katerina Despot[1], Vaska Sandeva[1], Zlatin Zlatev[2]

(1)Goce Delchev University, Stip, R. N. Macedonia,
Department of Architecture and Design
(2)Trakia University, faculty of Technics and technologies,
38 Graf Ignatiev str., 8620, Yambol, Bulgaria,
e-mail: zlatin.zlatev@trakia-uni.bg

Abstract

Design covers many different disciplines and each of them has its own specialized need, preparation and practice. By design we mean the integration of art and technology to create products, communication and the environment to meet human needs. We also think of design conveying the spiritual values of national art and culture in innovative artifacts. Great designers have a responsibility to subtly educate the company about values to create a striking and intuitive work, it is very important that the designer has something to say. Developing a design concept that strives to become innovative is of great importance, the more innovative the concept is and the more likely the visual interpretation is to be innovative. New ideas arise in the minds of creative individuals in their hard-to-reach lonely side of consciousness that the average person cannot comprehend. The discussed tools can be applied to improve the methods and methodologies in training future specialists in the subject area.

Keywords: Style, Design, Process, Space

1 Introduction

First design thought – The design? – From the line, we create forms and the forms we create reality. The emergence of design in the process of its creation, there are two basic underpinnings – creative and intellectual. In creative design it observes, form and under the influence of a certain emotion, it unconsciously creates a function, while the intellectual suppresses one and strengthens the other components, so that it gets an image appropriate to the creativity of the reality of the function (Baudrillard, 1996).

The final conclusion is the result of a spontaneous choice of the way the shapes and colors are organized, whose special character is determined by their place and function as a whole. The design process can take many forms depending on subject or individuals involved.

The definition of design as an activity is: furniture design is a creative activity, the purpose of which is to determine the formal properties of the product (Jan, 2002). These qualities include the external characteristics of the form, but mainly those structural and functional interdependencies make the furniture a unique whole, both from the point of view of the user and from the point of view of the interior manufacturer.

The goal of the design activity can be both the formation of a separate product, as well as the creation of a whole family of homogeneous products.

Designing the environment is another, more ambitious task that brings the profession of the designer closer to that of the architect. Regarding the above definition it is important to give an explanation of the shape of the furniture. It is the material structure of industrial products determined by the materials, construction and processing technology of these materials. Therefore, in order to solve the set task after determining the shape of a given product, the designer should give an answer to the question of what material, with what construction and what technology a shape will be created.

2 Design without strategy is called art, Design with a strategy is called marketing

Emphasize shapes and sizes to move space. And we aim to wake up the furniture so that warm winds can start blowing.

The combinatorics of strong color is our inner urge for emotions. The main inspiration is usually the circle as the main source of energy.

A new project, a step towards overcoming what has already been created. If we are what we create, every new design is a transcendence of ourselves. Free spirit, the only way to create a design without prejudice. To succeed we need to model the spirit (Lefteri, 2006; Ilieva et al., 2019).

The world around him sees it as a great exhibition of design artificial environments that are out of control day by day. In fact, everyone around us, every material object that we can see, feel, use, is designed is given a look, form, function, purpose and life.

Although designers, as creators of the world, play an important role and have a great responsibility to the consumers and the environment in which they place their creations, it all starts with nature.

Man is primarily a natural being and is destined to live and act in accordance with nature, to meet its needs, with minimal changes and damage to the flora and fauna around us, because he was created for the needs of man as a natural being.

The problem arises when the connection between man and nature ends. Unlike animals, our creativity leads to ego and emotions, which is sometimes not good for the world around us. Although all the materials that surround us come from nature, by that I mean they are not brought from another universe, or even plastic that comes from nature or from the oil that we, selfish creatively turned into plastic for the sake of obvious functionality, without thinking about its environmental damage (Serbedzija, 2007). It was that we destroyed our world around us with our needs and soon emotions and self-destruction will happen if we do nothing. The problem is not in the individual, the problem is in the mass.

Images as well as human awareness of natural development day by day, open many opportunities for quality design and redesign of the world, as well as hope for a better and better tomorrow. Many individuals and businesses today shape and consume this consciousness, transforming it into qualitative and naturally acceptable forms, but created for the good of man. There is a growing need for new and renewable forms and sources of energy (Intelligent Energy).

3 The shape of the creation of objects by man

Following Sandeva & Despot (2017), it is important to mention that "design activity is one of the characteristic and at the same time the most widespread studies of plastic creativity" in the material production of the 20th century. Its specificity is to build the image of industrial production, including aesthetic expression and informative readability of the subject environment. It places the design creativity in the dialectical depend on the basic way of production of material goods in the epoch of the scientific-technical revolution.

The modern society of design as a plastic creation to a lesser extent dominates human activity with thousands of thoughts of man to design and turn the world in which he lives into a "better designed place of understanding and beauty" (Ermolaev, 1998).

That duality, or rather the dialectical contradictory nature of the design, reflects on top of all its manifestations.

The internally contradictory nature of design creativity imposes an imprint on the final design, product, turning it into a sensitive indicator of the technological development of material production, a criterion of the degree of cultural society of technique by man. In this way, design is accepted by millions of people as a formal symbol of the culture of human societies in the modern world (Taneva et al., 2016; Despot et al., 2019).

Modern design in its deep interior is a typical human way of adopting the technosphere, of adapting it to the possibilities and demands of human relationships and individuals. In that sense, the design is a kind of continuation of that feature of the folk crafts, through which the light of the design is revealed to us.

Not only do we want to discover the design activity in us, but also to get acquainted with the laws that the design activity works according to. Indeed, "we are still in a time that provides an opportunity for an objective assessment of science and practice". This fact in itself enters the field of furniture design and formation as its core. At the time, it was increasingly cluttered with factual material in the field of design and revealed not only the need for historical study, but also marked by increased criticism of the campaign. We have the opportunity to study a rich and timely uninterrupted design body, we also have the opportunity to follow the formation and development of a necessary creative activity. The fact that we are modern and participate in some of the various phenomena of the design activity is a new feature of the study of work. There is a quality difference between the traditional scientific activity and the emerging design activity (Efimov, 2004). In fact, this is not what will be engaged in practice, but the sense of subjective assessment of the activity, whether we will succeed in maintaining professional and civic awareness in certain criticisms.

The same problem can be expressed in another way. The design activity, both as a multifaceted statement and as an appearance for its development, is a complex reality, characterized by the dialectical union between objectivity and subjectivity between the results of the activity and the representations given to it.

That reality or more precisely its properties enter the minds of the generations which also mean a reversal in history. To turn it requires social, artistic creation and organizational management experience in the historical consciousness of the activity (Dimitrov et al., 2016; Dimitrova, 2020).

Another issue is the numerous facts that have been accumulated up to that point, and not only likely but also necessarily to be the object of not one but several dependencies that will illuminate the path of design.

Each generation gives its own changes to the previous knowledge of design and so the design itself changes. We owe it to ourselves in due course to submit fairly easy principles to a better path and to overestimate. The history of design is before all the processes in which it is possible to get involved only if we are masters of the necessary degree of design modification. Based on Sandeva & Despot (2017), "breaking stereotypes and in that sense enriching the tradition and its development are necessary and that is the main condition for the emergence and establishment of an artistic fact". The question is from the positions of modern scientific significance and from the conditions set by the aesthetic creation.

The research is built through the principles of sequence in the development of the form-construction of the lower to the higher appearances, from more elementary to more complex forms of organization (Čikič, 2006).

Regardless of the more prolonged in time are the periods of quantitative accumulation and we stop mainly at those moments, which mark transitions. The main argument for this is that the previous periods are most strongly stated in the meaning and depth of the previous studies. On the other hand, the research is based on the specifics of human knowledge of the following techniques used in modern design processes.

Human society in every day of its development, stimulates activities that are necessary for its development - regularity, in full force, having it as the basis for utility. The effect of that lawful design conditionality is even more pronounced. The design activity, even if it is possible only when achieving a certain technical and production development of the material production, strengthens the stimuli of its appearance and development, primarily from the social and political spheres.

Design and division of design - There are many definitions of design, as you would expect from a creative endeavor. Some tend to categorize design to explain how different or related it is to other activities, while others try to inspire through good design. Design as a process can take many forms depending on the subject being designed and the individual or individuals involved, as shown on Fig. 1. We would say that design is creativity mixed with innovation. Every designer has a slightly different approach, different design skills and their own way of doing things, but there are some general activities that are common to all designers.

Discovery - Designers try to look at the world in a fresh way, noticing new things and looking for inspiration from everything around them. They gather knowledge, develop an opinion about what they see, and then decide what is new and interesting, and at the same time practical and functional. Whether they do it consciously or unconsciously.

Definition - The aim here is to develop a clear, concise and creative answer to what has been previously explored in the "discovery" phase.

Development - The development period refers to where solutions are created, tested and validated. This trial and error process helps designers improve and streamline their ideas.

a) b)

Fig.1. Overview of strategy from art to design

4 New design – functions

Many design productions are still subject to aesthetics, and rightly so. However, we call today's design a NEW DESIGN, it is completely finished and opposite to the old model. Today, the focus is on human-centered innovation, which re-examines human needs, functionality, market opportunities, usability and sustainability.

Appearance is just one dimension, among the many dimensions in complex interactions that help people discover, understand, learn and accept created artifacts and their meaning and begin to use and transform them.

This approach in professional practice - from the design of artifacts to the design of a socio-technological system, the options and experiences reached their peak about 25 years ago. Since then the traditional disciplines have been divided into industrial and graphic design, interior design and architecture have been replaced by new interdisciplinary practices in strategic design. New design methods are applied in order to solve complex problems of corporate strategies.

In the last 50 years of practice we have witnessed three waves in design:

- Individual design;
- Design policy;
- Process design.

The new design is too significant to be left to the designers. When we say this we mean two things, first the designers should work with non-designers, ie professionals from all other disciplines, secondly I think that the design methodology is as strong as a driver of innovation in all areas from technological artifacts to social systems for everyone to knows how to use them and not just designers. Design methods and tools should be available to everyone. Design as a discipline should be accepted as a subject in general education in addition to mathematics or physics in all schools.

We believe that the process that designers use in creating new ideas and turning them into innovations, anyone can learn and use:

- Innovation protocol – Old Design;
- Innovation protocol – New design.

In the last few decades, the term design has entered widely into both the specialized scientific literature and into bits. The etymological interpretation of the term design covers the theory and practice of art-design activities for the formation of the object-spatial and environmental, the middle of industrial production, as well as the results of this activity (products that are defined as a synthesis of different structures). In English guides the term design has the following meanings: concept, meaning, purpose, intention, idea; it is a pattern, drawing, sketch, picture; in a word pure composition. In the German art and technical literature, the term form education has been established, as a reflection of the entire artistic process of building and implementing the form. In Russian guides, industrial design is incorporated into industrial aesthetics, which in turn is a major part of technical aesthetics. The terms industrial aesthetics and artistic design of industrial forms have been imposed on us.

The design has a huge division, we can find it in the following type: *Some designed pieces of furniture are considered both classic works of art and engineering works.*

The interpretation of design is seen in the creation of conditions for the aestheticization of everyday life as a consequence of the postmodern consumer culture. With the overall development of society, which implies sociological, cultural and technological development, the opinion is imposed that consumers increasingly seek goods and services to symbolize the meaning relevant to their lifestyle. Although design has some common methods and cultural roles with art, it still differs in its approach to problem solving and meeting the needs of users.

Design as a problem-solving activity involves balancing a number of factors:

- technology,
- production and
- use.

Furniture as part of the design is the subject of creative human activities that reflect the living conditions, customs, tastes, people who created it, the level of development of art and techniques, materials and method of production of a nation or region. In terms of art it has a lot in common with architecture, an integral part of the interior and provides comfort and convenience. Features of modern furniture are: unity of use, functionality, technical-economic and aesthetic properties, durability, and more recently safety when using the furniture.

5 Conclusion

Good and successful design start with a big concept. So what happens if you have a visionary spirit is crucial for the designer. The designer must know the process of creating the concept.

The creation can be perfectly shaped but if there is no message, ie if it does not communicate with the customers in the right way, the creation will not be successful and will meet the needs of the target group. One of the most accurate and well-established definitions of design is that design is the shaping of objects and environments that meet human needs. The keyword of the definition is need.

Only the design that analyzes in itself the way of life of the modern man and the need of the users that arises from him and tries to satisfy those needs, leads to a happy and better society. At the beginning of the 20th century, people are very eager for information, new thinking and the growing need to answer the questions: who are we, what are our events, where do we strive?

Existing opinions are questioned, the value of everything that exists and the moral norms and aesthetic values of societies change. New information is sent through design messages. A design that does not have a precise concept and message that it wants to convey is a design without identity and that design has no future.

All in all, for design as a mixture of art (meaning emotion) of comprehensive essential and natural knowledge of this and aliens, depends our future. Although being a designer means being in that aspect primarily an educated person, every person is a designer of himself and his environment. As long as humanity exists there will be designs. Therefore, it is necessary to create, art is not the result of pleasure, if we were satisfied with everything around us, there would be no need for new creations.

Despite our individual needs, all living things on this planet merge into one thing, the need for naturalness. It connects me and you. That is the secret of design. In this way, the principles of design will be effectively used. Also, the discussed tools can be applied to improve the methods and methodologies in training future specialists in the subject area.

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Education in Functional Details of Space

Katerina Despot[1], Marta Kosturska[1], Miroslav Vasilev[2], Vaska Sandeva[1]

(1)Goce Delchev University, Stip, R. N. Macedonia,
Department of Architecture and Design
(2)Trakia University, Faculty of Technics and technologies,
38 Graf Ignatiev str., 8620, Yambol, Bulgaria,
e-mail: miroslav.vasilev@trakia-uni.bg

Abstract

The role of design is to create a product with the help of innovation and existing postulates. Effectiveness of design education is one of the deciding factors in the success of a product development. Decisions to own a product are primarily based on the design, i.e. the appearance of the product itself, because a good product design is the starting point for analyzing the function of that product which also provides quality, good performance, ease of use and reliability. The design also allows for product differentiation and clearly conveys the function of the product itself to the user. Its main purpose is to provide a creative and innovative design that will be economical, understandable, and easy to use and easy to maintain.

Keywords: Design, Concept, Idea, Product

1 Introduction

Design, as it is known, means applied art, and then science and philosophy, whose main goal is to adapt to man, so that it becomes more functional and aesthetic. Design is an art, because you must have a great sense of beauty and creativity (Ilieva et al., 2019).

Design is a science because it can be learned to some degree, yet not everyone can create aesthetically valuable products (Baudrillard, 1996). Design is also a philosophy, because you can always discuss things whether they are beautiful or not.

Product design means the exterior of the product that is experienced with the sense of sight, and part with the sense of touch, through the shape and texture. The main feature of the design is that it should be constantly changing, although it may appear the same in certain elements, in essence it should always be different. Design is an art or procedure for presenting an idea, function, or way of working on a certain object, through a plan or drawing.

Product design represents the process of efficiently and effectively generating and developing ideas to create new products. Product design includes all the engineering and industrial work that goes into the development of a product from the original idea to its production. When creating a new product, the final appearance of the product will depend primarily on the time and resources invested in researching the development needs of the

new product, then on the product design which is caused by the structural, functional, and aesthetic features (Čikič, 2006).

Good product design must meet the requirements of product usability, ergonomic flexibility, technical and economic safety, and aesthetic sensibility. Product design is a broad concept, which is essentially the efficient and effective generation and development of ideas through a design process that leads to new products. Thus, it is a major aspect of new product development.

2 Product design

Product design is defined as a process that consists of a set of tactical and strategic activities that starts generating ideas to commercializing space and creating product design. In other words, product designers develop and evaluate ideas, turning them into reality and useful products (Dimitrov et al., 2016). The role of the product designer is to keep abreast of science, technology, and the arts to innovate new products that people can use for their practicality and aesthetics.

Product design as a word: a set of properties of an artifact, consisting of discrete properties of form (i.e., the aesthetics of the material good and/or service) and function (ie its possibilities) together with the holistic properties of the integrated form and function (Dimitrova, 2020). Product design is the process of identifying a market opportunity, clearly defining the problem, developing an appropriate solution to that problem, and validating the solution with real users.

When designing a product, designers must understand the business objectives and be able to answer the following questions (NSAD, 2021):

- ✓ What problem are we solving?
- ✓ Who has this problem?
- ✓ What do we want to achieve?

"Answering these questions allows design engineers to understand the user experience of the product, not just the interaction or visual part of a design" (NSAD, 2021).

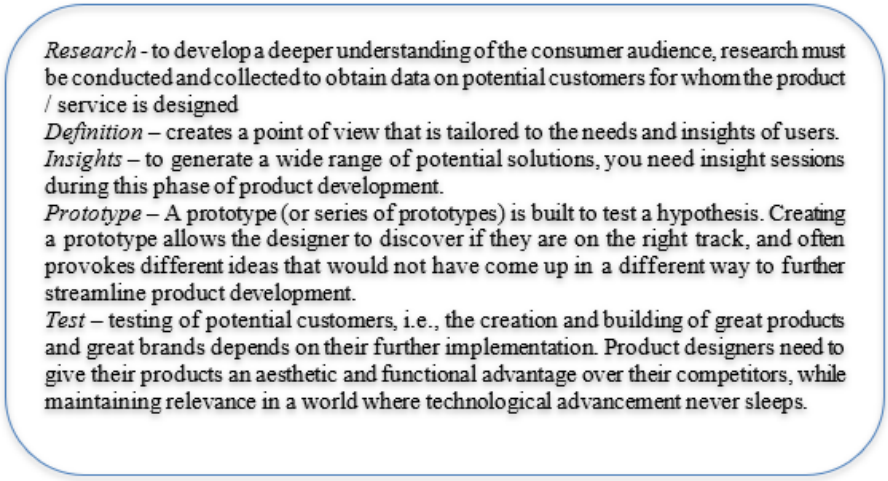

Figure 1. Steps of product development (NSAD, 2021)

The design expression of a product comes from the combined effect of all the elements that are in the product itself. The tone of the color, the shape and the size should direct the thoughts of the people towards buying that product. Therefore, it is in the interest of the product designer to consider the needs of potential consumers who will probably be the final consumers of that product.

One solution is to create a product that, with its designed look and function, will express a person or tell a story. Products that carry such attributes are more likely to give a stronger expression and attract more consumers.

It is important to keep in mind that the expression of the design refers not only to the appearance of the product but also to its function. The product may look attractive, but if it does not follow its function, it is likely to reduce consumer interest.

The term product means any object, service, or idea, which arose because of human work, to meet certain goals or needs of the user (Ilieva et al., 2020).

The purpose of the design on the one hand is that the product is adapted for mass consumption for human needs, and on the other hand to meet the demands of the market and the economy of production and thus provide benefits and freedom of human society.

3 Division of aesthetic components

The aesthetic components of the product can be divided into five groups as follows:

- ✓ Harmony factors: proportion-connection, rhythm-structure, module-whole, syntax, arrangement of the elements;
- ✓ Cultural factors: habit, knowledge, culture, religion;
- ✓ Social factors: meaning, appearance, identity, symbol, fashion, degree of communication;
- ✓ Functional factors: shape / function, durability, flexibility, comprehensibility, justification of the invested funds;
- ✓ Historical and technological factors: historical context, time context and technical development.

Cultural factors – Our aesthetic perception is relative and depends on the cultural system. The way of understanding and feeling depends on habits, knowledge, culture, and religion.

Social factors – Today's socio-cultural tendencies can be classified because the behavior and lifestyle of an individual are related not only to his material power, but also to the acceptance of social values, rules, tradition, and reaction to social political and economic events in society. The items purchased are signs and lifestyle and they classify the individual into a certain group in the society. This conscious choice allows the individual to create a set of rules and principles that become the model by which he seeks to identify. The dynamic nature of socio-cultural tendencies requires constant monitoring and adjustment of trends. These studies enable greater product diversification.

Functional factors – The functional dimension of the product is one of the basic factors for its aesthetics. The relation of the shape and function of the object derives from its purpose or from numerical calculations.

Architecture is a typical example of the relationship between form, function, and budget. In the "Charter of Industrial Aesthetics" written by Jacques Viénot, he sets out two basic

principles: The principle of usability and functional values - industrial beauty have only items that are perfectly adapted to their function (and technically recognized value). Industrial aesthetics include harmony between the functional character and the external appearance of the product.

The principle of harmony – between the exterior and the use - between the creations that satisfy the principle of industrial aesthetics, there is never a conflict, in them there is always harmony between aesthetic and practical pleasure.

The notion of clarity – the notion of clarity is extremely important because it is not enough for the product to satisfy only its function. It is necessary for the product to communicate with the user, i.e., the appearance of the product must be clear and logical. There is a visual connection between the function of the product and the presentation of the function itself. The function and perception of the user are very important in modern products, which are becoming more complex to operate and manage, due to the shorter lifespan of a particular technology on the market. If the function is not properly presented in the form, the product is not easily recognizable and noticeable, and thus its aesthetic impression is less.

Product development cycle – New product development is a huge part of the production process. All products have a limited lifespan because of innovation and rapidly changing technology. New products need to be constantly evolving, with manufacturers investing time, effort, and financial resources to ensure that their new products will be successful.

Design forecasting – The process of creating a design product in its pre-manufactured part involves 3 stages: Forecasting, planning, and designing. Forecasting is usually said to be the prediction of the development of the material environment in the future, the frameworks of which are conceived relatively conditionally on the color of the introduced data and on the suspected development processes. Two of the initial stages in design, planning and design are also tied in certain ways in the future. Projects that look to the near future have an empirical character, while those that look to the distant future have a prognostic character. Design forecasting refers to analysis, risk forecasting, technique, and architecture. At the same time, it is observed relatively often the availability of feedback - avant-garde design ideas can cause and especially in terms of technical progress. The most fantastic ideas have never been questioned, i.e., accepted in principle at some point when it comes to their socio-economic. When it comes to the works of the constructivists of the day when they created the new prestigious and graphic language of modern ethics, it undoubtedly facilitated the emergence of great masters.

4 Stages that make up a product design

The steps in developing a new product are: Generating ideas; Selection of ideas; Concept development and testing; Business analysis; Product development; Market testing; Commercialization; Launch of the new product.

Product life cycle management the life cycle management of a particular product covers the process from the initial idea, through engineering design and production, to service and disposal. It includes the following stages:

Imagination – idea, plan, innovation. This phase involves defining the product requirements and the scope of the project. The original design is used to define the

aesthetics and the main functional aspects. The transmission, i.e., the presentation of the idea is done with the help of a sketch. The sketch can be presented on paper or with the help of technology, i.e., software or 2D or 3D model. Technology today is mature enough for production and is an important part of this phase.

Design, description, definition, development, testing, analysis, validation – this phase involves detailed product design and development. 3D printers and CNC prototyping machines also play a role in this phase. The phase includes engineers from many disciplines, such as: mechanical engineering, electrical and electronic engineering, software development, and if necessary, architecture, aerospace engineering and automotive engineering. Simulation, validation, and optimization tasks are performed, which may include stress analysis, FEA finite element analysis, kinematics, dynamics, and mechanical event simulation.

Realization – preparation for production, production, construction, procurement, sale, delivery.

The third phase defines the production method, including a variety of design tools. The process of defining the method includes conception, molding and modulation and formation, while analyzing them. More modern production methods, such as 3D printers and CNC machines, can be used for shorter production processes, which saves even more time.

Service – use, handling, maintenance, support, communication, management, collaboration, and maintenance This phase is the communication between the user and the product. At this stage, the graphic design plays a big role, which simplifies the way of using and managing the product, but also the way of maintaining it.

5 Conceptual development concept for switches

Small details called serious function make the interior perfect. When it comes to refinement in the choice of an individual and high aesthetic criteria, the emphasis is always on the small functional details without which space has no function (Lefteri, 2006).

The main source of that is light (Rodkin, 2003). When with minimal effort we press and get emotion for the evening image of the space. In the next moment they are a factor for the intensity of the light. Strongly expressed or ambient, again the choice is ours. Combinatorics is the basic model of thought which is the starting point for the function called switch. The small closed functional format should be boldly worn in a different stylistic interior expression.

A complete view of the whole concept is the elaboration of pure geometric shapes where serious attention is paid to the compositional solution, i.e., the idea that with one line everything can be achieved, broken down into a pure function which in a small, closed format in strictly defined dimensions. Design is art or procedure to display an idea, function, or way of working on a certain object, through a drawing.

Product development is represented by the conceptualization, design, and marketing of newly created products, as shown on Figure 1. The whole presentation is conceptual solutions for switches and different variations that are presented in interiors with Renaissance admixtures to show the impact of small segments with a large function that in our opinion should be small modern relief surfaces.

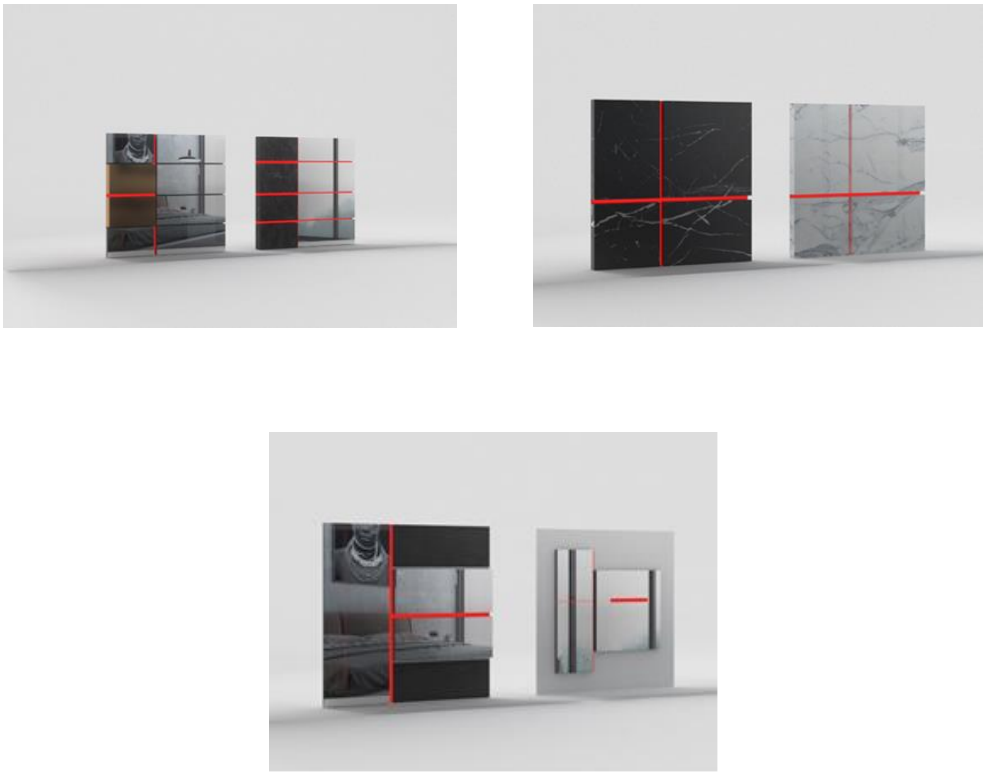

Figure 2. Concepts of switches
(*https://www.canvarto.at/en/pg/canvas-prints/p/modern-4-piece-canvas-print-red-frames-222300*)

Combinatorics is an expression in switches where there are light sources to combine primitives with the possibility of many variations.

Their division should be in the category of switches for residential and residential buildings where they should not be neglected in space, on the contrary, they should emphasize a sophistication that should be possessed by the buyer.

As part of the whole way, it is stated that the textures where the roughness is expressed should be used in the universal design, i.e., people with a high percentage of impaired vision.

The choice of materials according to your choice can be adjusted, but at the same time we wanted to play with the expression of the forms from the 60s of the last century in one of the solutions and the combination with the new futuristic materials that would initiate a completely different approach to switches.

6 Conclusion

Good and successful design start with a big concept. So, what happens if you have a visionary spirit is crucial for the designer. The designer must know the process of creating the concept.

The creation can be perfectly shaped but if there is no message, i.e., if it does not communicate with the customers in the right way, the creation will not be successful and will meet the needs of the target group. One of the most accurate and well-established definitions of design is that design is the shaping of objects and environments that meet human needs. The keyword of the definition is needed. Product design represents the process of efficiently and effectively generating and developing ideas to create new products.

Product design includes all the engineering and industrial work that goes into the development of a product from the original idea to its production. The goal is to get a product that meets the functional and aesthetic requirements, while being economical to produce and explaining that the small details called a serious function are part of the great architecture.

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Learning of the Space as an Accent in the Living Rooms

Katerina Despot[1], Silviya Dechkova[2], Vaska Sandeva[1]

(1)Goce Delchev University, Stip, R. N. Macedonia,
Department of Architecture and Design
(2) Technical University of Sofia,
Faculty and College, Sliven, Bulgaria
E-mail: si_yana@abv.bg

Abstract

The emphasis in space as the basic phonological pillar in the expression is based on the system of design laws that govern the emphasis. "One thought is only so deep and how much power it propagates with itself". Emphasis is the most important thought in conceiving the aesthetics of design and is in a law-proportionate relationship with the ontological-axiological aspects of design. It can be sought in many different ways and different aspects of looking at the emphasis in design processes. For example, is a process better than another, which is a "true" and "wrong" way of designing? Why are some processes advantageous to others? Do different processes lead to different qualities of the results? This view of viewing is based on the individualism of users who are part of spacious living. The proposed methods and tools can be used as a basis for creation of methods and methodologies in design education. Also, in the training of future interior design specialists.

Keywords: space, design, concept, accent

1 Introduction

In the last few decades, significant research is devoted to developing design theories with the ultimate goal of clarifying the human ability to design in a scientific way, and at the same time producing practical knowledge of the methodology of design (Indrie et al., 2017). It is believed that such knowledge is useful and essential for building a design that the designer himself is not sufficient to create the design. Many factors additionally affect the designer, i.e. the users, the technique and the technology, and the passion for art.

The space is a reality in which we live and in which we move. We experience it through 3 dimensions: width, length and height, but also through certain moments in a certain trend, which can add time as a 4 dimension in space. Albert Einstein adds physical space – time as an inseparable notion (Quarante, 1984).

The emphasis in space as the basic phonological pillar in the expression is based on the system of design laws that govern the emphasis. "One thought is only so deep and how much power it propagates with itself". Emphasis is the most important thought in conceiving the aesthetics of design and is in a law-proportionate relationship with the

ontological-axiological aspects of design (Karapetkov et al., 2002; Kandinski, 2016). It can be sought in many different ways and different aspects of looking at the emphasis in design processes. For example, is a process better than another, which is a "true" and "wrong" way of designing? Why are some processes advantageous to others? Do different processes lead to different qualities of the results? This view of viewing is based on the individualism of users who are part of spacious living.

2 Exposure

We call space between some of the shapes between spaces. By itself, we cannot experience the space, it is a gap between some forms that make up and shape it, so it is always connected with volume.

The space, although seemingly empty, inert, invisible resistance, to everyone is manageable, is essentially an active element in the design (Bogdanovic, 1991). He engages in artwork, he helps, but he can act the opposite if the required ratio between him and the object is not found, as shown on Figure 1. The real space creates the image of the viewer only that he approaches each individual.

Figure 1. The concept of space
(**https://www.kocsanmobilya.com/extreme-makam-takimi**)

Architecture is most closely related to the space, it is born from it, takes part of it, lives with and from it, together make a whole. Architecture is a space, but it itself divides the space with its purpose. The enclosed space - interior it feeds on from the complex compaction in which it has shapes - furniture without which the space would be empty and unfinished (Tambini, 1999; Pehlivanova, 2015). It limits the designer with its dimensions, but at the same time there are many requirements that need to be set up to be fulfilled.

The open space does not release, and with the creativity or the limitation of the mind it should be shaped and in many segments it should be brought to the polyurethane space that the designer assists and merges with functional and decorative forms.

All significant periods in history have given their types of spatial conception. They were also a reflection of the basic conditions of the civilizations they created (Ivanova, 1984). These types of spatial concepts appear in history as the same or as modified forms. During the duration of the understanding of a certain space, these types represent the norm for

human visions; manage the impression and the way in which it is viewed. The new concepts of space are bound up with great societal changes and usually initially encounter resistance (Figure 2), as long as the new concepts do not become new standards for perception.

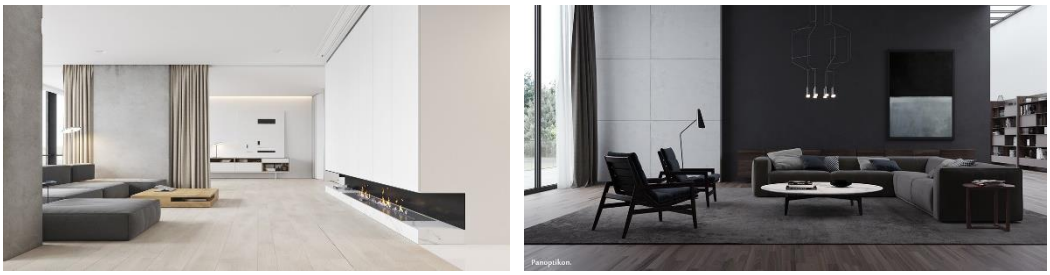

Figure 2. New concepts of space
(**https://dekormodelleri.com/siyah-salon-dekorasyonu/**)

Rapid changes supported by modern science and education have formed new perceptions of artistic perceptions (Zlatev et al., 2018). Today, the designer requires a way and a way of interpreting those conceptions that include and require new spatial dimensions. The limitations of this focused view, the designer developed a perspective and presented some distorted illusions in the real spaces as the human eye sees. In doing so, he had to exclude the moving and living aspects of nature. It is possible to penetrate into the internal and external structure of nature by using microscopes, cameras, telescopes (Ivanova, 1984; Uzunov, 2014). This led to a new view of the space; it became clear that the space cannot be viewed from one point. The main characteristic of this knowledge is the movement, and this has become the basis, regardless of whether it is a real movement or the creation of an illusion of movement. The movement has become part of the space, and this movement in space can be given only if the space component is included in the space, thus adding a new dimension to the spatial concept.

Thinking about the effect and its dimension does not lead us to the conclusion that the problem consists in the relationship, i.e. in their relativeness. It cannot be said that larger spaces have greater acceptance than the smaller ones, and vice versa. The initial information for a certain space depends on several factors: tone, color, shape, position, texture, etc. Because these factors are constant, we can always determine what the magnitude effect is in a given situation.

The accent can be shown in several ways. The repetition of various elements, creating an accent that attracts attention, for example, through vertical motifs (Haddad, 2014). If the combination of flowers binds, during the specified step, the place where those of the flowers are will attract attention. The use of dark gray and black colors gives a dynamic feeling to the room and is only a small part of the functional proposals for design and furnishing, for example, a studio.

High-tech dynamic solutions free up space in modern urban housing. The movable wall contains a hidden closet and a folding bed, and is the right design approach.

The use of the space in front of the door provides additional space and brings functionality and practicality. Mirrored surfaces give visual depth to the rooms and create the illusion of a much larger space.

The ceiling can be used as a main accent in the interior. This is done by hanging flowers or other decorative ornaments. Installation of non-standard lighting fixtures. The play with light creates a magical effect and perfectly visually separates the individual parts of the living room.

Wooden sliding doors give a finished look to the furniture, with elegant and simple motifs that will add a sense of space and style. Multifunctional furniture saves space and looks modern and innovative.

Glass partitions turn the living room into a design work and give organicity and purity to the interior. The wall of shelves will turn the living room into a highlight, but will also provide plenty of storage space for books, decorations, belongings. The modular furniture system is an ideal choice, as it saves a lot of space, but at the same time looks stylish.

The use of contrasting textures and colors for the floor and ceiling visually enlarges the space. Bold and accentuating colors for the furniture will turn the living room into a cozy and fresh place to live. Placing movable sections with bookshelves is an intelligent and modern solution for furniture in living rooms. If some of the cabinets have a glass display case, then on the front, you can display a plan of wine or champagne glasses or coffee cups with decoration. The built-in lighting in the cabinet will enhance the effect.

The furniture of the living room has its subtleties, for example, if the room does not allow the placement of tall and too bulky furniture. However, sometimes the key to a more harmonious atmosphere lies in creating a complete concept for the room. To make it look more spacious, it can be painted white, and the ceiling has been turned into a playful accent. The furniture is selected to complement the mood in the room, and the window can be placed enchanting curtain to create additional comfort.

Soft textile fabrics do not fully reflect the nuances of the colors used, but plush and velvet fabrics are very close to them. Upholstery in appropriate shades for the sofa or armchair will illuminate the room. If it is too intrusive, only a few decorative pillows with fringes and tassels in this color can be chosen. Shiny threads could be applied to the curtains and drapes.

Numerous decisions need to be taken so that each project can be completed within the deadline and budget. The training and work of the interior designer includes the determination of values of aesthetics, the cost of the materials used and the execution time. Restrictions may be based on budget, but there is no proper design, everything is judged, depending on the needs of the client.

Opening the volume, unity of shape and space – They contain an intermittent game of smooth, wide and clean bad, with the reliefs of multiple layered interventions and in the ultimate development will break away from the attractive world of nature, finding new solutions for their vision of life, stimulated from the constant fast pulse of everyday life (Dineva et al., 2011; Kandinski, 2016).

Looking at one such approach as an integral part of the space, which is an emphasis in the daily stay, opens many questions for discussion. Which marks the next, from 70 years of the last century to several years ago, the main day-to-day gatherings were the installation of the chi-commodity TV, with the advent of new technology and its strong expression, the accentuated part that TV had had already remained neglected, the change the habits and the fast way of life.

The development of the whole conceptual nucleus, which was called collecting, has already lost the power of domination. But leave questions that need to be answered, i.e. what is the New Accent in the Day Care? If we point to some retrospect in the history before TVs show an accent place, the place where there was a gathering place where it was placed in order to occupy the main view of the daily stay, very often as an elemental element were placed realistic sculptures that had the same goal as the fireplace, i.e. a place around which all members of the family were gathered.

Looking at the basic geometric shape, the up-to-date concept supported by the concentric lines that send the form in the given case does not make monotony, and directs the viewer to the central setup of the newly established priority, which has purely decorative rather than as a functional functional purpose.

In the geometric framework, there is compaction of dorsally-protruding infractions of horizontal, vertical or diagonally placed bad. The ravages of their movements vary depending on the position of the rhythmically designed notches in the convex-convex surfaces.

3 Conclusion

When considering the concept in learning of the Space as an Accent in the Living Rooms, we can draw the following conclusion: the space is the base from which we begin to distribute, analyze and solve all problems related to the interior design. The main gathering in the residential areas is the daily stay with all its specifics, but the loneliness of the new time has doubled that space in a so-called reception hall where there is no space for long-term use.

The best place to replace the TV in the minimalist spaces is an accentually placed luminous sculpture taken as an inspiration from the ancient period which will have an accentual place in the daily stay, that is, a form that would be the only topic for long-term conversations.

The opening of the visas breaks the dynamics in contemporary spaces the very form that is emphasized, supported by colorful elements that send the dominant form and provide a specific view. The proposed methods and tools can be used as a basis for creation of methods and methodologies in design education. And also, in the training of future specialists in the field of interior design.

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Online Education at the Beginning of the COVID-19 Pandemic - Views of Pupils and Teachers: A Two Survey Approach

Oana Moșoiu[1], Elena Lotrean[2]
(1) University of Bucharest, Faculty of Psychology and Education Sciences, Bucharest, Romania
E-mail: oana.mosoiu[at]fpse.unibuc.ro
(2) Finnish Teacher Training Centre, Sibiu, Romania
E-mail: elena.lotrean[at]sfsb.ro

Abstract

As a result of the global COVID-19 outbreak and the imposed social distancing measures, schools were shut down and the entire educational process was moved online. The rapid shift to online learning has brought about multiple challenges for students, teachers and parents alike, from simply being present online, to assimilating educational content. The present study represents on the first empirical attempts to capture the traits and outcomes of online schooling during COVID-19 in Romania, right after the end of the emergence estate. Particularly, the research has explored the overall assessment of online education, the debut of online schooling, educational outcomes and duration of courses for students and teachers. The findings of this research indicate the short-comings of digital schooling as a consequence of the fast passing from physical settings to online applications; as well as opportunities in the light of students' positive appraisals.

Keywords: online education during COVID; students' evaluation of online schooling; teachers' perspective of online learning; educational outcomes

1 Introduction

Declared as a global pandemic by the World Health Organization as of March 2020, the COVID-19 outbreak has changed the face of numerous industries and organizations. As a result to contain the virus, educational institutions and workplaces were forced to move their activities online, with or without proper training (Bao, 2020). Naturally, most schools were completely unequipped for the switch to entirely online education. In the beginning, the majority of institutions had important deficits in regards to infrastructure and plans (Zhang, Wang, Yang, & Wang, 2020); and some educational environments in Romania are still struggling in this regard (Edelhauser & Lupu-Dima, 2021).

While the numbers and complexity of online applications have evolved significantly in the last 30 years, and these advancements have been particularly relevant during the COVID-19 pandemic (Dhawan, 2020), some teachers have felt uncertainty in using their digital skills and organizing educational activities in an online arena posed certain difficulties (Moșoiu et al, 2021). Furthermore, teachers and students encountered a variety of technological issues (Peters et al., 2020). Some studies in Romania have reported even cyber-bullying to students and teachers, and notably, cases of strangers entering online

classrooms, writing offensive lines on the virtual blackboards, streaming pornographic content and using an inadequate language altogether (Velicu, 2021). In addition, the lockdown itself has had a detrimental effect on individuals' social, financial and health needs (Islam et al 2020), all of which have shaped students' presence and adaptation to online education. If the pandemic initially created the illusion of a greater equality to educational resources, it actually deepened the existent cleavages (Jæger & Blaabæk, 2020).

The present research looks at the overall evaluation of online schooling from the perspective of students and teachers alike and tries to understand the traits of online schooling in Romania in the dawn of the COVID-19 outbreak.

2 Methodology

During 12-25 June 2020, in collaboration with the Coalition for Romania's Development, 2 surveys were carried out, one for pupils and one for teachers, on the Intuitext.ro platform (dedicated to educational resources, teaching materials and textbooks). The study covered participants in rural and urban areas, at all levels of secondary education, and this two-sided perspective of online schooling was meant to validate the overall findings, as well as to provide greater depth into the empirical perspective. The pupils' survey had 2,873 respondents and its objectives were, as follows:

- to identify the participants' experience of online schooling in terms of positive and negative aspects
- to explore whether the lack of institutional organization in Romania during the pandemic has triggered late shifts to the online format
- to investigate what online channels were used for teaching and learning
- to assess students' presence in online schooling and reasons of absenteeism, where this was the case
- to understand how much time was allotted to each subject matter
- to investigate whether students and teachers felt poorer educational outcomes

The teachers' survey had 3,575 respondents and its objectives were, as follows:

- ✓ to explore the presence of students in online courses according to teachers
- ✓ to identify the beginning of online courses
- ✓ to analyze the difficulty of adapting to the online environment
- ✓ to explore the need to come back with clarifications in regards to the taught lessons
- ✓ to assess the proportions of the subjects from the second semester that were not taught
- ✓ to investigate the extent to which online school was used for teaching versus reviewing or other activities
- ✓ to identify the channels used for online teaching
- ✓ to explore the online platforms used for teaching
- ✓ to highlight which person or institution was responsible for organizing online courses
- ✓ to estimate the extent to which the resumption of concepts was necessary
- ✓ to underscore the estimated reasons for non-participation of students in online courses
- ✓ to emphasize the attractive, as well as less attractive, elements of online schooling.

3 Results

3.1 Students' perspective of online schooling during the pandemic

The sample of students was predominantly composed of individuals who attended schools in urban areas, and just over a quarter (26%) in rural areas. From the point of view of the level of schooling, the sample was quite heterogeneous, comprising students in the middle school in a significant majority (56%), followed by the number of high school students (28%), and in the primary cycle (16 %). The general distribution of those who participated in online courses is circumscribed to a percentage of 93%, only 7% not participating or not having the chance of online courses. The gaps are not very large between urban and rural areas from this point of view, the percentages of attendance at online classes being 93.1% in urban areas, respectively 90.9% in rural areas. However, we must take into account that in the general distribution of the sample, those 7% of students who did not attend online courses actually mean about 200 students - a significant number, which cannot be ignored, and which is significantly higher in rural areas.

The beginning of online courses was predominantly in March 2020, along with the onset of the state of emergency (67% of respondents), and for about a third of the sample, immediately after the spring break. Paradoxically, a small percentage of students in rural areas (5%) started online classes a little earlier (in March) than those in urban areas (after the spring break).

As for the reasons for not participating in online courses, the answers tend to be quite divided. On the one hand, the disinterest of teachers is invoked (36%); the disinterest on the part of the students was also signaled; but there was also an important technical component, which justified non-participation for a segment of students (28% - lack of internet access or technical resources). It should be noted that if support had been provided for this technical component, absenteeism from online courses could have been reduced by approximately 60 students, according to our sample.

In most cases, online courses took place with the participation of teachers and students (86%), a low percentage indicating that work in the online environment was done through text messages on different platforms (7%), and an equal percentage indicating the lack of participation of any kind in the online school. The picture of the number of hours spent with online school reflects disparate trends: a quarter of the sample spent 1-2 hours a day, about a third (29%) 2-3 hours a day, 21% benefited from 3-4 hours a day, and only 11%, over four hours a day. Although it is a low percentage, it should be noted that 8% of respondents spent less than an hour a day in online school. It is worth mentioning here that it would have been unrealistic and unrepresentative for the purpose of this study to simply add the percentages of the number of hours spent online, when our main goal is the particular activity of students (quantified in the individual numbers of estimated hours).

Primary school students spent about 1-2 hours a day in the online school in a proportion of about 50%, 2-3 hours in a proportion of 28%, 3-4 hours a day in a proportion of 9% and an equal percentage less for 1 hour. Although we know that long-term exposure to screens is not recommended for children, we believe that this time spent online is particularly low and could have been somehow optimized.

In the case of high school students, we find a slightly higher online presence in the segment 2-3 hours per day (31%), respectively 3-4 hours per day (26%), and slightly lower

in the segment of one 1 -2 hours a day. However, as a whole, we consider that the number of hours spent online is a small one for the gymnasium cycle if we consider the comparison with the previous, offline school and with the much higher potential of concentration and attention of the gymnasium students. In the case of high school students, it is worth noting the high percentages illustrating the lack of participation in online courses (or failure to take these courses) - 10% - respectively participation less than an hour a day (10%). At the same time, the participation on the longer time segments is reduced, both in terms of the concentration potential of these students, and in relation to the students in the gymnasium: 3-4 hours per day (19%), 2-3 hours per day (24%). In the primary cycle, Romanian language and literature represented the subject in which approximately half of the sample participated for 1-2 hours per week, the percentages being exponentially lower for the other durations provided by the questionnaire: 2 hours-10%; between 2 and 4 hours - 27%; more than four hours - 16%. A percentage of 5% of primary school students did not benefit from online Romanian language courses. In the gymnasium cycle, students benefited from a significantly longer duration of online Romanian language and literature courses (30% - 2 hours; 30% - 2-4 hours; 15% - more than 4 hours), but equally, the percentage of those who did not benefit from such online courses is higher (9%) than the primary cycle.

In the case of high school students, the proportion of those who did not have online courses in Romanian language and literature is much higher than those in middle school and primary school (14%). However, what could be observed was a higher percentage of participation in Romanian language courses on the 1-2 hour segment (34%), compared to the previously mentioned student categories, but lower on all other time segments (2 hours - 20%; 2- 4 hours - 24%; more than 4 hours - 8%)

Regarding online mathematics courses, we can see a much higher percentage of high school students who did benefit from courses in this regard than those in Romanian language and literature, and a similar trend in the case of high school students. The attendance on average durations of participation in online mathematics courses (2 hours; 2-4 hours) tends to be higher in the case of middle and high school students (31%, 29%; respectively 14%, 26%), but at the durations high participation (over 4 hours) are found in higher percentages students in primary (15%) and middle school (15%), compared to high school students (11%).

In all the other subjects, the general trend was towards course times of 1-2 hours (over 61% in history, geography, biology, computer science and computer information technology), and with exponentially lower percentages at longer course times. The same predilection for duration can be seen in physics and chemistry, albeit in smaller percentages. Computer science, technology and Computerized information is the only subject among the abovementioned with a slightly higher percentage in terms of duration of over 4 hours (4%, as opposed to 1% in the case of each of the other subjects).

It is important to note that no online courses were taken in 15% of all the subjects mentioned here, and those with the highest percentages in which the lack of courses was reported were physics (23%) and chemistry (25%). Modern languages lessons in the online environment took place predominantly in a proportion of over 40% in all school cycles for a period of 1-2 hours, and in a much higher proportion (62%) during this period in the primary cycle. In the same trend, the lack of these courses was reported in the case of over 16% in all school cycles, and especially in primary school. Course durations of 2 hours and

between 2 and 4 hours could be observed in equal percentages of 34% in middle school and high school students.

Over 41% of the students who participated in the study indicated that they did not complete a unit of study in the subjects considered fundamental (Romanian language and literature, mathematics, geography and history), with higher percentages in history and geography. More than 2 learning units remained uncovered in a proportion of over 25% in Romanian language and mathematics, and over 17% in history and geography. It was reported the lack of completion of any learning units in percentages of over 14% in history and geography, and less in Romanian and mathematics (5, respectively 7%).

In the other subjects, what could be observed is that the learning units have not been completed in quite high proportions - over 24% in physics, chemistry, computer science and ICT; and over 16% in modern biology and languages.

As in the case of basic subjects, there is a lack of attendance of one learning unit in proportion of over 40% in physics, chemistry, biology, computer science and information technology, respectively modern languages.

More than a third of the sample states that there were no other subjects taught online. Where secondary subjects were taught, in the assigned order of their duration, they were: physical education (24%), other subjects (21%), religion (16%), music (13%), personal development / civic education and social (10%). More than half of the sample (51%) say that there were lessons they did not understand well enough. This can be attributed not only to the new teaching channel, but also to the fact that students may have been more reluctant to ask questions regarding certain topics.

The subject with the highest percentage where there were ambiguities was mathematics (35%), followed by Romanian language and literature (16%), chemistry / biology (9%), physics (8%), other subjects (8%), respectively more subject-matters (7%). More than half of the teachers discussed other topics with students during this period, the top topics being: pandemic / safety / health (28%); exams / future plans / school competitions (18%); mood (11%); extracurricular activities / social life (11%); online school (11%). 9% of respondents say that there were no other collateral topics discussed in the online school.

A significant percentage of the sample reports that they had colleagues who failed to connect to online course platforms (60%). In the case of the majority of the sample (71%), 1-5 colleagues did not participate in the online courses. If we consider the previous percentage, of 60%, we understand, therefore, that the lack of participation was not only due to the lack of possibility to connect to platforms. For 18% of the sample, between 6 and 10 colleagues did not connect to the online courses.

These positive aspects of online schooling, were, in order of importance given by the students:

- more free time /a more flexible program / the possibility to organize one's program independently (35%)
- online socialization with classmates and teachers (14%)
- continuity of teaching lessons / a greater teacher involvement (14%)
- the possibility of doing homework online/ material structured on main ideas (6%), longer time spent with family (6%).

Responses to the poor aspects of online schooling have been quite disparate. 14% of the sample did not answer this topic.Where they were reported, the unpleasant aspects of online schooling were, in order of importance:

- Not having the colleagues and teachers around (social distancing itself) (20%)
- Disorganization and disinterest of some teachers / colleagues (10%)
- Too much homework (9%)
- Online school itself (8%), demanding program / stress / use of devices (8%), misunderstanding of certain aspects taught (8%)
- Other aspects, unspecified (3%)

3.2 Teachers' perspective of online schooling during the pandemic

The general description of the teachers' sample corresponds to the following features: predominantly from urban areas (65%), less rural (35%); teaching in approximately equal proportions to the students from the primary cycle (32.86%) and the gymnasium (30.93%), respectively in proportion of 19.25% to the high school students, and 15.51% in the preschool education. The other levels of education taught (vocational education, post-secondary education, extracurricular activities, special education) totaled less than 1.5%.

Most of the teachers stated that they held online courses in digital classes (75.3%), but a worrying percentage of this sample (23.7%) indicated that this was not done, either for technical reasons on the part of the students. (16%), or because they opted for interaction through written messages on different platforms (7.2%), or due to the lack of possibility to get in touch with students (0.5%).

Regarding the differences between rural and urban areas in this regard, we find the following trends:

- where students participated in online courses, attendance was lower in rural areas (65.5%, as opposed to 82.1% in urban areas);
- where the lack of technical infrastructure for students to participate was reported, the absence from classes was more than double in rural areas (26.1%, as opposed to 10.6% in urban areas);
- similarly, where it was indicated that they opted for interaction with students through various messages written on social platforms, this happened mainly in rural areas;
- the same pattern was observed when the teachers failed to contact the students during courses, with a slightly greater predilection in rural than urban areas.

In most cases, teachers affirm they started classes in March (77%), and about a quarter of the sample say they started classes immediately after the spring break (22.7%). Regarding the difficulty of adapting to the online environment, more than 40% of the sample rated this online experience as easy, the remaining about 60% indicating that there was an indisputable degree of difficulty (37% - average degree of complexity felt; 15,8%-high degree of complexity; 5.8% - maximum degree of complexity). Similar to the pattern illustrated so far, the predilection to evaluate the online teaching experience as difficult has been in for teachers in rural areas. More than half of the respondents in the sample of teachers noted that they had to come back with additional explanations several times for certain concepts (53%).

We believe that this can be attributed in part to the unstable internet connection on both sides, but at the same time, it can be an indicator that online education has clear premises for development - if there is a desire for students to ask questions, to clarify various aspects that have been taught, this means that there is a clear interest, enhanced perhaps even by the online environment itself. In this direction in particular, it appears that the interest of rural students to seek further clarification was somewhat higher than that of urban areas.

More than half of the teachers who took online classes failed to teach 10% of the subject in the second semester (53.1%), and about a quarter of them (24.2%) failed to teach between 11 and 30% of the matter. It is important to mention that a percentage of 14.5% is represented by teachers who, for various reasons, did not teach between 31 and 100% of the subject, in very distinct variable proportions. In this direction, the differences between rural and urban areas are very small in percentages and few in number of cases, which is why we consider them insignificant.

Of the matter planned to be taught in the second semester, between 0 and 10% were not taught and un-assessed at the following levels of education:

- lower secondary education - approx. one third (32%)
- primary education - an equal proportion (32%)
- high school education - approx. one-fifth (19%)
- preschool education (17%).

To an overwhelming extent, teachers stated that they used the online environment exclusively to teach new lessons (87.5%), and less only to recap (9.43%), the rest of the responses being composed of mixed activities (teaching and assessment, practical activities, age-specific activities, respectively activities dedicated to certain subjects).

A sensitive half of the sample of teachers (55.1%) conducted their classes through established teaching platforms: either through different school platforms (24.9%), or through live platforms - e.g. Zoom, Skype- (30.2%). The rest of the sample (44.9%) used worksheets sent via WhatsApp / Messenger, email, corrected homework (30.5%), quizz-type applications, short films, various internet resources (13.9%), audio / video recordings, personal files sent by mail /
telephone.

Where online platforms were used, they were: Google applications (30%), Zoom (25.4%), 11.6% other platforms- not mentioned in the questionnaire. The remaining 34% was composed of uses of asq.ro, Intuitext school, AdServio, Messenger-Facebook, Kinderpedia, WhatsApp, didactic.ro.

Regarding the coordination of classes during the online teaching period, half of the teachers state that they were the main ones responsible for the organization (50%), the other half indicating the school or the principal (41%), the administration (2%), other answers (2%), or no answer (5%).

Here, it is noted that the responsibility for organizing online courses fell to teachers in a slightly higher proportion in urban than rural areas. At the same time, the organization by the school or principal took place among a slightly higher proportion in rural than urban areas.

The sources of information needed to teach online courses consisted in more than half of the cases in the resources offered by the Internet in general (54%), the rest of the sample

indicating in different proportions their own materials / own experience (11%), teaching aids / methods / standards (8%), Didactic / Intuitext (8%), information provided by colleagues (8%), other answers (5%), or no answer (5%). The resumption of certain lessons or concepts addressed in online teaching was considered necessary in varying proportions in the majority of the sample (63.08%).

It is interesting to note that only 2% of teachers say that all students participated in online courses. Approximately 44% indicated the lack of technical resources or financial possibilities, respectively the lack of a good internet connection, and in proportion of 16%, the absence of students is attributed to their disinterest or lack of motivation.

The remaining 38% of the sample either considered other reasons or stated that they did not know the reasons for the absence, or did not respond in any way. We deduce from this that there was poor communication between teachers and families of students who missed online courses for various reasons, and this can be attributed to the speed with which teachers had to manage the situation of online teaching during the pandemic. This could be the result of the fact that teachers had no choice but to approach those who responded positively to their invitations to online lessons.

In the top elements considered useful from the online school experience that can be applied in the future, we note the following:

- capitalization of online applications and platforms (19.8%)
- capitalizing online educational resources that can be more easily accessed and used: movies, games, etc. (18.33%)
- online communication and collaboration with students and its advantages (students are more relaxed, more involved, and more receptive) - 14.86%.

The answers regarding the attractive elements of the online school from the teachers' perspective were, however, very disparate and close in percentage, from where we understand that, in fact, the online school experience was quite confusing for the teachers. They had to take on a new role in a short time and in conditions where they did not receive technical support, with wages affected in the legislative context of telework, and without receiving guidance on easily accessible sources of information. for educational purposes. This is reinforced by the fact that 10% of the sample state that they did not find any useful element from the online teaching experience.

As a consequence, the challenges felt by teachers during the months of online schooling were particularly varied, in the top of the first ones remembering:

- motivating and communicating with students (23.47%)
- technical aspects related to online communication (19.24%)
- teaching, planning and preparation of materials (15.47%)
- the remaining 39.23% of the answers received were summed up in aspects related to homework and assessment, issues related to parents, time management, adaptation to the online environment, obtaining feedback, and other answers.

The experience of teaching online during the pandemic was undoubtedly a particularly confusing one, full of events and challenges for teachers. This can be deduced from the contradictory information that emerges from this study. The fact that initially the teachers reported a low percentage of students' non-participation in classes, and then a particularly high percentage, combined with the low memorability of the communication channels

used, is evidence of the ambiguity characteristic of the pandemic period. What can also be understood from here is both a poor communication between teachers and students' families, as well as a lack of motivation and organization of teachers.

4 Conclusions

The online school project was, without a doubt, a project of resistance for Romanian education, from which useful conclusions can be drawn for its continuation.

The study conducted on the sample of students indicates that, in general, the time spent online was quite short and priority was given to online teaching for middle and primary school, and less, for high school students. The fact high school students were less present online compared to those in the mentioned cycles represents a major issue of online education during the pandemic, and especially given these students' particular potential for concentration and educational needs. In general, the organization of courses related to basic subjects was quite disparate as a distribution (up to 50% each) and for a short duration of courses, of 1-2 hours. In the other subjects, on the other hand, courses of the same duration were organized for more than half a sample.

A significant part of the students' sample indicated that they did not go through a learning unit in the subjects, and a quarter did not go through more than two learning units in Romanian and mathematics. In the other subjects, the learning units were not completed in notable proportions (24% respectively, 17% and 16%). More than half of the students reported that there were lessons that were not understood well enough, and the subject with the highest percentage in this regard was mathematics, followed by Romanian language and literature.

The results of the student questionnaire also indicate conflicting data regarding participation in online school for technical reasons. If in the first part of the questionnaire, the lack of internet connection or technical resources was first incriminated by 28% of the respondents, in the second part of the questionnaire we find that 60% of respondents had colleagues who failed to connect to online platforms. We deduce from this that on the one hand, the absence from online courses was voluntary for some students, and on the other hand, it is possible that due to lower communication between colleagues, they did not know exactly who did not participate and for what reason.

Clearly, active technical support is needed and not only so that the online school project can be continued in the future.

A significant advantage mentioned by the respondents is the more generous free time as the lessons move to the online environment, and this is not exceeded in terms of the importance of distancing oneself from colleagues and teachers.

Consequently, online education has good premises for development in terms of the relationship with students, where it is created. Increased attention and focus is needed to maximize online presence and effectively calibrate it to meet students' educational needs.

In what concerns teachers' experience with online schooling, we should keep in mind that during the state of emergency, teachers had to manage the entire educational situation in a very short time, mostly alone, without any technical support (which, undoubtedly, affected the teaching activities for some), having reduced wages under the conditions of telework legislation - a situation in which it would have been necessary, in fact, to

temporarily increase wages to facilitate adaptation to the new work requirements, not specified in the collective agreement - and without receiving guidance regarding the reliable sources of information to be accessed for educational purposes. The coordination of the teaching activity was left to the initiative of the people who undertook this, and this had visible consequences. Just over half of the sample used established teaching platforms, and of these, few teachers used live platforms.

In the context illustrated here, we believe that on the part of teachers, the project of online education in the emergency period was a an attempt not to lose the basic landmarks of education, with very few attractive many challenges, and dealt with completely alone. It is clear that if we want an evolution of any kind of online education, one must consider motivating teachers, financially and technically, administratively and pedagogically. There is a need to set quality standards in online education, which cannot be met without creating the necessary premises for teachers.

At this moment, we notice a potential that cannot be ignored in the online education project, and which results from the fact that students still have the curiosity to ask questions, to clarify certain things. Only by providing the necessary premises for a good teaching activity for teachers, is it possible for these important student questions not to stop and to find the optimal answers.

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Section TECH
Technologies & Virtual Laboratory

Super Processes, Tools and Skills for Contemporary Digital Collaboration and Learning - in the Times of Covid-19

Alexandra Crăciunoiu[1], Ștefan Morcov[2]

(1) Tremend Software Consulting
(2) Tremend Benelux, Katholieke Universiteit Leuven, Belgium
E-mail: stefan.morcov@gmail.com

Abstract

The new remote distributed work model raises challenges but also provides major opportunities to contemporary society. This paper argues that the digital space is a different, but not inferior, communication and education environment. It also proposes a practical, structured approach for online collaboration. Digital learning can produce a different but relevant experience through a mix of traditional and online methods and tools.

Keywords: eLearning, training, digital collaboration

1 Introduction

Organizations, schools and learning practices of all shapes and sizes have been for more than one and a half years with an unprecedented migration to alternative media for performing their everyday endeavours.

The Covid-2019/Coronavirus pandemic provides astounding an contemporary proof of the benefits and importance of technology in today's economy and society. The global challenges posed during the last two years (2020-2021) were successfully tackled with the help of technology. The new remote distributed work model offers, in fact, significant opportunities to business, economy, and society, as well as to educational systems.

Before the COVID-19 pandemic, at most 5% of Americans worked from home for more than three days per week (Bloom, 2020), and less than 15% of Europeans declared they had ever teleworked (Milasi, González-Vázquez, & Fernández-Macías, 2020). Currently as many as 37% of Americans are working from home full-time (Barrero, Bloom, & Davis, 2020).

Moreover, the current pandemic offers the opportunity to validate that digital collaboration environments are not only attempting to simulate the physical world, but instead they offer different, enriched experiences.

Skeuomorphism (Interaction Design Foundation, 2021) has always been a driving principle in the experience design of new artefacts, based on pre-existing mental models – i.e., we design new artefacts by mimicking the behaviour of older artefacts, even if out of context. Digital artefacts thus tend to mimic their physical equivalent. Calendar applications simulate printed calendars; the memos or notes management apps look like

paper-stickers and have paper clips drawn in the corners; e-books look like paperback; the mouse pointer displayed on screens look like a finger, a pen, or a pencil.

At the same time, digital collaboration enhances the available toolset with *different* tools – not available in the traditional physical environment - which therefore cannot follow skeuomorphism principles. A simple example is remote videoconferencing: while it tries at a basic level to mimic a physical meeting, videoconferencing does much more: it also replaces the travel, and it includes *new* tools for real-time hands-on collaboration. Another simple but already common example is the large-scale co-editing of documents: using tools such as Microsoft Office 365 or Google Workspace, large groups of tens of people can create a document working together at the same time – which is impossible in a physical environment.

Digital collaboration tools and behaviour go beyond the principles of traditional classroom collaboration. The available set of tools goes way beyond the capabilities of real-life collaboration – we, however, constantly try to go back to our "classroom" mental model. This is not wrong; it is skeuomorphism at its best.

What started as a temporary emergency solution became the largest pilot project for digital collaboration across domains and cultures. The results for education will be visible in standardized test results in the following years and are not foreseen to be positive, since the digital divide is still painful, with an average of less than 60% for Europe's citizens having at least basic digital skills in 2019 (Eurostat, 2021). There are initiatives at all levels in the educational sector to develop digital competency skills in students of all ages via dedicated curricula, and teachers, via lifelong learning programmes (Eurydice, 2019). However, the digitization of the educational system is a lengthy process and involves significant changes, including change in mindsets.

However, on a larger scale, digital collaboration has been confirmed to work and to provide results – issues to be addressed pertaining to:

- Students needing to be able to function in a society more connected than ever;
- Teachers having to prepare students to function in this highly digitalized world.

At some point, we need to take a step back and reinvent the entire teaching-learning process:

- Building upon the existing "classroom" model that everyone is used to;
- Generating a paradigm shift in the teaching process;
- Adding collaboration best practices from all domains
    - Business leaders use dedicated tools facilitation, ideation, brainstorming;
    - Project teams use collaborative environments to work together in real-time and to parallelize work;
- The teaching process should not be linear.
- We do not need VR and AR for a better experience – the best tool for learning is the one that one has readily available – a modest computer with an internet connection or a mobile phone is frequently enough.

Digital interaction is a challenge for many, and digital literacy can be a barrier hard to overcome – this time, not only for students but also for teachers. The "comfort zone" that allowed schools and teachers to be reluctant to change has suddenly disappeared – somehow everyone had to manage – unfortunately, with irrecuperable losses for many.

2 Background: collaboration and communication in the Covid-19

The Covid-19 society made a significant impact on our lifestyle, society and economy. The Covid pandemic forced an abrupt adoption of technology, which in turn imposed significant changes to our work and social environment and culture. The impact is social, technological, economic, as well as cultural and anthropological. During the last two years, the New Manhattan business district has moved online, as well as schools, parties, social and personal lives (Morcov, 2020b).

All collaboration became virtually remote distant online digital collaboration. In this kind of interaction, three types of distances are perceived (Morcov, 2020b):

- Spatial distance, i.e. working from the same office vs working from different places, including home or exotic holiday islands;
- Temporal distance, i.e. working hours vs personal time;
- Psychological distance, i.e. maintaining a sense of community and closeness.

These three categories of distance produce different types of distortion to the information exchange, which is key to the communication process. Communication is formed of actors (sender and receiver), information, and medium. The information transmitted by the sender does not immediately reach the receiver. Instead, it is transformed by the communication medium. What we call a message is, in fact, an interpretation of the original information, in a specific context, transformed by a specific communication medium, and as per a specific receiver.

2.1 Beyond Skeuomorphism

The natural tendency in digital collaboration and education is to simulate online the physical classroom.

The 2nd level of digital collaboration is to exploit the opportunities of digital learning environments beyond the traditional classroom. In face-to-face meetings, it is impossible to imagine models such as simultaneous editing of whiteboards or documents in teams of tens of people working in parallel.

2.2 Tools and Resources for Digital Collaboration

A digital collaboration environment, as a whole, is a complex system that is different from the sum of its components (Aristotle) (Morcov, Pintelon, & Kusters, 2020a).

Participants in digital learning and collaboration environments need three types of resources: processes, tools, and skills. These three elements are the basis for building a structured practical approach to digital education and collaboration.

Several lists of potential tools and platforms are proposed (Morcov, 2020c) (Morcov, 2019).

Not only the tools but also the processes required by digital collaboration are different from the traditional processes. Digital collaboration skills are related, but not identical, to general collaboration skills. Digital tools offer more, and especially different, collaboration methods.

2.3 The impact of Remote Digital Distributed Communication

Remote digital collaboration requires better and stricter organization. The timing of meetings is improved, the agenda is respected more rigorously.

At the same time, diminished non-verbal communication devices the overall efficiency and quality. A recent Microsoft study shows a surprising increase in communication overhead. The time spent for messaging increased by 50%, the number of documents by 66% (Yang, et al., 2021).

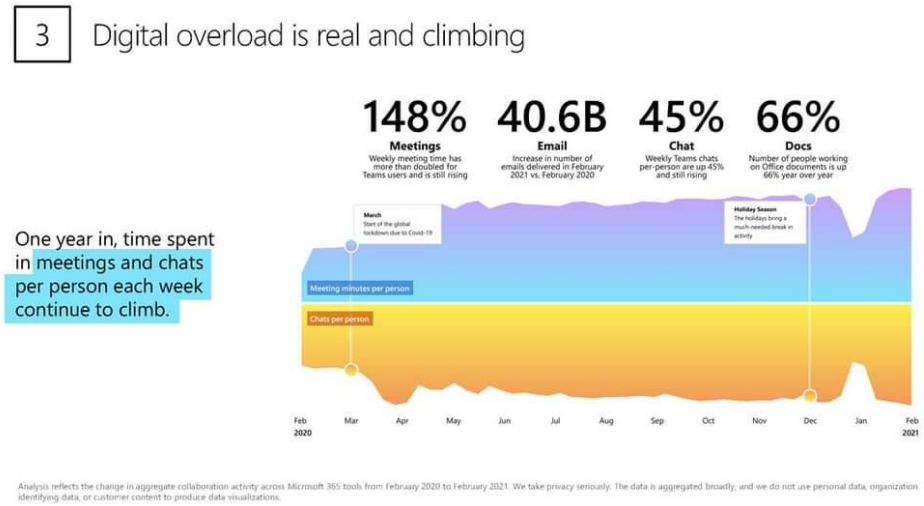

Figure 3. Change in aggregate collaboration activity across Microsoft 365 tools between Feb 2020-Feb 2021 (Yang, et al., 2021)

3 Effective digital education solutions

The general principles expressed above are operationalized into three categories of simple guidelines and effects, detailed in the table below.

Table 1. Guidelines and Methods for Digital Environments

	Traditional methods applied in the digital environment	**Specific digital methods**
1. Signal and message: raising and maintaining attention online (Morcov, Effective, interactive video-conferences, webinars, online eLearning. 3-minutes guide, 2021)		
	Simulate the typical physical environment as much as possible. Always use the video camera. It is preferable and valuable to see the face of the speaker rather than seeing presentation slides. Switch from video to slides, rather than	Hint: tools like Logitech Capture, OBS or Prezi Video can be used to combine and/or to switch between several screens, slides, videos.

	projecting only slides that are not always useful.	
	Allow and encourage the audience to use video, especially when someone speaks.	
	Try, as much as possible, to maintain eye contact with the camera -	
	one should not look at the screen where the presentation is but at the audience. The camera needs to be positioned at eye level. If you have notes that to be read, place the window just under the camera to give the impression that you're still looking at the audience.	
	When there is a panel, only the speaker should look at the audience; the rest of the panellists should look at the speaker.	
	Maximize the useful signal and eliminate noise. Audio: the voice of the presenter is useful – any background noise is noise.	Visual: the background behind the presenter is noise. Any books, posters, flowers should be minimized or eliminated. A white or light-colour background is best.
	Too much visual information is noise. Do not exaggerate with visual props. Do not add much text on slides, never read slides, do not use animations, keep slides simple and clean (standard guidelines for any kind of presentation).	Presentation slides are very rarely information. They are mostly noise. Slides with text are only noise because they are redundant with the audio message – the voice of the presenter. Pictures and diagrams are useful message, if they complement the presenter – they can be used as props.
Interactivity		
	Allow and encourage the audience to participate. Allow the audience to ask questions.	Use online collaboration features, e.g. chat rooms, raise hands to ask for the microphone. Use voting and polls.
	Ask questions to the audience.	Real-time surveys are very practical and effective in engaging large audiences.

Preparation: it takes a lot of practice to be natural		
	Preparatory decisions include making sure that the digital environment simulates as naturally as possible a natural physical environment: • Location, set, background. • Preparing the slides. • Test the connectivity and tools. - Consider potential bandwidth issues. One might want to reduce video quality, eliminate video if needed, use low-quality video or slides if needed. • Consider the screen size, orientation, and resolution to offer a natural setting. Smartphone users cannot read small text when sharing slides. Smartphones are great for viewing a vertical picture, but laptops favour horizontal pictures.	Preparatory decisions include making maximum use of the specifics of the digital environment: Decide whether to use: Personal, virtual, or professional background. It may not be appropriate to use a very personal environment or background, such as a home setting. Virtual backgrounds are often distorted if there is low contrast between the presenter and their background. Live vs pre-recorded webinar and moments. Videoconferencing tool. What digital collaboration features will be used – e.g. chat, survey, raise hands, online tests.
Next-level digital online collaboration		
		Large scale online conferences
		Automated generation of subtitles, automated text transcripts, automated minutes of meetings/summation, automated translation

Figure 4. Structured Approach to Digital Collaboration

4 Conclusions

Digital collaboration is here to stay, and we need to acknowledge it, and to adapt teaching methods and skill development for the teaching and training staff. Students need to be in school, but not so much for the learning experience as for the social interaction that cannot be simulated fully by the digital environment.

Digital collaboration is less personal but more efficient. When online, professors, trainers, and participants tend to stick more to the agreed agenda; time-tracking is much more rigorous, discussions do not deviate as much and do not split into separate or lateral conversations – which so often happens in the live environment.

This article argues that the digital space is different but not necessarily inferior to the traditional space.

This change of paradigm can be challenging at first, but digital online collaboration and learning also offer significant opportunities, such as:

- Remote participation, allowing a large number of participants and decreased costs.
- Better and more diversified collaboration tools: chat, application sharing, voting, quizzes, shared whiteboards, shared documents, video recording.
- Very advanced communication tools, such as automated generation of subtitles, text transcripts, or automated translation, using AI/NLP (Artificial Intelligence, Natural Language Processing).

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Technical and Humanities Students' Management of Social Presence in the Online Classroom Through the Use of Webcams

Vasile Gherheș[1], Mariana Cernicova-Buca[1]

(1) Department of Communication and Foreign Languages,
Politehnica University of Timișoara,
Petre Râmneanțu street 2 A, 300596, Romania
E-mail: vasile.gherhes[at]upt.ro

Abstract

Emergency remote education adopted almost worldwide as a solution to maintain students on the educational track during the COVID-19 pandemic-related restrictions brought to the fore issues of mastering technology, but also overcoming challenges such as students' behavior in the online classroom. The paper presents data based on the quantitative analysis of 527 students polled online regarding their management of social presence in the synchronous online classes, manifested in their option to be on or off webcam in the virtual learning environment. The responses were further analyzed along the variable indicating students' specializations, differences between technical and humanities students being recorded. The paper proposes that managing social presence is a digital skill to be intentionally developed by educational programs, in preparing young adults for the post-crisis world. The findings bear implications for developing student-centered curricula and class management in the virtual learning environment.

Keywords: synchronous online classes, on/off webcam, social presence, technical vs. humanities students, teacher-student communication

1 Introduction

The outbreak of the COVID-19 pandemic in spring 2020 put on hold face-to-face interactions and called for emergency measures to maintain social, economic, and political life ongoing, while ensuring public health safety (World Health Organization, Timeline, 2020a). In the educational sphere, the most widely spread solution was to adopt the emergency remote teaching and continue the teaching and learning process according to the pre-crisis schedule (WHO, 2020b), massively adopting technologically mediated solutions (World Bank, 2020).

Higher education, building upon pedagogical acquisitions of online and blended learning experiences, substituted the traditional on-campus face-to-face courses with synchronous videoconferencing sessions, resorting to a variety of technical solutions, from using available online tools to building specialized platforms and producing tailored educational content. Among the many challenges teachers and students faced in the

transformational times brought by the pandemic was maintaining teacher-student communication and educational interactions, while experimenting with emergency remote solutions (Gherheș, Stoian et al., 2021; Ali, 2020; Cernicova-Buca and Dragomir, 2021). Romanian universities did not make an exception, the debate around the efficiency and challenges brought by the emergency remote education being lively and significant (Edelhauser et al., 2020).

Out of the many aspects related to the sudden online education the present study focuses on the aspect of the social presence of students, manifested through their use of the webcam during courses, seminars, and lab activities. A simple Google search gives back thousands of responses to the issue, mainly educational blogs, university norms and regulations, advice on etiquette and attempts to collect data on the various practices embraced either at the level of one institution, or at larger scales. Scientific literature on the topic is less prolific (Gherheș, Șimon et al., 2021; Bedenlier et al., 2021; Massner, 2021), but signals the fact that building a learning community is an essential factor of ensuring the success of the educational process.

According to Randy Garrison's influential book *E-learning for the 21st* century (Garrison, 2017), the community of learning and inquiry is built through a delicate interplay of thought, emotion, and behavior in the online environment, between the private world (that is, the inner world) and the shared world (that is, the outer world). As Palloff and Pratt pointed out (2007), the success of online community building depends largely on the social presence of the participants. In online environments there is a greater chance for learners to feel isolated because of a sense of loss of contact and connection with others. However, even though social presence gives learners a feeling of connecting and belonging to a community, many of them prefer to be off camera, thus depriving professors from the nonverbal cues (smiles, frowns, head nods, looks of confusion or boredom, etc.) that help evaluate teaching in real time (Castelli and Sarvary, 2021).

The present study investigates the motivations behind students' use of the webcam during synchronous online classes, aiming to help professors develop appropriate pedagogical strategies to build the community of learning and foster student success, according to student-centered instruction principles (Hoidn and Klemenčič, 2021). The research team authoring this study proposes that online social presence be included in the digital skills developed through educational programs (Cernicova-Buca, 2015), since remote work, videoconferencing, and enhanced capabilities of using digital technologies are foreseeably part of the 21st century key elements of work and life environments.

The research questions posed by this study are:

- What is the self-reported social presence of students in the online classroom (on or off-camera)?
- What motivates students' decision to be on or off camera during synchronous online classes?
- Is there a difference in the webcam use between technical and humanities students during synchronous online classes?

2 Method

The present study is a based on quantitative approach, relying on data collected via an anonymous online questionnaire, posted on Isondaje.ro (a free Romanian online survey platform). All participants are students enrolled at Politehnica University of Timișoara, Romania, an institution which has over than 20 years' experience in digital education, developed by the E-learning center (CeL). The center extended the use of the existing Virtual Campus platform for all study programs and Zoom conferencing system was recommended for synchronous online classes. The use of webcams by students during the educational process is recommended, but not mandatory.

527 responses were recorded between December 2020 and January 2021, at a time when the health crisis brought by COVID-19 did not seem to lessen in intensity and in-person education was not possible in Romania. The recorded margin of error was ±4.2%. Students were asked to select to express on a 5-point Likert scale their level of agreement or disagreement with ten statements, identified as the most frequent issues motivating the webcam use during synchronous online classes.

3 Results and discussion

The first issue under discussion was to determine students' self-reported webcam use during the synchronous online classroom, as presented in Figure 1 below.

The results show that for the assessment *I keep my webcam off during online classes* the largest share of respondents, 30.7%, is formed by students who chose the variant *to an average extent*, followed by response variants to a large extent – *25.2%*, and *to a very large extent, 23.1%*. At the other end of the scale, the response variants *to a small extent* and *to a very small extent* were selected by 10.4% of the sample. Almost half of the respondents (48.3%) prefer to be off camera during classes, no significant differences being recorded between technical students and students in humanities.

The second research question aimed at refining students' motives for the turning the webcam on or off during the online synchronous classes. Literature on the topic places high three main reasons for turning the webcam off: technical (due to low quality of Internet connection), psychological and normative issues. Romania is a country with good Internet connections, the average fixed connection speed being of 190.50 megabits per second and 45.93 MBPS for mobile ones respectively (We are social, 2021). The remaining two motives were codified in the statements *Turning my webcam on depends on my inner state* (reflecting the psychological aspect of the issue) and *Turning my webcam on depends on the professor with whom I interact* (to account for the external stimulus). Results show that the emotional aspect ranks high, the response variants *to a very large extent, to a large extent and to an average extent* being selected by close cohorts of respondents (26%, 24.1% and 24.1% respectively). Emotional presence is important for students' self-regulation, influencing young adults' capacity to control one's attention, cognition, emotion and/or behavior to better meet social standards or personal goals (Cacioppo and Hawkley, 2009). For this assessment significant differences were encountered between technical and humanities students, as highlighted by Figure 2 below. The Chi square test registered values of $\chi 2 = 22.252$ and $p=0.000$ ($p< 0.05$) respectively. The results show that the turning on the

webcam depends more on the inner state in the case of students from humanities and less so for technical students.

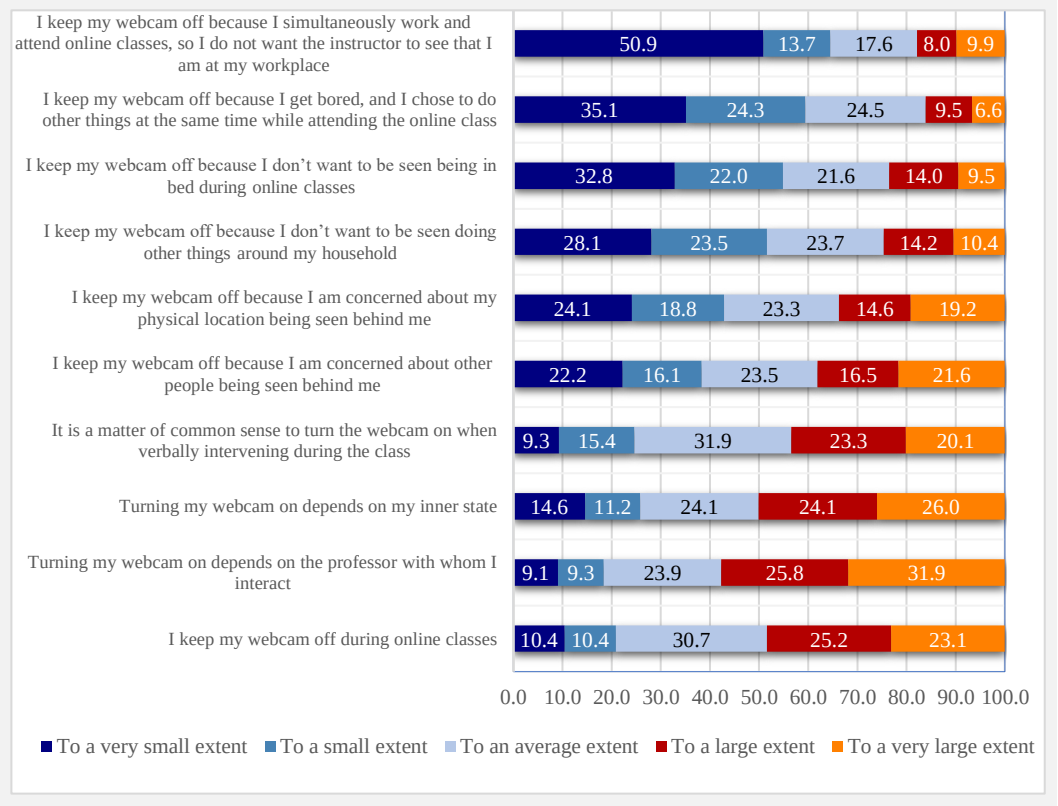

Figure 1. Students' use of the webcam during online classes

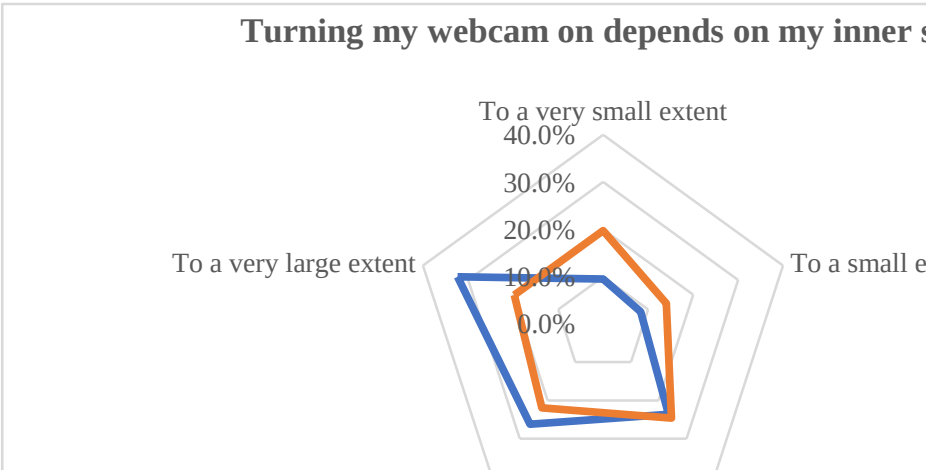

Figure 2. Emotional influences on the webcam use

As far as perceived etiquette, students seem aware that full-fledged participation and verbal interventions should be accompanied by face-presence (Castelli and Sarvary, 2021). The questionnaire contained this issue codified in the statement *It is a matter of common sense to turn the webcam on when verbally intervening during the class*. Over 40% of the respondents agree with this statement *to a very large extent* and *to a large extent*. However, the largest group displays a neutral attitude, 31.9% selecting the response variant *to an average extent*. No significant differences were encountered among students, along the variable type of study (technical vs. Humanistic).

The external stimulus, i.e., the personality of the professor, also plays an important role in the decision to turn the webcam on, more that half of the respondents choosing the variants *to a very large extent* (31.9%) and *to a large extent* (25.8%). Previous studies in the topic (Gherhes, Șimon et al., 2021) deepened the responses, which boil down to such motivations as *out of respect for the professor* (20.1%) and *to facilitate a better interaction/communication with the professor* (15.2%). The Chi square test highlighted the following differences between students in humanities and technical students:

- For the statement *I keep my webcam off* values of $\chi 2= 7.5982$ and $p=0.006$ ($p<0.05$) were encountered. Results indicate that such a behavior is more frequent among technical students (28.4%) than among those from humanities (18.3%).
- For the statement (I turn my webcam on) *out of respect for the professor* values of $\chi 2= 6.917$ and $p=0.009$ ($p<0,05$) were obtained, indicating that students in humanities are more likely to be animated by this reason (24.7%) than their colleagues from technical programs (15.5%).
- For the statement (I turn my webcam on) *to facilitate a better interaction/communication with the professor* no significant statistical differences were encountered, although humanities students have a stronger predisposition to adopt this behavior (17.5%, by comparison to 12.9% in the technical students' cohort).

To refine data regarding the reasons behind turning off the webcam and inclinations to multitask behind the black screen in parallel with the online classes several statements were proposed for evaluation. As shown by Figure 1, the first three reasons (obtained by cumulating the *to a very large* extent and *to a large* extent variants) are:

- I keep my webcam off because I am concerned about other people being seen behind me (38.1%)
- I keep my webcam off because I am concerned about my physical location being seen behind me (33.8%)
- I keep my webcam off because I don't want to be seen doing other things around my household (24.7%).
- Other motivations for turning off or keeping off the webcam are:
- I keep my webcam off because I don't want to be seen being in bed during online classes (23.5% to a very large extent and to a large extent)
- I keep my webcam off because I simultaneously work and attend online classes, so I do not want the instructor to see that I am at my workplace (17.8%)
- I keep my webcam off because I get bored, and I chose to do other things at the same time while attending the online class (16.1%).

Subjected to the Chi square test, the responses showed differences between the technical and the humanities students only in the following cases:

- For the statement *I keep my webcam off because I don't want to be seen doing other things around my household* the Chi square test showed values of $\chi 2 = 10.925$ and $p=0.027$ ($p<0,05$). The motivation is more typical for students in humanities than for technical students, as presented in Figure 3 below.

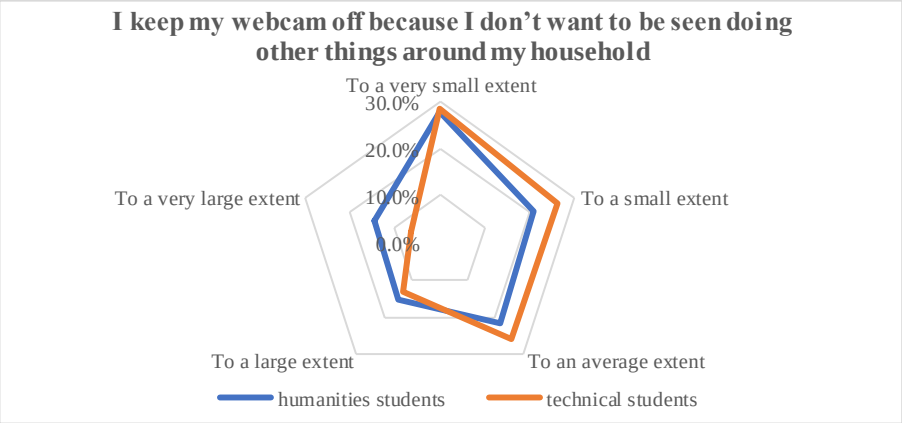

Figure 3. Multitasking in the household

- For the statement *I keep my webcam off because I simultaneously work and attend online classes, so I do not want the instructor to see that I am at my workplace* the Chi square test showed values of $\chi 2 = 9.861$ and $p=0.043$ ($p<0.05$). Once again, the motivation is more typical for students in humanities than for technical students, as highlighted by Figure 4, apparently multitasking being more likely to be encountered in the cohort of non-technical specialization.

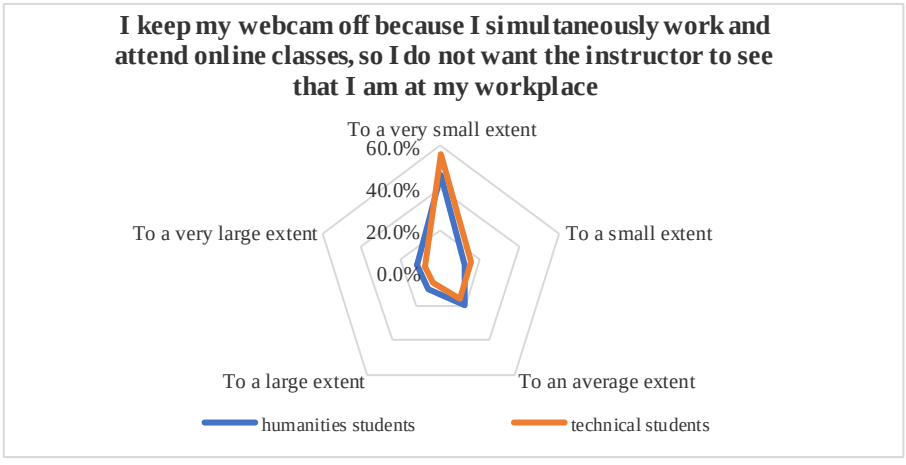

Figure 4. Blending work and education responsibilities

The differences between the two groups, technical vs. Humanities students do not indicate prevalence or hierarchy, but are useful for developing tailored, student-centered, adequate pedagogical strategies, while understanding the characteristics of learners, their behaviors, motivations, capacity to self-regulate while pursuing specializations towards the desired career. Cultural differences are also important, as similar studies, such as the one carried out by Bedenlier and others (Bedenlier et al., 2021) showed that in Germany, for instance, technical and humanities students displayed motivations different from the ones presented in this case from Romania.

4 Conclusions

While acknowledging that the present study has its limitations, since students from one university only have been polled and more research methods need to be applied to get a complete picture of the webcam use during online synchronous classes, the findings are valuable for developing teaching strategies for online education even beyond the pandemic-related restrictions. The extensive use of webcams during the emergency remote teaching led to *zoom fatigue* according to some researchers, to teachers' being forced to imagine new ways of engaging learners and build supplement social, emotional, and cognitive presence with innovative methods, encouraging students to self-regulate and pace themselves in their pursuit of knowledge and career-building experiences. Understanding students' unique characteristics and motivations helps professors design curricula, teaching methods and strategies that resonate with the learners' expectations and motivations and help overcome the barriers in building the desired learning and inquiry communities necessary for education to be a successful process. Engaging pedagogies, a variety of activities and compelling teaching content need to also consider, for online learners, also a dimension less discussed so far: incorporating the management of online social presence as a feature pertaining to the digital skills intentionally developed by educational programs. And this is to be done not for the sake of spiritual comfort for professors, who rely on the visible presence of learners during educational activities, but mainly for young adults' sake, who need to be prepared to work, act, live and enjoy leisure activities in unpredictable settings, on and offline, in times of crisis and beyond.

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Remote Laboratory for Renewable Energy Courses

Radu Tîrcă[1], Luca Mihăilescu[1], Eleonora Popescu[1], Daniel Costache[1], Victor-Tiberiu Dumitru[2], Sanda Voinea[1]

1) University of Bucharest, Faculty of Physics, 405 Atomistilor Street, 077125, Magurele, Romania
2) University of Bucharest, Faculty of Mathematics and Computer Science, 14 Academiei Street, 010014, Bucharest, Romania
E-mail: sanda.voinea@unibuc.ro

Abstract

Due to the surge of remote teaching caused by the COVID-19 pandemic, experimental laboratories in all STEM fields have to be fundamentally reconsidered. In this article, we look at ways through which we can turn a classic water electrolysis experiment, as a source of hydrogen production, into a fully-fledged remote laboratory. We address automation challenges through passive control systems as well as active systems. Further, we detail the process for 3D printing a robotic arm as an active control system. Finally, we look into methods for integrating the experimental setup with a web-based control dashboard that will be accessible for students. This remote lab is an economical way for students to experiment with the method of obtaining hydrogen for fuel cells and to understand the theoretical concepts.

Keywords: remote lab, electrolysis, hydrogen, renewable energy, 3D printing

1 Introduction

In the last decade, society's focus has shifted towards distance learning, on the one hand due to students' ability to use digital tools and the need to modernize education, on the other hand due to the Covid-19 crisis (Gamage et al, 2020). Various studies conducted in the last year have shown that most schools were closed during the lockdown period and that they offered online courses for students (Morgan, 2020). In such situations , teachers need to find new educational tools for better e-learning and remote experimentation in science, technology, engineering and mathematics (STEM) subjects, by electronic means. There are a lot of studies that have put forward innovative methods and tools to improve the teaching act, adapted to students' levels of knowledge (Dănesc and Voinea, 2019; Dinu et al., 2019; Pantazi et al., 2019; Voinea et al., 2019; Chiriacescu et al., 2020; 2021a; 2021b, Voinea et al., 2021; Tîrcă et al., 2021). This study presents a remote lab for the Master's courses in renewable energies focused on the phenomenon of hydrogen production by electrolysis. It is well known that hydrogen production is a priority in the context of the current energy crisis and the threat of climate change (https://ec.europa.eu/energy/topics/energy-system-

integration/eu-strategy-energy-system-integration_en). The aim of this article is to show ways through which we can turn a classic electrolysis experiment, as a source of hydrogen production, into a completely remote laboratory. The idea behind the concept of remote laboratory is to be able to perform all or an important part of lab work from a distance by means of remote services.

The most important part of such a concept is automation. This means that for all definable tasks there exists a way of implementing both software and hardware solutions in order to perform the specified activity. Another key component of the system is the eventual web server that needs to mediate all interactions between the scientist and the lab (services) by means of authentication and maybe even storage and initial processing of data. The latter is optional though, as many scientists might prefer to process the raw data themselves. The set-up of the experiment is made entirely by the authors, starting from the design of the passive and active control systems, to the integration of the configuration with a web dashboard so that it can be used remotely by students. The paper also details the building process of a robotic arm as an active control system, as well as the integration of these components into the system. This remote laboratory is an alternative for students to experiment with a method of obtaining hydrogen, when the face- to-face laboratory is not available.

2 Methods

2.1 Theoretical considerations

The origin of the term electrolysis comes from: "lysis" - decomposition and "electro" - current. Therefore, the reduction-oxidation process that takes place at the electrodes when continuous electric current passes through the solution or melt of an electrolyte is called electrolysis (Sawyer, 2003). The electrolyte is a chemical that can decompose under the influence of an electric current.

In the electrolysis process, the electricity supplied is transformed into chemical energy. The phenomenon is complex and consists of the following:

1. If we introduce 2 electrodes in the electrolyte solution and we connect them to a direct current source: the cathode (-) and the anode (+) then, under the action of the electric field the following take place:

a. Migration of positively charged ions (cations) to the cathode and negatively charged ions (anions) to the anode,

b. Their neutralization. At the cathode the cations add electrons and reduce. The anions, approaching the anode, give up the electrons and oxidize.

2. The cathode is a reducer and the anode is an oxidizer.

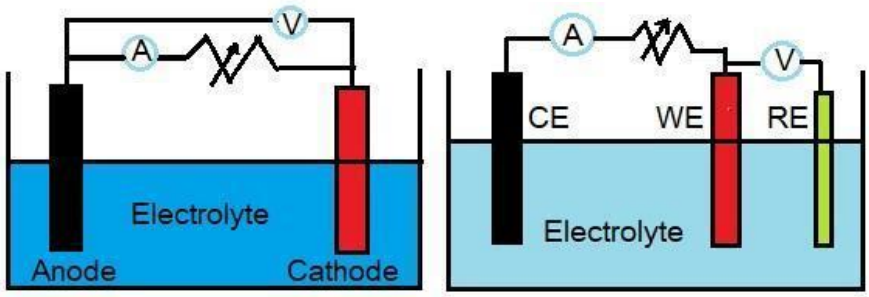
3. Atoms transformed in the electrolysis process may be deposited as such on the electrode or may react with each other to form gas, liquid or solid, or may form by-products of electrolysis if they react with the solvent molecules of the electrode. The products of electrolysis depend on the nature and concentration of the electrolyte, the nature of the anode and the density of the electric current.

Electrolysis can take place in different ionic conductive media (electrolyte) such as aqueous solutions, melts, or others (Kumar and Himabindu, 2019).

Generally, an electrochemical system (electrolyzer, fuel cell, battery) is composed of two electrodes immersed in the electrolyte - its main role being that of ionic conductor. This system can provide energy, or use energy for its operation.

In the particular case of electrolyzers (fig.1a), the positive electrode (anode) has a higher potential than the negative electrode (cathode).

Electrodes are the main components of electrochemical measurements. The applications of electrochemical measurements cover a wide range of fields from electrochemical engineering, renewable energies, to bioelectrochemistry, environmental protection and biomedicine. For the electrochemical measurements, it is important to know the potential of each electrode, which, in practice, is very difficult. This is the reason for which we use three electrodes: the electrode of interest named the working electrode (WE), the counter electrode (CE), the auxiliary electrode that allows the current flow and the reference electrode (RE), as reference of the potential. For successful electrochemical measurements the RE type is essential (Napporn et al, 2018).



a) b)

Figure 1. a) Electrolyzer, b) Set-up for electrochemical measurements with counter electrode (CE), working electrode (WE) and reference electrode (RE)

2.2 Lab design

The experimental setup is centered around a remotely operated SCARA (Selective Compliance Articulated Robot Arm), operated by an Arduino microcontroller, which can be accessed via a web interface (fig.2). The robot is controlled by an Arduino microcontroller, which drives the motors that put the robot in motion and operates the valves used to control the concentration of the working liquid in the beaker.

The SCARA is fitted with a gripper end controlled by a servomotor, which allows for fine adjustments in the grip width of the claw. In this case, the gripper end will hold the reference electrode and move it inside of the beaker, so that different voltages can be measured.

The plastic frame of the robot was 3D printed using an open-source model designed by How To Mechatronics. There were two 3D printers used, a Tevo Tarantula Pro and a Creality Ender 3 Pro, which worked in parallel. The files were sliced using the software Ultimaker Cura and additional or customized parts were designed using software such as FreeCAD and TinkerCAD.

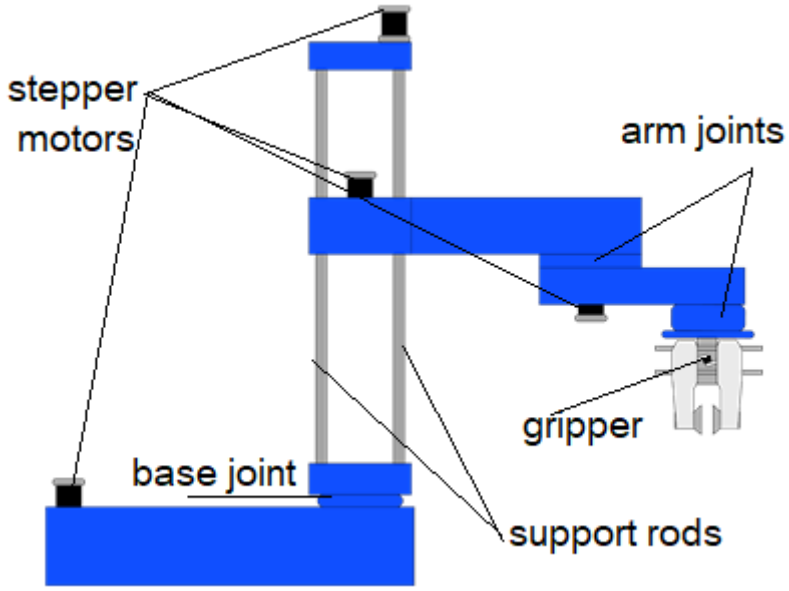


Figure 2. Diagram of the SCARA used in the project

Other than the robotized part of the experiment, the setup (fig.3) consists of necessary elements in order to carry out the electrolysis process:

•Two containers: one with a saturated electrolyte solution and one with distilled water. By mixing these two liquids the working solution will be obtained. The mixing of the liquids is controlled using an electromagnetic valve, in order to control the concentration of the solution.

•A beaker - built with an overflow drain and drainage system controlled using a valve.

•A working electrode and a counter electrode, both made out of graphite, which will be connected to the power supply.

•A reference electrode -which will be moved around by the robot arm, under the control of the operator, to vary the distance between the reference electrode and the working electrode.

This setup is designed to be operated remotely by the electromagnetic valves controlling the flow of liquid to and from the main beaker. The valves are programmed such that the user can control the concentration of the solution.

With the aid of the robot, the operator of the experiment can move the reference electrode in order to vary the distance between it and the working electrode and measure the voltage drop between the two electrodes.

2.3 Data collection

The data acquisition is facilitated by a programmable power supply, which can send the values of the current and the voltage directly to the user. The students are provided with the aforementioned web interface through which they can tune the parameters of the system

and take the relevant data and measurements, which they will then process and from which they will draw physically important conclusions. The system is also equipped with a camera that captures the experimental set-up, such that the student currently operating the experiment will be able to also observe the phenomenon of electrolysis take place.

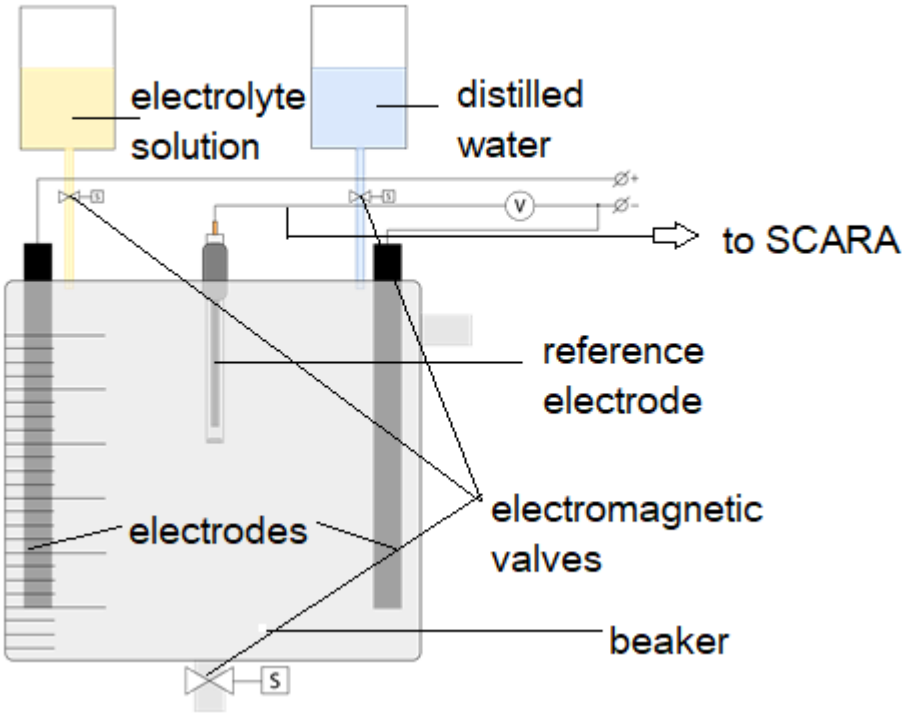


Figure 3. Schematic of the lab setup

3 Experimental Procedure

The aim of this experiment is to highlight the role of the electrolyte solutions in the electrolysis process and the utility of the reference electrode in electrochemical measurements. Our objective is to provide laboratory conditions and equipment while working from home in order to give the user as accurate of a depiction as possible.

The first step is preparing the working solution. Distilled water and electrolyte will be poured into the beaker from their respective containers. This will be done by opening and closing the valves, which are electronically operated through the interface.

When the operator establishes the desired concentration of electrolyte solution, they can set the reference electrode at a certain distance from the working electrode with the help of the robotic arm.

The next step is applying tension to the system. The voltage should be increased incrementally until we can notice water splitting. The observation of the bubbles inside the beaker will be aided by the video cameras mounted around the ensemble.

Using the SCARA system, the student can then move the reference electrode to different distances from the working electrode and measure the voltage draw between these electrodes.

The available web interface allows the operator to tune the parameters of the system in order to allow remote control.

All of the measurements will be taken using a data acquisition system that will then make those values available to the operator.

4 Conclusions

Our work examined methods of converting a classic water electrolysis experiment into a fully-fledged remote laboratory. Our approach involved intentional redundancy in building a robotic arm for the active control systems. While simpler solutions could have been used for this particular experiment, this approach warrants maximum flexibility. The robotic arm can later be repurposed for other experiments, it can serve as a general laboratory tool, or can be used as a didactic tool in itself.

Moreover, we prove that building such an experiment is an accessible feat for most higher education institutions. The setup is built using recyclable materials, such as home-use water containers. The SCARA robotic arm, in itself, relies on an Arduino microcontroller and other cheap, widely used electronic components. Since it is 3D printed, it is accessible to people who don't have access to a mechanical workshop. Additionally, the CAD schematics are open-source, letting those interested in using the SCARA robot for a remote laboratory focus on experiment design, rather than mechanical implementation.

Overall, our setup turns the water electrolysis experiment, which was previously a highly repetitive task, into a tool for further exploration of the underlying physical principles at play. By automating the experiment, students will now be able to use the limited laboratory time for tasks such as data analysis, rather than data collection. We intend for this to be a motivating factor for teaching students to deduct physical equations, formulate hypotheses, and correlate them with the course material.

More generally, the robotic arm in itself can be used as a tool for teaching students about robotics and challenging them to develop and program applications for other experiments they might be invested in. Since the SCARA is controlled by an Arduino microcontroller, programming it is an unburdensome task and represents a highly transferable skill.

An important avenue for further development would be organically integrating the remote laboratory into a virtual course. Due to the widespread use of e-learning caused by isolation conditions, the virtual laboratory can partially replace the experiment held in the laboratory. Further integration could lie in the gamification of a full course. For instance, completing certain experimental outcomes could be one of the achievements required to pass to the next course chapter. As new technologies and computer applications become increasingly prevalent, teaching material should start integrating them in order to attract more students to STEM fields.

5 Acknowledgements

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Virtual simulation - 3D protective knee pad prototype

Arina Seul[1], Diana-Roxana Viziteu[1], Antonela Curteza [1], Aura Mihai[1], Manuela-Lacramioara Avadanei[1]

(1) "Gheorghe Asachi" Technical University,
Doctoral School - Faculty of Industrial Design and Business Management,
29, D. Mangeron, 700050, Iasi, Romania
E-mail: viziteudianaroxana@gmail.com

Abstract

This paper presents a methodology of using 3D modelling software such as RHINO to create a virtual prototype of a protective knee pad, which will be later evaluated in virtual simulation using Finite Element Analysis (FEA). A brief overview of the steps involved in designing a model using multiple simulation tools will also be covered. Due to its importance for the analysis and design of many engineering products, the FEA method has been included in most new versions of engineering software in various ways. The preparatory and primary stages needed to develop 3D models and perform FEA simulations are presented: design and model of the 3D object, import and check the geometry, assign materials, set the analysis requirements (create the mesh and define contacts between the components), establish loading conditions of the model (forces, fixed supports and constraints), set solution parameters, solve the model, generate and analyse the results. For example, for displacement evaluation and stress distribution on the knee and knee pad during contact with the rock, two parameters could be considered: total deformation and equivalent Von Mises stress. After completing these steps, any person working in industrial design and having access to RHINO and ANSYS software solutions will be able to develop original concepts or test any available models. Through simulation, the users will see how their designs behave in different real-world scenarios in a short time without any material cost for physical testing.

Keywords: Simulation, Virtual prototype, Knee pad, Finite element analysis

1 Introduction

Modern designing involves complex methods, beginning with the modelling phase and leading to virtual prototyping and simulation. The use of 3D technologies offers designers, engineers, or students a better understanding of the design and development process.

Virtual learning based on simulation applications is becoming a norm for industrial engineering curricula, but it is usually introduced after teaching theory concepts. Teaching

and learning are complex issues, particularly in the pandemic context, as this process takes many forms, both online and offline. Modelling software and Finite Element Analysis (FEA) application have become essential for virtual learning in science and engineering in various academic fields. 3D modelling plays a crucial role in FEA simulation. Computer-based simulation is a standard and practical method used to study the behaviour of various 3D products for fields like engineering design graphics, mechanical engineering, basic mechanics courses, statics, and material science. (Sracic, 2016; Plevris et al., 2018).

Virtual prototyping and simulation for education allow learners to analyse and solve real problems and optimise the product's performance in the design phase.

This paper presents a methodology for virtual learning using the mentioned software applications to extend the educational experience and deliver instructions to design and test the behaviour of a 3D knee protective pad prototype. The learner will acquire skills in 3D modelling, virtual simulation, applying engineering and science principles, analysing and drawing conclusions.

2 Methods and Setting

2.1 Development Of The 3D Model

The 3D computer model can be developed by scanning an existing product, downloading an existing model from the website, or creating a new design. For this practical application, the first step is to model the protective knee pad using RHINOCEROS version 6, computer-aided design software (CAD), also known as "RHINO", or "RHINO 3D". This program is based on NURBS (Non-Uniform Rational Basis Splines) geometry, modelling curves rather than linking polygons. Rhinoceros is commonly used in architecture, engineering, automotive, product design, and jewellery design.

Using RHINO, the shape of the knee pad is formed by fitting it around existing data of anatomical skin surface extracted from accurate medical scans. The knee is the largest and most complex joint in the human body, and it keeps together the thigh bone, shin bone, fibula, and kneecap (patella). The base of the pad is modelled from the standing posture around the generic shape of the knee and slightly flexed midway to accommodate the patella idle position of the knee joint. In the first step, the learner uses the Polyline command to draw a series of joined line or arc segments and create many inflexion points to achieve an ergonomic shape for the knee pad.

The next step is to transform the drawing into a three-dimensional surface with adaptive mesh and manipulating curves. There are several commands for creating a surface, such as Loft, Revolve, Sweep and Pipe. In the case of complex surfaces, the Network Surface function is better to be used. The student engaged in virtual learning must select the Loft command to create the surface and build it between various profiles. Following the shape of the knee, using polyline loft and other specific surface modelling commands, the user creates the knee shape of the protective pad with plates and structural arches. For surface manipulation, to obtain organic and anatomical shape, T-Spline mesh is utilised. In the wireframe viewport, the model is highlighted with a network of crossing curves. This type of view helps us visualise the shape of the knee pad (figure 1).

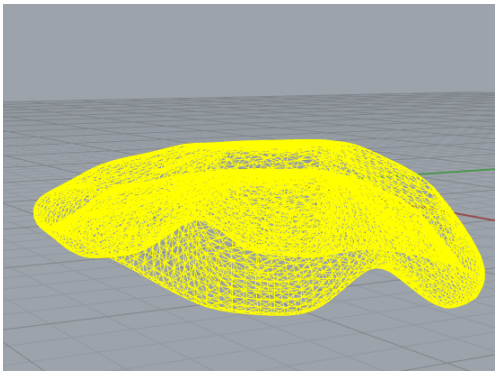

Figure 1. Wireframe viewport- Knee pad design

In the rendered and shaded viewport, the object will first render in white. After that, the trainee is expected to add different attributes from the properties panel and material page, such as rendering colour, texture, transparency, highlight or bump-maps to produce a high level of detail to each engineering design project (figure 2).

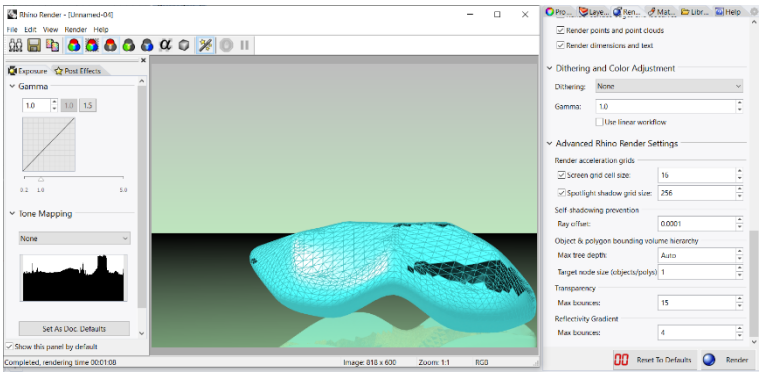

Figure 2. Rhino render settings panel area

By working in RHINO, the learner can understand how to create, edit, analyse, and translate NURBS curves, polygon meshes, surfaces and solids, render, to bring designs from sketch idea to final product.

After the model is complete, it must be exported in a compatible format for the virtual stress test analysis. For export, the user goes through the following steps: select objects to export > export selected > in the save as type box, select Stereolithography format (*.stl) > Click Save. In the STL Mesh Export Options dialogue box, tolerance can be established, representing the maximum distance allowed between the surface of the drawing and the polygon mesh of the STL file.

Next, it is essential to validate the knee's practical aspects and simulate the model's behaviour under mechanical conditions. Finally, in case of too many vertices, it is indicated to simplify the *.stl file. The easiest way for the user to simplify the STL model is on websites such as https://3dless.com/ (using vertices reduction), where the 3D model file is

uploaded, and the vertices amount is specified. This website works entirely offline, which means that the file will not be uploaded on the internet. The final step is to save the file on the learner's PC in the default download location. Also, more complex methods are available for reducing the complexity of the resulting mesh model, but they are not the end goal of this research.

2.2 Finite Element Simulation

FEA is a numerical method used to simulate a detailed view of where changes in structure occur and indicate the distribution of stresses, displacements or strains. The process is applied separately to a series of small regions obtained by discretisation and called finite elements linked together by nodes.

The application of computational models to studying and predicting a designed product's behaviour enables engineering students to receive practical learning, even in a virtual environment, to develop and apply critical thinking in new and dynamic situations, forming connections between the aforementioned concepts.

Nowadays, various FEA-based software systems can solve problems with a high degree of difficulty, use inputs from most CAD design programs, and provide modules for designing and editing geometric shapes. Popular computer programs based on the finite element method are ANSYS and ABAQUS. In this gradual tutorial for virtual learning, the simulation is performed with the ANSYS software version 17.2.

The FEA process includes pre-processing, simulation (analysis and evaluation), and post-processing stages.

2.2.1 Pre-processing

The pre-processing phase is crucial for preparing the simulation process. In this stage, the user prepares the geometric model for simulation and establishes the properties of materials. Both processes influence the accuracy of the FE model and improve the analysis efficiency in engineering applications.

The *.stl format of the knee pad 3D model has to be imported into the ANSYS workbench software and processed in the Space Claim application to provide a simplified and accurate geometry. The imported knee pad is a body made up of a multitude of facets. The user will transform it into a solid using Convert to solid function and Repair menu.

The knee's behaviour is observed by simulating the contact between a rock-like surface, the kneepad, and the knee's simplified shape (represented by a ball). The final 3D geometry is presented in figure 3.

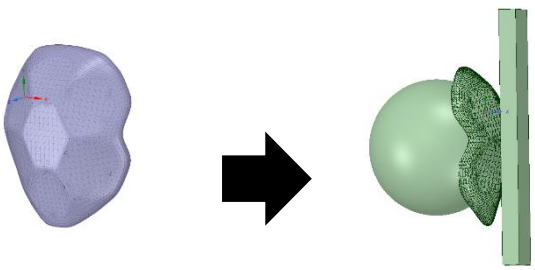

Figure 3. Geometry imported and edited in Space Claim

For FEA simulation, it is essential to describe the mechanical behaviour of materials by defining Young's modulus and the Poisson's ratio. Therefore, the ANSYS software provides a library with predefined materials. This way, using the menu Engineering Data, the existing materials could be selected by the user from the software's database or new materials could be defined. In the case of user-defined materials, the designer can choose which properties to assign to them.

The modelled knee pad is from polylactic acid (PLA), a material testified as having good mechanical properties in 3D printing (Anirudh & Yeole, 2021). The material is considered to have elastic-plastic, isotropic, and homogeneous properties.

2.2.2 Simulation

The ANSYS application offers over 15 types of analysis chosen by the virtual user depending on the experiment to be solved. These include design assessment, explicit dynamics, harmonic response, modal and static structural.

This case study simulates the behaviour of materials used for knee pad manufacturing and how the material influences the pressure distribution on the knee surface when it comes in contact with a rock. For this purpose, the Static Structural analysis module of the ANSYS software application is used. According to this type of analysis, the learner must follow these steps:

- import the verified geometry;
- assign materials to the knee, knee pad and rock;
- create the mesh and define contacts between the components;
- specify analysis conditions (forces, fixed supports and constraints);
- set solution parameters;
- generate results.

The previously edited 3D geometry is opened in the Mechanical application by double-clicking on the Model tab. Next, the user assigns to each component one of the materials defined in the pre-processing stage. Contacts between the components of the geometric model are defined, and the mesh is generated. Both are chosen depending on the sort of problem to be solved.

ANSYS software has six types of contacts (Ozgun, 2018): bonded, no separation, frictionless, rough, frictional and sliding. The user has to select the knee, knee pad and rock, and define a bonded contact with automatic scope mode.

Next, the learner generates the mesh. The resulted mesh includes 68025 nodes with 38805 elements and has adaptive size function, coarse relevance centre and default element size.

Once the mesh and contacts have been defined, the loading and boundary conditions are set. Moreover, the biomechanics of the knee must be taken into account to define the loading pattern.

According to Kumbhalkar (2013), when the body's total weight is acting over a single knee joint in the straight position, the external force system includes three ground-to-leg forces (Fx, Fy, and Fz). Fx is the frictional force acting at the leg in the line of progression, Fy is the vertical component, and Fz is the side-to-side ground-to-leg force. For example, for a 55 kg body mass, the Fy is 539.55 N, Fx is 152.20 N, and Fz is 101.20 N.

Based on these data, a force defined by components is applied to the simplified model of the knee, and fixed support is applied for the rock (figure 4). The simulation time was set to one second.

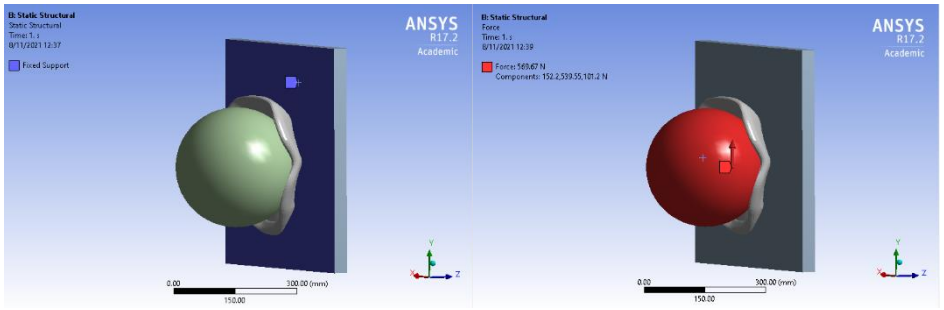

Figure 4. Boundary conditions

Two parameters are considered to evaluate the behaviour of materials used for knee pad manufacturing and their influence on the stress distribution on the knee surface in contact with a rock: total deformation in mm and equivalent stress in MPa for both knee and knee pad.

2.2.3 Post-processing

Once the simulation has been performed, the application generates the results in two ways: as values and as a scale of colours where red means maximum values, and blue is for the minimum ones.

For this study case, the simulation results are the changes, namely displacement (figure 5) and stress (figure 6), that occur on the knee and the knee pad in static conditions during one second.

In the end, the user generates a final report with the solutions and the settings of analysis. The input data could be changed to optimise the design. Finally, the obtained results are validated against the data from the literature (Anirudh, 2021).

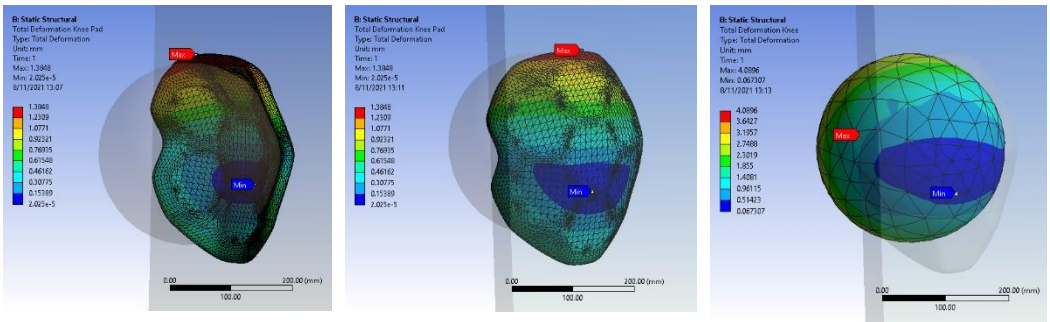

Figure 5. Total deformation for knee pad and knee

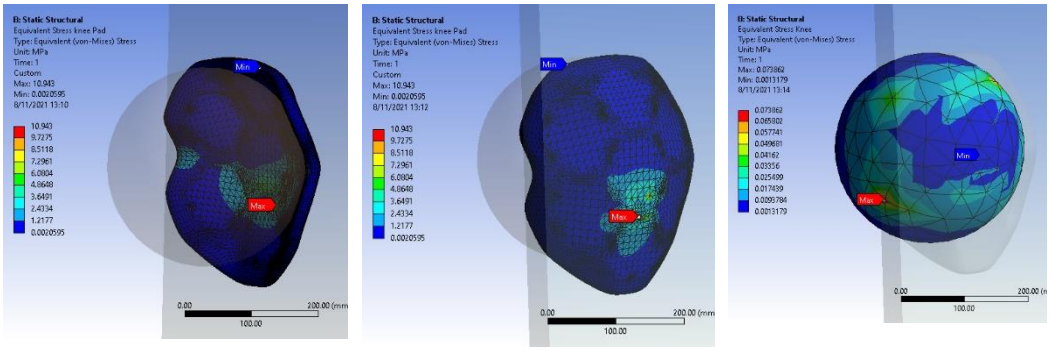

Figure 6. Equivalent Von Mises stress for knee pad and knee

3 Conclusions

Virtual prototyping and simulation are used in industrial, educational and research fields. Computer simulations based on FEA have significant potential in industrial engineering and education. Simulation is a very efficient and effective method for helping students engage in virtual learning, for understanding a dynamic situation including several objects that would otherwise require physical prototypes and extensive testing.

In this paper, the analysis shows the displacement and stress distribution on the knee and the knee pad - made out of PLA - during contact with the rock.

FEA allows performing simple simulations quickly, without producing a physical prototype, which decreases designing costs.

Following the workflow (import the verified geometry, assign materials to the knee, knee pad and rock, create the mesh and define contacts between the components, specify analysis conditions: forces, fixed supports and constraints, set solution parameters and generate results) and data analysis, the user/learner can predict the behaviour of the product even from its development stage, in real-world scenarios, by varying parameters such as material or shape of the geometry. With virtual learning environments, students access and interact with resources in ways they would not be able to in the physical classroom.

As described in the current paper that covers cross-platform and cross-software workflows, methodological virtual learning is essential for learners to maximise output with the limited resources available in the current global context (reducing waste, using resources sparingly and simplifying logistics). Simulation, as a disruptive technology in engineering virtual learning, represents a method to equip students with the skills needed for the real world.

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Virtual Instrument for Measuring Light Intensity

Mihai Bogdan

Computer Science and Electrical Engineering Department,
"Lucian Blaga" University of Sibiu, 550025, Romania,
E-Mail: mihai.bogdan[at]ulbsibiu.ro

Abstract

Lighting and light distribution have a crucial influence on factors such as performance and occupational safety.
This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode. The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set
value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.

Keywords: Light intensity, Photodiode, Arduino, LabVIEW

1 Introduction

A light source, like the filament of an incandescent bulb, emits light in all directions. Effectively, it sits at the center of a sphere of radiated light (which is why light units reference the steradian). The total energy of all the light given off is termed the "luminous flux." (https://www.omega.com/en-us/resources/shining-a-light-on-intensity-measureme)

The light intensity is part of the light flux that falls on the surface of a certain size and depends on the light flux of the light source, the angle of the beam, and the distance between the surface and the light source.

An important feature when choosing a light source is the luminous flux which represents the total amount of light that is produced by the light source in all directions in one second.

$$E= \Delta\Phi/d\Omega$$

Lumen is the unit of measurement of the total amount of perceived light emitted by a source (luminous flux or light power). The candle is the unit of measurement of light power emitted by a source in a certain direction (light intensity). Luminous flux or light power is a measure of the perceived power of light. (Bogdan 2018).

A photodiode is a PN junction diode that consumes light energy to produce electricity. It is sometimes called a photodetector, light detector, and photo-sensor. These diodes are specially designed to operate in reverse polarization conditions, which means that the P-

type part of the photodiode is associated with the negative terminal of the battery and the N-type part is connected to the positive terminal of the battery.

The PIN photodiode is a certain type of photodiode in which an intrinsic layer is placed between a strongly doped p-type layer and a strongly doped n-type layer. As the resistivity decreases with increasing impurity and vice versa, the p and n layers have a very low resistivity, while the resistivity in the first layer is very high. The PIN-Photodiode has a large depletion region that is used to receive light.

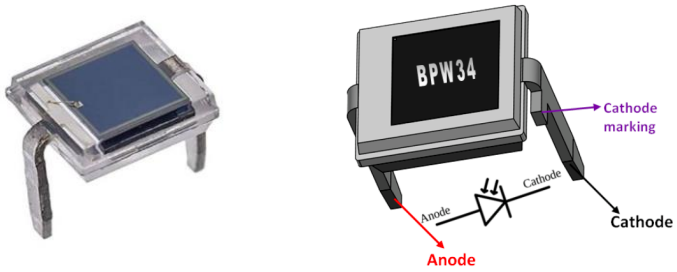

Figure 1. BPW34 Photodiode and BPW34 Pinout

For implement this project we will need the following materials: an Arduino UNO, a BPW34 Photodiode, one suitable resistor for the BPW34 Photodiode (10KΩ), breadboard, 1 LED, 1x220 ohm resistors, and jumpers wires to connect.

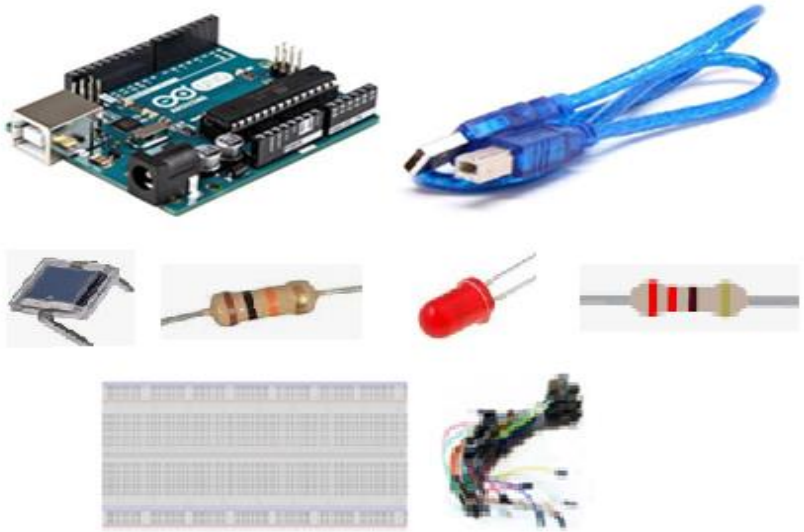

Figure 2. The components necessary for the elaboration of the technical project

The decor of a warm air home, of an accommodation unit that wants to be as welcoming as possible or of a veranda arranged for summer nights can never be complete without the right lighting equipment. In the process of choosing light sources, there are many criteria that can be applied. Their appropriate intensity, in relation to the demands they will respond to during use, must be at the top of their concerns, and the most important aspect in this regard is the indication of the luminous flux.

2 Build a VI and Data Acquisition

This paper aims to create a virtual instrument (VI), developed around the Arduino Uno development platform, designed to measure the light intensity using the BPW34 sensitive silicon PIN photodiode.

The reverse-biased photodiode can be used as a light detector by monitoring the current flowing through it. Coupled to a 10Kohm resistor and considering the specifications of the BPW34 model, a simple relationship is offered between lux (light intensity) and the voltage across the resistance. The virtual instrument reads this voltage and converts it to a light intensity value in Lux. There is also an alarming function if the light intensity exceeds the set value. The VI also shows basic statistics like Max, Mean, and Min light intensity values.

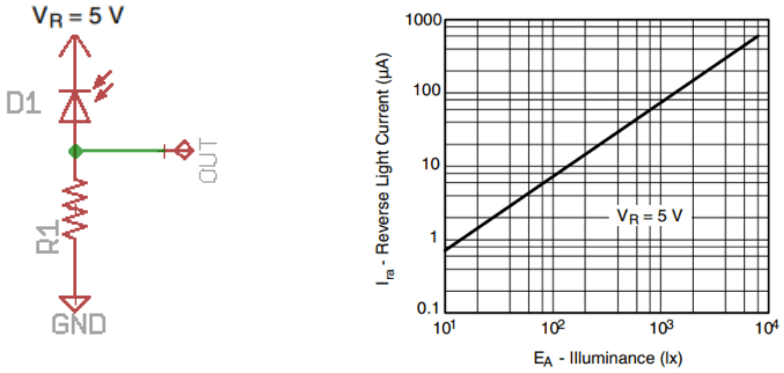

Figure 3. Measuring circuit and current- light intensity characteristic of the photodiode

Taking into account the specifications of the photodiode and taking into account the resistance of 10Kohm connected in series with it, between the light intensity and the voltage at the terminals of the resistance is given by the relation:

$$lux = 1333 * V_{out} \quad (1)$$

Using the Arduino electronic platform together with a computer we will measure this voltage.

To create the interface between LabVIEW and Arduino, we will need the following software:

- LabVIEW;
- NI VISA;
- VIPM;
- LINX

NI VISA - National Instruments Virtual Instrument Software Architecture is an API that provides a programming interface to control Ethernet/LXI, GPIB, serial, USB, PXI, and VXI instruments in National Instruments application development environments like LabVIEW. The API is installed through the NI-VISA driver (https://www.ni.com/ro-ro/support/documentation/supplemental/06/ni-visa-overview.html).

VIPM - VI Package Manager reduces project costs by helping you implement a code reuse process in your organization. VIPM makes it easy to manage and share reusable VIs

across multiple projects, computers, and teams of developers (http://sine.ni.com/nips/cds/view/p/lang/ro/nid/209002).

LINX - LabVIEW for X (LINX) is designed to replace LabVIEW Interfaces for Arduino and to provide a LabVIEW generic protocol for the interface with any programmable device, but specifically targeting Microcontrollers and SoCs (System on a Chip). LINX will provide a high level of programming that allows users to communicate with several devices, including Arduino (https://www.labviewmakerhub.com/).

Represented in Figure 4 and Figure 5 is the Front Panel and respectively the Block Diagram of the VI.

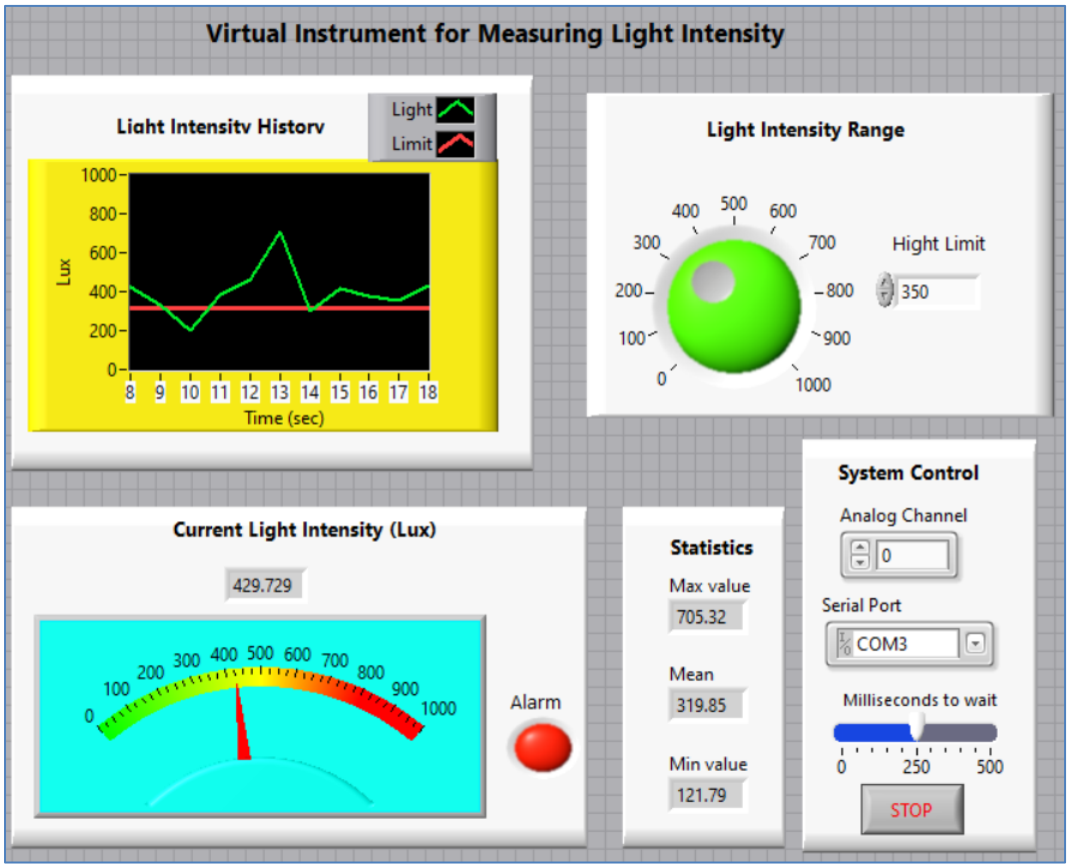

Figure 4. The Front Panel of the VI

In addition to the entire graphical interface, the LabVIEW environment (like the other simulation, testing and programming) allows connection to physical equipment (hardware). In addition to the dedicated equipment, compatible with LabVIEW, there are other platforms development devices such as Arduino, which can be used in the environment LabVIEW.

The Front Panel contains buttons, graphics, and other controls and indicators. The Block Diagram is the window that contains the source code of the virtual application. This window contains:

-terminals, which represent the correspondent of the objects in the Front Panel in the Block Diagram and which are represented by suggestive symbols;

-nodes, which have inputs and outputs and are equivalent to instructions, functions, and routines in text-based programming languages;

-structures, which are equivalent to cycling and conditioning instructions in text-based programming languages;

-wires, which allow the circulation of data in the Block Diagram.

The Block Diagram created below, reads the voltage at 10 Kohm resistance terminals, using Arduino Uno development platform, and then converts this voltage into light intensity, using relation (1).

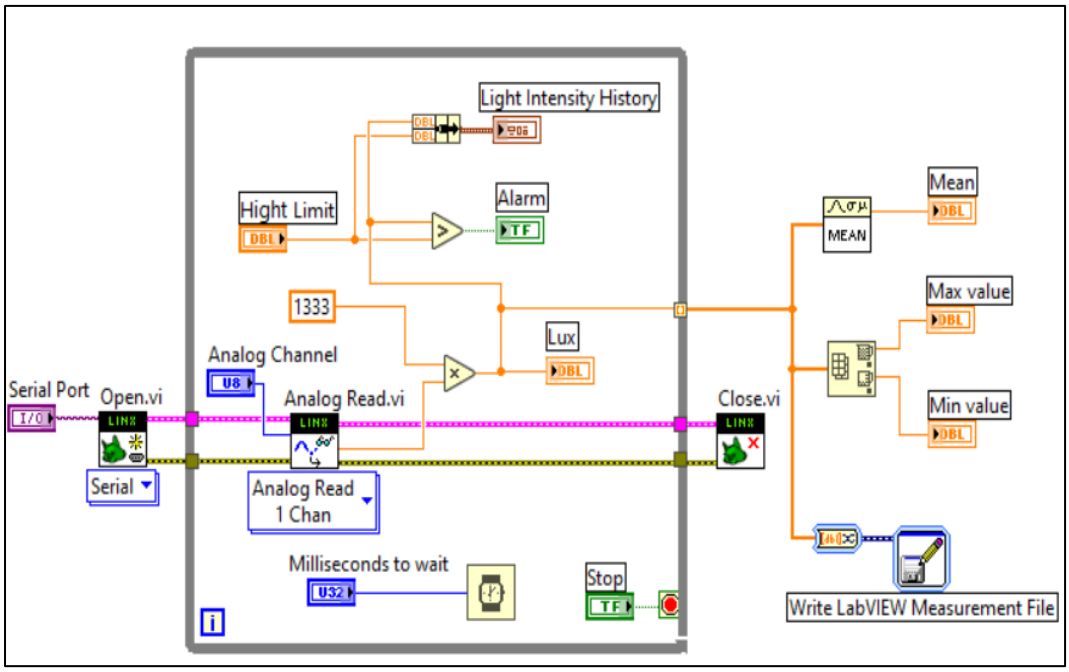

Figure 5. The Block Diagram of the VI

3 Conclusion

This paper explains how to use the Arduino Uno development platform, together with the LabView graphical programming language, to measure the light intensity in space, using a photodiode as a sensor.

LabVIEW integration with Arduino, makes prototyping even easier using LabVIEW's GUI environment with the Arduino platform. The LINX extension package enables a variety of built-in control development platforms, such as the Arduino Uno, to interface with electronic circuits, electromechanical components, and sensors, easily using

LabVIEW software. LINX firmware enables the communication between interface components and embedded development platforms for development via USB, I2C, and SPI interfaces. Analog, digital and PWM signals can also be easily controlled using LabVIEW software.

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Section SOFT
Software Solutions

Case Studies of some Educational Applications in Computer Science Domain

Mihaela Oprea[1], Bogdan Burlan[1], Ion Georgian Dinu[1]

(1) Petroleum-Gas University of Ploiesti, Department of Automatic Control, Computers and Electronics
Bdul Bucuresti, No 39, Ploiesti, 100680, Romania
E-mail: mihaela[at]upg-ploiesti.ro

Abstract

Learning various technologies and software tools that are currently used in industry is a key issue for students studying computer science in order to achieve good competencies in applied science. Examples of educational applications that are developed in the field of computer science based on different software technologies and tools are: virtual museums, environmental systems (e.g. environmental pollution analysis and forecasting systems), educational robots systems (e.g. mobile robots navigation systems), educational platforms (e.g. intelligent tutoring systems) etc. The paper focuses on two types of educational applications developed at their diploma project by students that studied Computer Science specialization at the Petroleum-Gas University of Ploiesti: a virtual museum and an air pollution analysis and forecasting system for which a comparative study was run.

Keywords: Educational applications, Virtual museum, Environmental system, Air pollution analysis, Air pollution forecasting

1 Introduction

The development of educational software support systems such as e-learning platforms and intelligent tutoring systems would increase their efficiency if a variety of illustrative educational applications specific to each program of study and their courses are integrated in these systems. For example, the applications can include simulations, virtual reality applications or real world (e.g. industrial) applications recorded as educational videos. Moreover, updating these applications with new case studies that reflect the current status of technology and software/hardware tools that are applied in industry would offer good practical competences to students following that program of study. In this sense, the paper presents two case studies of some educational applications developed at their diploma project by students that followed Computer Science specialization at Petroleum-Gas University of Ploiesti and ended with success their studies in July 2021. One application presents a virtual museum for which specific software tools and technology were studied by the student and used in the implemented educational application. The other application presents an air pollution analysis and forecasting system developed for the Ploiesti city, which is based on artificial intelligence techniques. The student that developed this educational application performed also a comparative study between different techniques in order to select the best one for the implemented air pollution forecasting system. Both

applications are useful educational resources for the Artificial intelligence course that students from the Computer Science specialization are studying in the first semester of the final year.

The paper is organized as follows. Section 2 makes a brief overview on virtual museums and environmental forecasting systems. The air pollution analysis and forecasting system is presented in section 3. The educational virtual museum is described in section 4.The final section concludes the paper and highlights some future work.

2 An overview on virtual museums and environmental forecasting systems

Among the educational applications that can have a great potential to improve the efficiency of current and future educational software systems used in universities in different domains (e.g. Computer Science, Environmental Informatics, Environmental Sciences, Automatic Control, Aeronautics) we can mention two of them: virtual museums and environmental forecasting systems.

The development of educational virtual museums opens new joint collaborations between different universities and public/private institutions (in particular, museums). The specialized literature (see e.g. (Atamuratov, 2020), (Franks et al., 2016), (Kampouropoulou, 2013)) emphasizes the importance of museum pedagogy by using virtual museums in the teaching process and students' skills increase during the learning process.

Several virtual museums were developed so far. An example of using virtual reality (VR) for educational virtual museums is given in (Paliokas and Kekkeris, 2008). The authors developed a prototype VR Learning Environment as the low cost support of a virtual museum creation applied in the Art education. By using this tool, a variety of digitalized artefacts can be created by students as components of their exhibitions in a virtual museum. The main software tools that were used for this educational VM are 3D Studio Max 9 package and AutoCAD6. Several VM resources including e-learning and online resources are provided by the Museum Computer Network (https://mcn.edu). Some examples are portals (such as Science Museum Group, Alaska's Digital Archives), art and culture museums (such as Byzantine and Christian Virtual Museum; The Louvre, Paris; Georgia Museum of Art), and e-learning (such as Birmingham Museum of Art). A recent VM application that use learning agents is presented in (Linda, 2020). The author performed an analysis of 36 applications of VMs by evaluating them according to three criteria: technological solutions, information architecture and educational value. The whole analysis was made from a learning perspective and focuses on the remote use of museum collections for the learning process emphasizing the main advantages of using educational virtual museums. Another study that analyzed virtual museums from the viewpoint of the technologies they use, the opportunities and perspectives they open is described in (Anton et al., 2018). The authors described how is impacted the human life by museum virtualization. They also analyzed the use of 3D technology for cultural heritage preservation and made a presentation of top five most amazing VMs presentations. A research study that analyzed if educational VM applications can change the attitudes of students that follow open education studying History discipline based on a VM application is described in (Ulusoy, 2010). The conclusion of this work was that the motivation of students and the conceptual understanding can be enhanced by the use of educational VMs.

Another research (Tserklevych et al., 2021) that was recently published tackles the use of virtual museum space as an innovative tool for the research practice that students will follow during their university program of study. The authors propose the application of visual teaching methods and presents details related to online resources of Ukrainian museums that are used by students studying Economic History discipline.

The other type of application that is discussed in this paper is environmental forecasting systems, in particular, air pollution forecasting systems. Air pollution in urban regions became an extremely important environmental problem that requires real time monitoring, analysis and forecasting. There are several forecasting systems that were reported in the literature tackling air pollution forecasting with different types of methods, either specialized numerical methods or artificial intelligence and machine learning based methods. A brief review of selected papers that were recently published in the specialized literature is presented as follows.

An overview of air pollution forecasting models is described in (Bai et al., 2018). Various types of models are discussed, as for example, statistical methods, artificial intelligence based methods and other hybrid methods that combine different types of approaches. A state of the art related to urban air quality prediction models is presented in (Croitoru and Nastase, 2018). Another research work that propose an air pollution forecasting system for Macedonia based on the WRF-Chem model is detailed in (Spiridonov et al., 2019). The authors analyzed the performance of system use in Skopje for PM10 forecasting. The experimental results showed good forecasting accuracy. A novel air pollution forecasting system based on artificial neural networks and neuro-fuzzy soft computing is described in (Tunckaya, 2020). The system was developed for a Turkish cement plant and proved good forecasting results. A comparative study of three forecasting models applied to air pollution forecast in Munich was recently published in (Humpe et al., 2021). The experiments were run on data collected in the period 2014-2018 for three air pollutants: PM, NOx and ozone. The experimental results showed that ANFIS model gave better results. Another research study on using computational intelligence (CI) methods for solving PM2.5 air pollution forecasting is described in (Oprea et al., 2017) revealing that artificial neural networks and other hybrid methods based on CI methods provide good forecasting accuracy.

The brief review on selected papers that tackle the problem of air pollution forecasting shows that different types of forecasting methods are currently applied with success in the air pollution domain. The air forecasting models and the comparative studies that were performed would provide valuable educational resources for students studying Environmental Science and Environmental Informatics. Developing some educational air pollution analysis and forecasting systems would increase students' competences in using and better understanding of certain forecasting models (e.g. statistical models, computational intelligence models) for real world air pollution scenarios.

In the next two sections we present two educational systems that were developed by students from Petroleum-Gas University of Ploiesti at their diploma project: an air pollution analysis and forecasting system for Ploiesti city and a virtual museum.

3 The Air Pollution Analysis and Forecasting System

The development of the air pollution analysis and forecasting system (Burlan, 2021) was made for the Ploiesti city by using data collected by the National Romanian Air Quality Monitoring Network (public available on http://www.calitateaer.ro) at the monitoring stations existing in the Ploiesti area. The design and implementation of the educational system was realized by the student following the general methodology for developing information systems. The main air pollutants whose concentrations were analyzed are CO, NO, NO2, NOx, SO2, benzen, PM10. The main components of the system are: the analysis module, the forecasting module, databases with air pollutants concentrations measurements, and the comparison module. Three machine learning algorithms were applied for air pollution forecasting: artificial neural networks, decision trees (CART, ID3, C4.5), and k-nearest neighbors. A comparison analysis of the results obtained with these algorithms was performed. Different criteria were used, as e.g. correlation coefficient, mean absolute error, and mean root square error. The software tools that were used for system development are: Weka, HTML, CSS, JavaScript, PHP, XAMPP, MySQL.

Figure 1 shows some records with hourly air pollutants concentrations measurements from the PH-1 monitoring station.

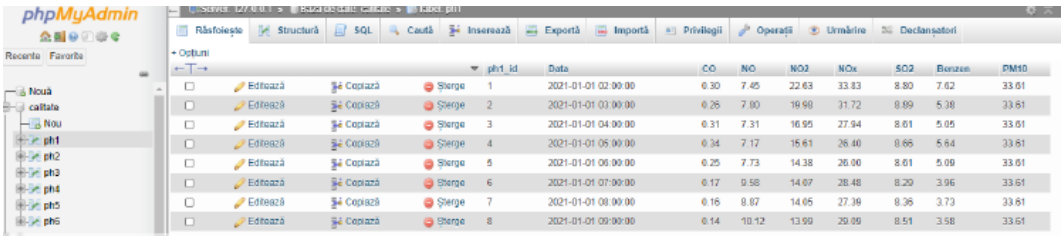

Figure 1. Sample records from the air pollutants concentrations monitoring database

An example of graph with measurements of CO concentrations is shown in Figure 2. This type of graph is used during the air pollution analysis for each air pollutant that is monitored in the Ploiesti city area.

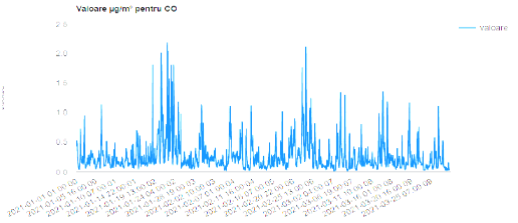

Figure 2. Example of graph with CO concentrations measurements

The artificial neural network (ANN) architecture that was implemented in Weka is shown in Figure 3. A multi-layer perceptron model with two hidden layers was designed for air pollutants concentration forecasting for next two hours.

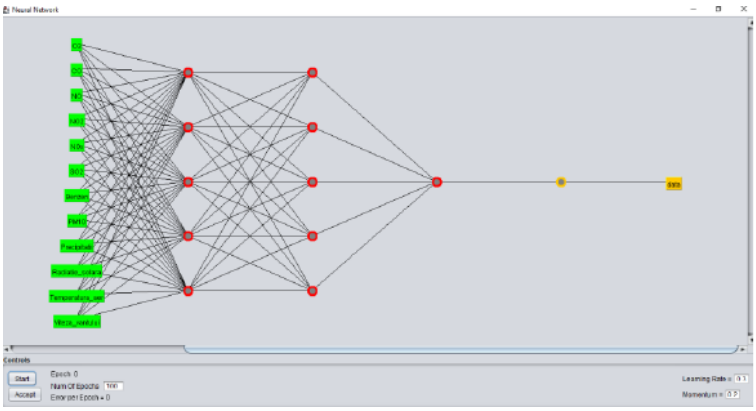

Figure 3. Artificial neural network architecture implemented in Weka

The results obtained by J48 algorithm are given in Figure 4. Different metrics were computed and analyzed in order to evaluate the efficiency of J48 algorithm.

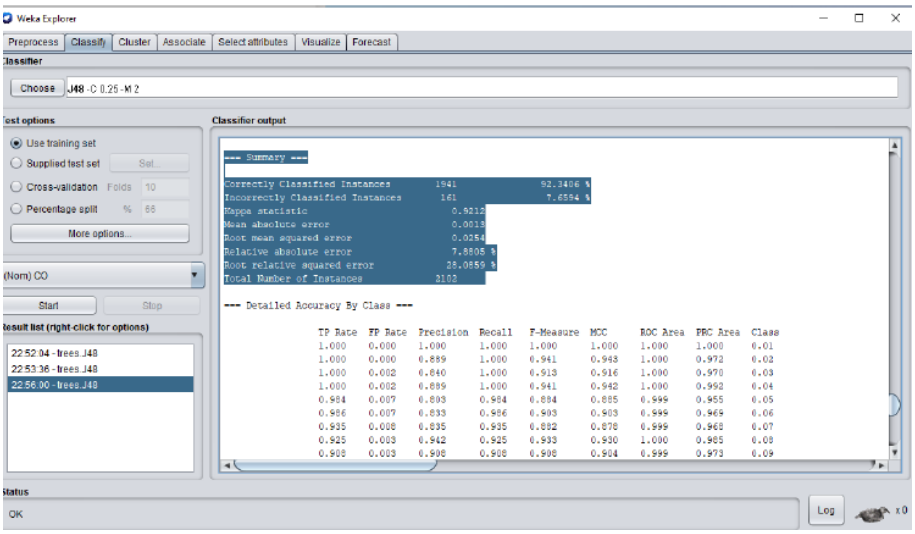

Figure 4. Results of J48 algorithm run

The experimental results obtained with all three algorithms: artificial neural networks, J48 and k-neighbors are synthesized in Table 1 for two air pollution monitoring stations (PH-1 and PH-2). The comparative study revealed that J48 gave better results in terms of mean relative error and mean absolute error.

The air pollution analysis and forecasting system was developed for the Ploiesti city and can be extended for other urban air polluted areas. The main benefit of using this system for educational purposes at Artificial Intelligence course teaching and learning is given by the three machine learning algorithms (ANNs, J48, k-nearest neighbors) better

understanding used in real world scenarios. Other important benefits for students are the new competences obtained by using machine learning software tools such as Weka.

Table 1. Experimental results of the comparative study

	PH1					PH2				
	Coeficient de corelaţie	EAM	EMP	ERA	ERP	Coeficient de corelaţie	EAM	EMP	ERA	ERP
KNN	0.9596	0.0456	0.084	21.8872%	28.177%	0.9226	0.0494	0.0862	32.6177%	38.6775%
RNA	0.8439	0.1523	0.1819	99.5373%	81.6393%	0.7818	0.1312	0.2089	63.0394%	70.1202%
J48	0.9212	0.0013	0.0254	7.8805 %	28.0859%	0.9142	0.0011	0.023	8.5804%	29.3039%

4 The Virtual Museum

The other educational system is a virtual museum (Dinu, 2021) with the following modules: the narrative module, the scene module, the navigation module and the gamification module. The main software tools that were used for the implementation of the virtual museum (VM) are the React VR language, JavaScript, Node.js and web programming tools.

In a first attempt the student started to create a museum with 3D objects under a virtual reality environment. Figure 5 shows a preliminary form of the museum with 3D objects. However, the implementation of this museum was not finalized due to resource limitations of the personal computer used by the student. Finally, the solution that was adopted by the student was a museum with 2D objects and 360^0 static photos. The museum is composed of several rooms, each room being described in the file muzeuData.js. Also, each scene has associated a static image. Figure 6 and figure 7 show images with rooms of the developed virtual museum.

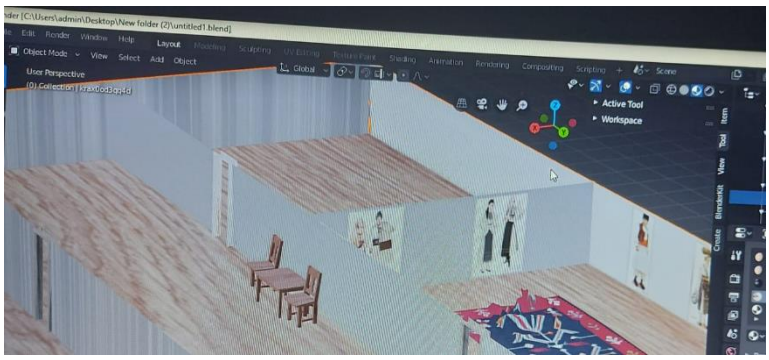

Figure 5. First version of the virtual museum (solution with 3D objects)

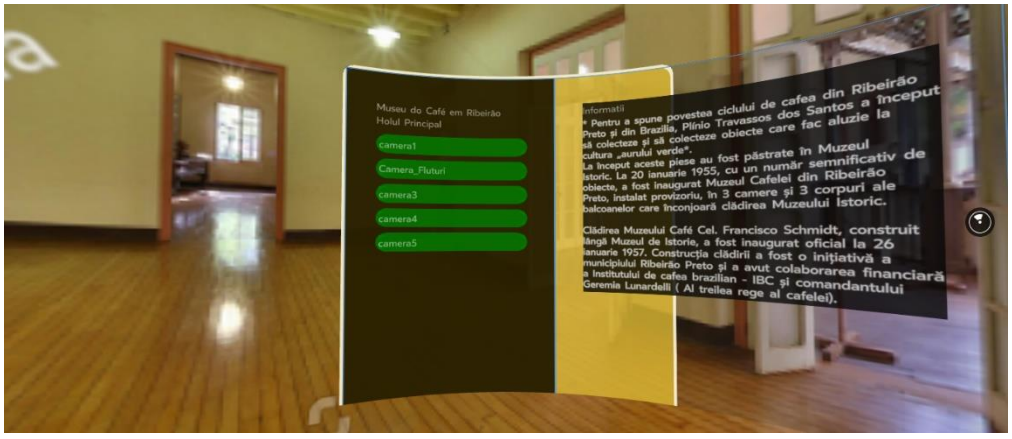

Figure 6. Example of room from the virtual museum

Figure 7. Another room type from the virtual museum

Two scenarios were run. The first scenario proposes a virtual tour in all rooms of the virtual museum. The second scenario is a random virtual tour.

The main benefits of using the virtual museum in the engineering education domain are the use of real equipment that exists in a technical museum that is transposed in a virtual museum, and the competences obtained by students when learning and using new software tools.

5 Conclusion and Future Work

The paper presented two educational systems that can be integrated in e-learning platforms or intelligent tutoring systems for teaching and learning Artificial Intelligence discipline. In particular, an air pollution analysis and forecasting system was developed by a student at his diploma project by integrating knowledge received at the course of Artificial Intelligence. Moreover, the student performed a comparative study between some forecasting models selecting the best one for final implementation of the system. The second educational system is a virtual museum developed also by a student at his diploma

project that integrates knowledge accumulated during a documentation process related to developing virtual museums with different tools and technologies that are free available. Both systems can be used as valuable educational resources by the students enrolled in the Computer Science program of study at Petroleum-Gas University of Ploiesti.

Future work include possible integration of both systems in the faculty e-learning platform and the evaluation of their efficiency when used by students during the learning process performed for the Artificial intelligence discipline.

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Enhanced Data Mining Application for Graph Database Management System

Valentin Pupezescu[1], Marilena-Cătălina Dragomir[2]

(1) Electronics, Telecommunications and Information Technology Faculty,
Polytechnic University of Bucharest
Bd. Iuliu Maniu, Bucharest, Romania
E-mail: vpupezescu[at]yahoo.com
(2) Electronics, Telecommunications and Information Technology Faculty,
Polytechnic University of Bucharest
Bd. Iuliu Maniu, Bucharest, Romania
E-mail: catalina.dragomir[at]protonmail.com

Abstract

The COVID-19 pandemic has many disruptions in society on multiple levels. The educational process is one of them. This paper will help students interested in the KDD (Knowledge Discovery in Databases) process to overcome the problems caused by the pandemic by enhancing our previous application with new functionalities such as graph oriented data storage solutions. The Database Management Systems (DBMS) that use the graph data model are becoming very popular nowadays because of the explosion of social media content or the data acquisition from IoT devices. With a graph oriented DBMS the students can discover hidden patterns in stored data. They can also achieve better control and security over stored data sets. Moreover, if the data has complex relationships, users can easily find associations between the interconnected nodes. This paper proposes a KDD application that mines in a graph oriented database. Three data sets were used in our experiments: iris, wine and conc (a concentric generated set of data). The goal of the application is to accustom students not only with data mining algorithm but to also deal with other steps from the KDD process such as: data preprocessing(data generating and structuring in a graph data model) and data transformation. In this application, the students will have the possibility to work with three neural networks: the classical multilayer perceptron, the pulsating multilayer perceptron and the autoresetting multilayer perceptron. This research will also pave the way for connecting the previous versions of the application with the IoT and edge computing fields.

Keywords: Elearning, Data Mining, Graph Oriented Database Management Systems, Machine Learning, Knowledge Discovery in Databases

1 Introduction

The biggest challenge of the Knowledge Discovery in Databases(KDD) research field is to find useful information among data stored in real Databases Management Systems (DBMS). The data can be structured or unstructured, with or without relationships between entities, with or without transaction support (Vukotic et al, 2015). For each mentioned

category, users can make use of different software solution of storing the data (DBMS): relational model, object-relational model (which supports the relational behaviour plus some object oriented features), non-relational model (also known as NoSQL). Although most of the people think at DBMS like MongoDB, CouchDB or Apache Cassandra when they refer to the non-relational (NoSQL) model, we consider that this approach is wrong because the non-relational model include all the data models that do not store and make use of relational model. Such models are: object oriented model, hierarchical model and graph oriented model.

This paper focuses on finding useful knowledge in data stored in a graph oriented DBMS (Neo4j) which (of course) follows the graph oriented model (Jordan, 2014; Kemper, 2015; Sonal, 2015; Kemper, 2015; Baton and Bruggen, 2017; Frisendal, 2018; Needham and Holder, 2019). This research will be used in the databases for scientific applications course in our university and aims to help students to better understand the multidisciplinary KDD research field.

The present eLearning application that was enhanced (version 1.3) adds support to the previous versions (Pupezescu, V., Dragomir, M., 2020) for the Neo4j DBMS.

2 Application Architecture

Figure 1 shows the architecture of the DM application that we developed. We made a centralized version of a Committee Machine (CM). In the future we will expand the application and make a full Distributed Committee Machine (DCM).

On the same computing node we run a Java TCP server that receives from the combiner module the initial setup parameters for the neural networks. Students will be able to setup the parameters and start the experiment. The module that runs the neural network will read the data directly from Neo4j DBMS and calculate the misclassification rate for a certain classification problem.

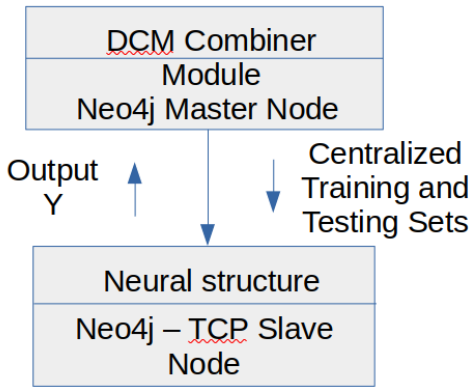

Figure 1. The implementation of DM application with the Neo4j DBMS

We used the same operating system (Ubuntu Linux 20.04) and programming language (Java) for the development of the application like in our previous versions. The implementation was made in Eclipse IDE. Besides learning to work with the Linux

operating system and with the Java programming language, the students will also learn to configure the Eclipse platform in order to connect to the Neo4j DBMS.

3 Data Preprocessing for the Neo4j DBMS

The first challenge for the participants to the laboratory is to import the data sets into the Neo4j DBMS. They will have two options in the virtual lab: first, to import the data from CSV files and second, to import the data directly from another DBMS.

To import data sets from CSV files, the students must first open from the Neo4j Desktop application and go to the Open section; they will open the Import section(Figure 2). This is the location where all the CSV files must be placed. The main classification problems that are available for the students in the application are: Iris1, Wine1 and Conc1 (Figure 3) data sets (https://archive.ics.uci.edu/ml/datasets/iris, https://archive.ics.uci.edu/ml/datasets/wine). Conc1 set is a concentric generated data set. Each data set will have two CSV files (for training and testing).

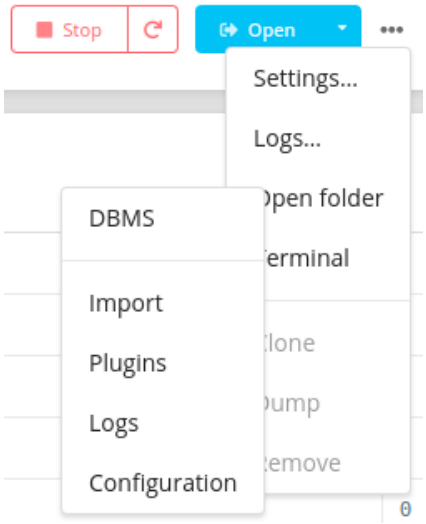

Figure 2. Import section for the CSV files

After placing the files in the import directory, the students must run the following command (we give example just for one CSV file):

LOAD CSV WITH HEADERS FROM 'file:///iris1trrtsr.csv' AS row WITH row WHERE row.IdEsantion IS NOT NULL MERGE (c:iris1trrtsr {IdEsantion: row.IdEsantion, NumeEsantion: row.NumeEsantion, t1: row.t1, t2:row.t2, t3: row.t3});

The second option for importing data is to use the Neo4j ETL Tool (Figure 4, Figure 5). This option is very valuable in case the data is stored in other real DBMS. In the example below we imported an entire database from the MySql DBMS to the Neo4j DBMS.

Below (in Table 1), we present the metadata for the main data sets stored in Neo4j.

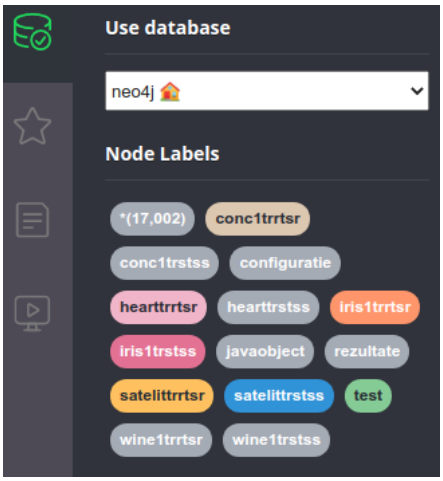

Figure 3. Available data sets for the classification task in the application accessed in the Neo4j Browser

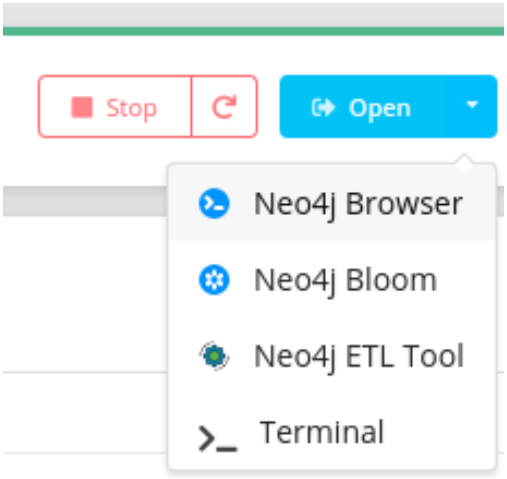

Figure 4. Neo4j tools

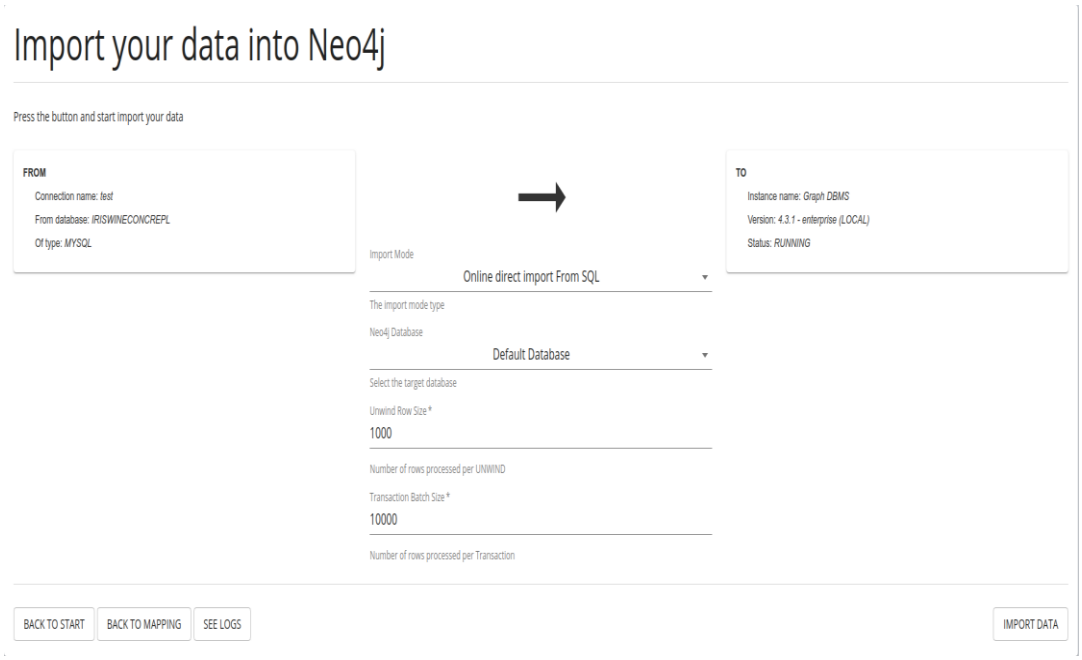

Figure 5. Importing data with the Neo4j ETL Tool

Table 1. iris1, wine1 and conc1 data sets (Pupezescu, V., 2016)

iris1	trr	tsr	trs	tss
Lines	100	50	100	50
Columns	3	3	4	4
wine1	trr	tsr	trs	tss
Lines	90	88	90	88
Columns	3	3	13	13
conc1	trr	tsr	trs	tss
Lines	200	100	200	100
Columns	1	1	2	2

As we can see below (Figure 6, Figure 7) the nodes are entities in the graph. In this case a node have a number of three important attributes (key-value pairs) called properties: IdEsantion, numeEsantion and t1. Besides these properties we have two more that were added by Neo4j when importing data: id, RowIndex.

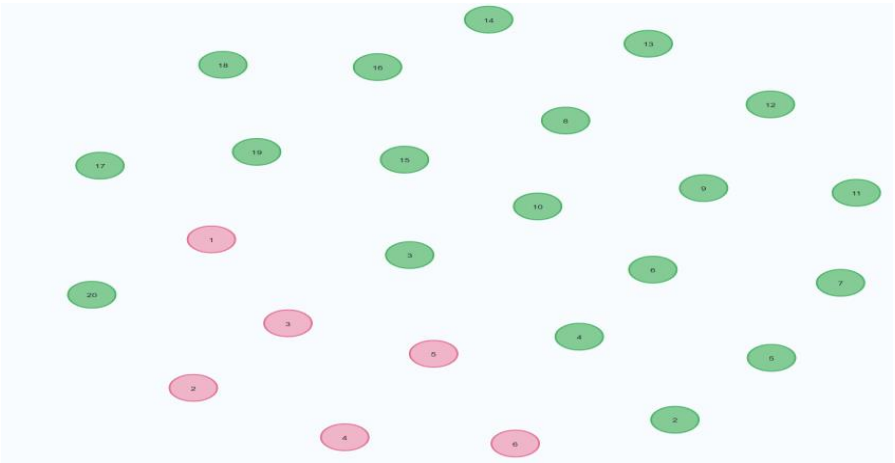

Figure 6. Sample data represented in the Neo4j Browser

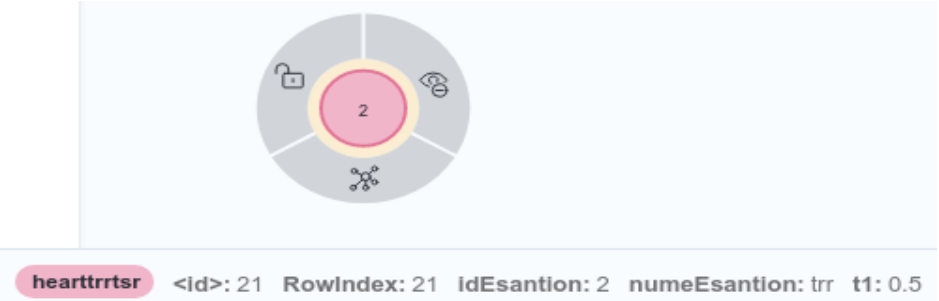

Figure 7. Detailed node information

Figure 8. The start_neo4j.jsp page

Another important observation is that in this case we do not have relationships (Figure 6). This is the case in many IoT applications were sensor data is stored in an independent manner. Although this might be considered a draw back (because we do not use the full potential of Neo4j) users can later add relationships between nodes to enrich the meaning of stored data.

4 Experimental Data Mining application – version 1.3

For this version of application, we added a new option in the application menu for the Neo4j DBMS. The students will have multiple options in the "start_neo4j.jsp" page (Figure 8): they can choose the type of multilayer perceptron, the classification problem and the neural network parameters (learning rate, number of training epochs, the number of hidden layers, network protocol for sending the data over the network, pulse etc.).

As we can see in Figure 9 (trimite_neo4j.jsp), we kept the option to send the configuration parameters to multiple distributed nodes for future development of the application. After this step, the students will press the "Run" button in order to send the initial setup parameters to the neural network compute module. Furthermore, they will press the "Continue" button for displaying the best classification results obtained by the neural network (Figure 10, Figure 11). In this experiment, we obtained the best missclasification value of 1.36% after 636 training epochs.

Figure 9. Setting the configuration parameters for the neural structure

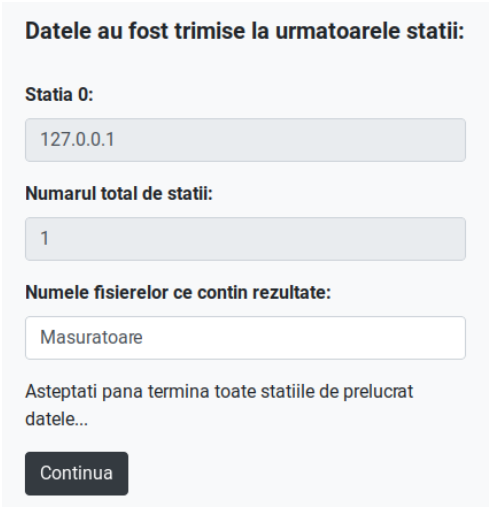

Figure 10. Acknowledgment for sending the startup configuration parameters

The results will be written also in excel files for the possibility of reconstructing past experiments by the students.

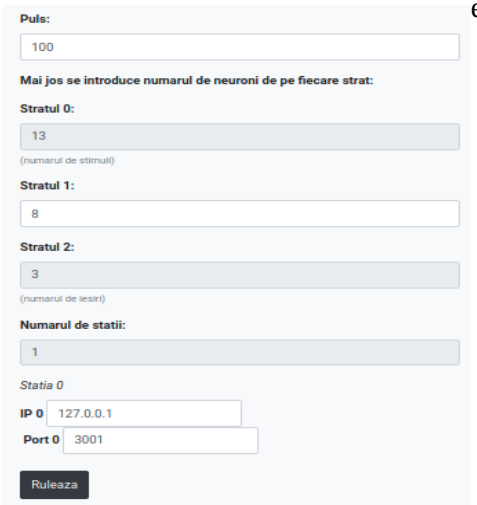

Figure 11. Centralized results for the wine classification problem

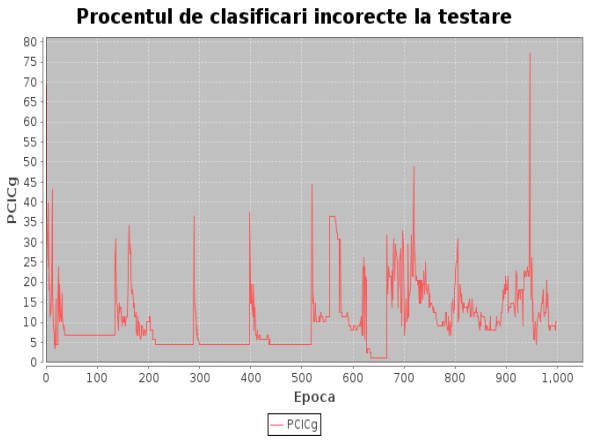

Figure 12. The final classification result

5 Conclusions

This paper presents the addition of support for the Neo4j DBMS to our previous application. Neo4j is a hugely dependable DBMS that offers scaling capabilities, great read and write speed, full transactional support (Vukotic et al, 2015; Needham, M., Hodler, A., 2019), cluster support and high availability with its implementations for the replication

process (Kemper, C., 2015). In addition, it has an excellent graph query language named Cypher (Sonal, 2015) that allows users to store and obtain useful information from the graph database.

The application helps the participants to study the steps of the KDD process. As it is known, these KDD steps are: data selection, data preprocessing, data transformation, data mining and data interpretation or the evaluation of the obtained information (Pupezescu, 2016). The developed application allows students to combine several fields of study such as: data preprocessing, working with data stored in graph-oriented databases and their processing using implemented neural algorithms.

The next version of our application will provide support for a Distributed Committee Machine with data stored in Neo4j DBMS. The application will enable the execution of multiple neural networks in a distributed topology in order to achieve better classification results on a given data set.

The work is important because research areas such as Data Mining, Machine Learning or IoT are constantly expanding. While the interaction between well known database management systems (such as MySql, Oracle, MS SQL Server etc.) and the data mining task is quite well studied, there are some DBMS (such as Neo4j) that can bring a lot of benefits to this research field.

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Interactive Elearning Application for Exploring the Latent Space of a Progressive Growing GAN

Marilena-Cătălina Dragomir[1], Valentin Pupezescu[2]

(1) Department of Applied Electronics and Information Engineering, Faculty of Electronics, Telecommunications and Information Technology, ETTI, Bucharest, Romania
E-mail: catalina.dragomir[at]protonmail.com
(2) Department of Applied Electronics and Information Engineering, Faculty of Electronics, Telecommunications and Information Technology, ETTI, Bucharest, Romania
E-mail: valentin.pupezescu[at]upb.ro

Abstract

The ongoing COVID-19 pandemic has caused the most severe global education disruption in history. With a focus on keeping the educational process moving forward, both teachers and students had to embrace the online learning platforms. In an effort to create a conducive online learning environment we continued enhancing our previous interactive GAN e-learning application by redesigning and extending it to include a pretrained Progressive Growing GAN model (ProGAN) that generates artificial faces. Our contributions include converting the pretrained ProGAN model from the Pytorch GAN Zoo toolbox to TensorFlow.js so that it can be run in the browser. We introduce the students to the concept of interpolation in the latent space for Generative Adversarial Networks and help them explore it. For this, we developed a section dedicated to visualizing the ProGAN latent space by performing a linear interpolation between two latent vectors. Every time the user accesses this section, two random images are automatically generated by the ProGAN model and are displayed in the interface. A range slider that variates between 0 and 1 allows the students control the interpolation degree between the two latent vectors that underlie the two images synthetically generated. After the user submits the "Interpolate" button, he can see the impact of the interpolation factor over the resulting image. We implemented a new documentation page in the web application that elaborates on the theory behind the ProGAN model and redesigned the existing interactive web application to organize the new content in an intuitive way that helps the students easily access and absorb knowledge regarding different types of Generative Adversarial Networks.

Keywords: Generative Adversarial Networks, Progressive Growing GANs, Latent Space Interpolation, Virtual Learning, Responsive Web Interface

1 Introduction

In this paper we describe our work for implementing an interactive interface that helps the students explore the latent space of a ProGAN model that generates artificial faces from latent vectors. We developed a web interface where the students can perform a linear interpolation in the latent space of the Progressive GAN and see the result of the interpolation operation between two random latent vectors.

1.1 Progressive Growing GANs

The Progressive Growing of GANs (ProGANs) architecture was introduced by Tero Karras et. al. In the paper "Progressive Growing of GANs for Improved Quality, Stability, and Variation" in 2018 (Karras, T., et. al., 2018).

The progressive growing training methodology described in the ProGAN paper (Karras, T., et. al., 2018), which consists in progressively increasing the number of layers in both the generator and discriminator networks during the training process (as described in Figure 1), resolves a problem that plagued the Generative Adversarial Networks since they were invented (Goodfellow, I., et. al., 2014): their challenging training process due to instability. This novel approach for the training process is highly effective at generating high quality images.

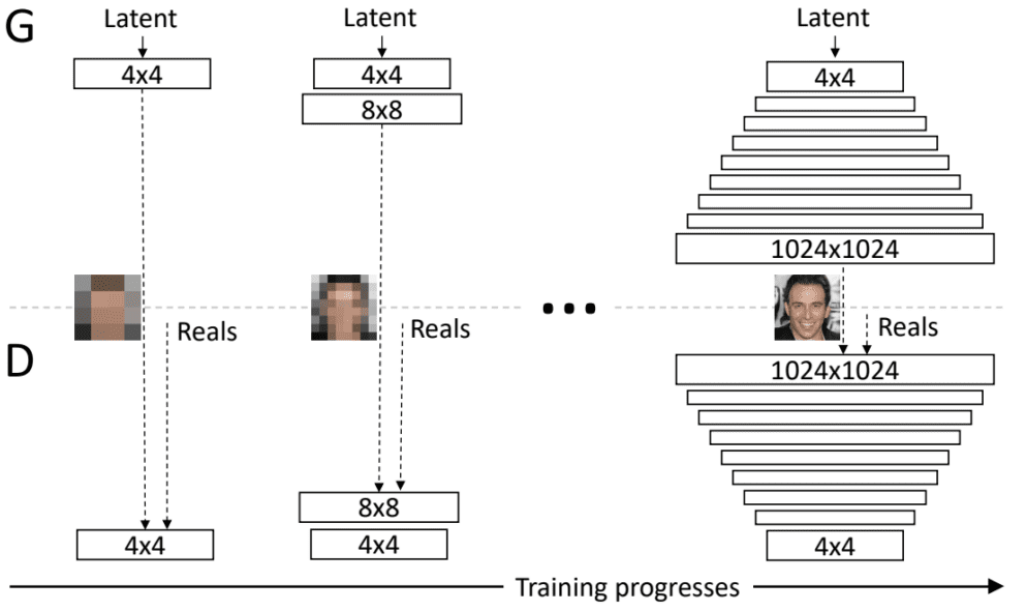

Figure 1. Progressively adding layers to Generator and Discriminator Networks (Karras, T., et. al., 2018)

The progressive growing technique involves the following major steps: progressively growing of models and layers, increasing variation using mini-batch standard deviation, equalized learning rate and pixel-wise feature vector normalization in generator (Karras, T., et. al., 2018).

Figure 2 illustrates phasing in the addition of higher resolution layers in both the generator and discriminator networks. The new layers are faded in smoothly to avoid shocks in the lower resolution layers which were already trained (Karras, T., et. al., 2018).

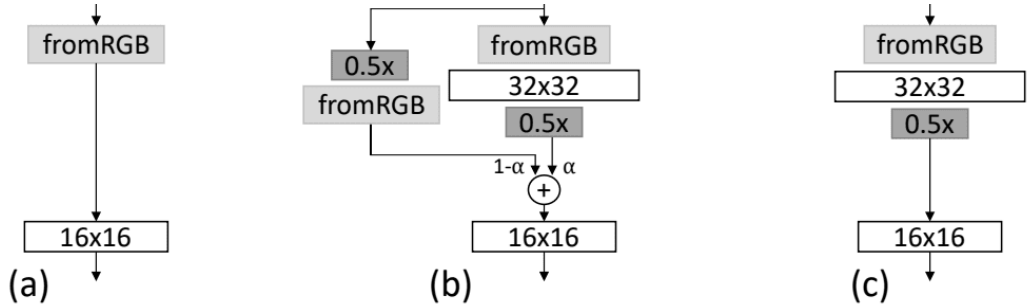

Figure 2. ProGAN: addition of new layers to the generator and discriminator networks (Karras, T., et. al., 2018)

1.2 Latent Space of Generative Adversarial Networks

During training, the Generative Adversarial Networks learn to map latent vectors from a low dimensional latent space to a high dimensional space. It has been of high interest for researchers to understand the non-linear spaces that are learned by the generative models and how the generative models bridge the points in the latent space to the semantic space in an image (Shen, Y., et. al., 2020). The latent space of GANs is typically treated as Riemannian manifold (Shao, H., et. al. 2018; Shen, Y., et. al., 2020).

2 Our work

In our experiments we perform a morphing transition between two randomly generated faces. In order to achieve this, we apply the vector arithmetic (Radford, A., et. al., 2016) described by formula [1]. Terms $\mathbf{z_1}$ and $\mathbf{z_2}$ are latent vectors, $\mathbf{z_1}, \mathbf{z_2} \sim \mathcal{N}(\mu, \sigma)$, μ, σ represent the mean and the standard deviation that characterize the normal distribution. They are the inputs applied to the ProGAN generator network.

The interpolation factor α weights the difference between $\mathbf{z_1}$ and $\mathbf{z_2}$ vectors and it variates in the [0, 1] interval. The resulting $\mathbf{z_3}$ vector is applied to ProGAN model for generating the interpolated image.

$$[1] z_3 = z_1 + (z_2 - z_1) * \alpha$$

Figure 3 reflects the synthetic face images generated by the ProGAN model when the interpolation factor α variates between 0 and 1. When α = 0, the resulting image is identical to the image generated when $\mathbf{z}_1$ is applied to the input of the ProGAN generator. Similarly, when α=1, the resulting image matches the image generated when $\mathbf{z}_2$ vector is applied to the input of the ProGAN generator.

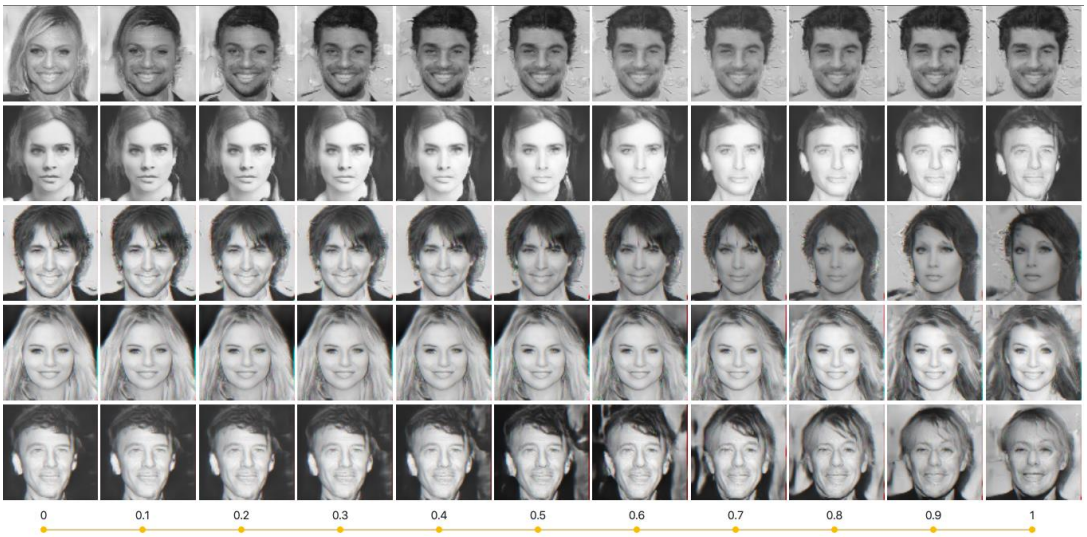

Figure 3. Image interpolation results

2.1 ProGAN model

In our experiments we used the pretrained ProGAN generator model from the Pytorch GAN Zoo toolbox trained on the CelebA-HQ dataset (Karras, T., et. al., 2018). In order to run it in the browser we needed to convert it to a model that could be loaded in Tensorflow.js. This conversion happened in several steps. First, we converted the model to ONNX (Open Neural Network Exchange) format, then, we converted the .onnx model to a protobuf file (.pb) to be used in TensorFlow. A new conversion was needed to convert the protobuf file to a model that could be loaded in TensorFlow.js. For this, we used the command line utility from the TensorFlow.js converter (tensorflowjs_converter).

2.2 Interactive application

We redesigned the existing interactive web application to enhance the user experience and we reorganized the content in an intuitive way that helps the students easily access the content. We also included a new section under the documentation category to expand on the Progressive GAN theory.

We extended the Applications section by developing a new interactive section dedicated to visualizing the ProGAN latent space. We used the TensorFlow.js library for running the ProGAN generator model directly in the browser.

The students can explore the latent space by performing a linear interpolation between two random latent vectors. Every time a student accesses this section, two random images (*Output image 1* and *Output image 2* from Figure 4) are automatically generated by the ProGAN model in the background and then they are displayed in the webpage. The students can variate the interpolation factor between the two latent vectors from where the two images were generated by using a range slider that variates between 0 and 1. After the student submits the "Interpolate" button, he can see the result of the interpolation operation reflected by the *Interpolated image*, as illustrated in Figure 4.

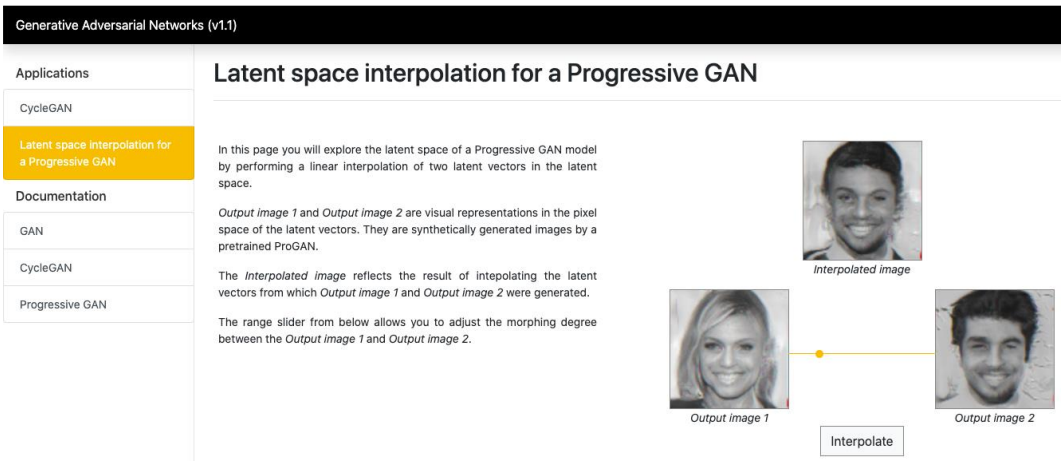

Figure 4. Application section

3 Conclusions

In this paper we emphasized the key points that underlie the progressive growing training methodology behind the ProGAN model and we briefly introduced the notion of latent space in the context of the Generative Adversarial Networks. Next, we presented the key formula that we used for the interpolation operation. Then, we described the steps performed for converting to TensorFlow.js the Pytorch ProGAN pretrained model from Pytorch GAN Zoo toolbox. The next section highlighted the interactive application dedicated to visualizing the ProGAN latent space by performing linear interpolation between two latent vectors randomly sampled from a Normal distribution.

In the next version of this interactive web application we will expand it to allow the students perform various experiments in the latent space of the GANs by modifying the parameters that impact the latent vectors (e.g the distribution from where the latent vectors are drawn). In the future we will also extend it to include more applications in the field of Generative Adversarial Networks.

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Illegal Landfills Detection by Educational LoRaWAN Electronic Markers

Krum Videnov, Vanya Stoykova, Miroslav Vasilev, Antoaneta Dimitrova

Trakia University, Faculty of technics and technologies,
38 Graf ignatiev str., 8602, Yambol, Bulgaria
e-mail: adimitrova77@abv.bg

Abstract

The educational IoT technology works together with many integrated smart devices and applications, which facilitates the detecting and operating from everywhere. It is regarded as one of the solutions for ease monitoring of places. IoT-based applications perform navigating and tracking of devices, vehicles, humans, or animals, then transmit data to the cloud, to mobile device. Short-range communication technologies (such as Wi-Fi, Bluetooth) have issues - coverage limitation, high power consumption, which are not suitable for some specific IoT applications, i.e., unofficial tracking of company trucks. Thus, LoRaWAN technology differs as a promising communication method to take this place as smart monitoring system for garbage trucks, illegal landfills. A case study was provided that demonstrate practical applicability of LoRaWAN technology in garbage tracking systems. After discussion of the results, guidelines were given for the practical application of this system in the subject area. Also, the proposed tools can be used as methods and methodologies in training of engineers in IoT and low-cost computer networks.

Keywords: Low power, waste management, wireless sensor networks, Smart cites, Geolocation

1 Introduction

With the term observing we allude to arrangements pointed toward following or geolocating vehicles that for the most part visit and dump squander in uncontrolled waste dumps. Utilizing LoRaWAN electronic markers, covered up with squander compartments, we distinguish the following uncontrolled landfill site, however we can discover who fills it and while, applying the significant proof (guide of the city worker, photographs on the waste dump). With enlisted directions can plan illicit garbage removal destinations in the area.

Uncontrolled and poor waste administration rehearses are inescapable. Illicit unloading destinations are made predominantly because of the absence of information and common obligation. Unlawful garbage incorporates things like development and destruction materials, asbestos, substance drums, furniture, garden squander, family trash, beddings, TVs, tires, homegrown machines, plastic (Shivacheva et al., 2016).

This illicit waste is ordinarily kept on the land surface illegal and in an uncontrolled manner, causing land debasement. These destinations are on specific danger to the surface layers of soils, because of the infiltration of hurtful substances gathered in the stored squander into the dirt, underground waters, emanation of gases; risk of fire and so forth Explores have shown that the presence of contamination additionally contrarily impacts upon human wellbeing, especially where there is drawn out immediate or roundabout contact with perilous waste (Biotto et al., 2009).

Generally, these are locales found near singular structures, unfrequented spots, yet additionally discard, streams, woodlands and regions covered with shrubs. Contamination, exhaustion of water assets, making the critical harm greenery or fauna, ranger service or agribusiness, fish stocks involve criminal obligation. Expulsion of unlawful dumps conveys an expense (Podevijn et al., 2018) and makes it important to complete remediation. The aim of this paper is to analyze and check the plausibility of the proposed approach for Illicit landfills location in a genuine world testbed.

2 Related works

GPS is required to determine the location of the moving waste truck. Among the alternative communication technologies are GSM, RFID, ZigBee, WSN, 3G, 4G, 5G, etc. (Zolich et al., 2018). These technologies have many monitoring drawbacks (Sanchez-Iborra et al., 2019): less energy efficient, higher cost, short-range communications, and frequent disconnection of the wireless link.

As (Manzoni et al., 2019) reviewed, “in its basic implementation, geo-localization involves the generation of a set of geographic coordinates and is closely related to the use of positioning systems”. The Global Positioning System (GPS) is probably the most widely known. However, in many cases GPS may not be the best choice. Other options are necessary for indoor applications where the GPS signal would be weak, or “blocked by thick, solid materials as brick, metal, stone, wood”, or in battery-powered sensors where low power consumption is critical (Want et al., 2018).

Solutions based on LoRaWAN are adequate for use cases where precise location is not need, but battery life and cost are important. LoRaWAN networks “can locate devices without GPS, using fewer radio communications signals”. LoRaWAN supports geolocation without any hardware dependency using Received Signal Strength Indicator (RSSI) or Time Difference of Arrival (TDOA) algorithms from 200 m to 20 m accuracy. The resolution of the system is highly depended on the gateway deployment density. At least three gateways are enough to determine the location of the end-node.

The non-GPS proposal “is based on the use of the multiple associations that a LoRaWAN node can establish with surrounding gateways”, as (Manzoni et al., 2019) say. According to the standard, all GWs receiving a packet coming from a LoRaWAN node forward it to the controlling network server. Data from the network server can be obtained using various APIs (Application Programming Interface) and we will take advantage of this feature. The network server provides in the form of metadata the various details of the data channels and the gateways where the packet got through. A critical condition for this solution to work is that in any position inside the monitored area the client must have connectivity with a minimum of three gateways. The LoRaWAN architecture directly

provides complete information about the gateways that received the packet sent by the client device and the strength of the signal (RSSI) with which it was received (Manzoni et al., 2019). With such data can be applied the localization algorithm. This solution for determining the localization of a client is based on trilateration.

Geolocation with LoraWAN can be used "to locate vehicles of any type, trace the garbage trucks as they move, send an alert if a driver or an object moves outside a defined area". In this case, the LoRaWAN client will be (mostly) located in the bowels of a massive metal truck, passing through additional obstacles affecting the range of coverage, such as industrial setting, underground car parks, tunnels, tall buildings, etc. For our assessment we analyzed literature sources, which have measured values of RSS, PDR at LoRa GWs.

Trilateration is a geometry-based method that identifies a location by measuring distances to some known reference points, the satellites in the case of GPS.

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3 A case study of LoRaWAN-based garbage tracking system

This project aims to evaluate the performance and capability of a LoRa-based tracking system. The system is tested in urban and suburban areas. The upcoming experiment consists of a scenario with a static LoRaWAN Gateway also acting as a transmitter to data collection server and a LoRa-enabled mobile client user (garbage truck with LoRaWAN).

Dragino LoRa/GPS Shield is an expansion board for LoRa/GPS to be used with the Arduino.

The garbage driver will determine its location periodically using a GPS localization and transmit to the monitoring system via LoRaWAN technology.

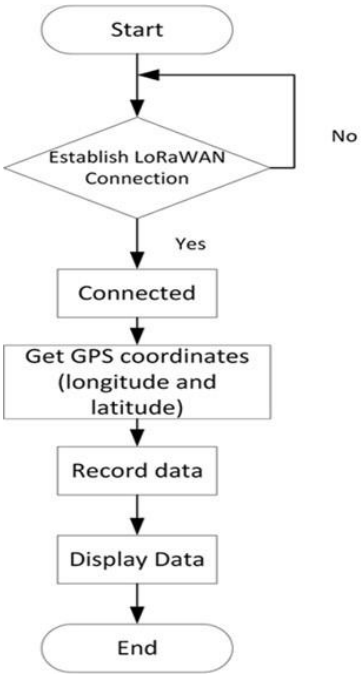

Figure 1. LoRa-Tracking Flowchart.

Figure 2. Visualization of garbage tracking trajectory, picture Google earth (Google Inc.)

Figure 1 shows that both LoRa devices (node and GW) initially begin with establishing their contact with each other (exchange greetings). The LoRa tracking system is monitoring the path while waste truck is moving (Figure 2).

Once they are connected, the LoRa client will read its position coordinates from the GPS module and transmit this information to the LoRa gateway via LoRaWAN. The LoRa GW will then save this location data (longitude, latitude) in its server to be displayed online on map. LoRa gateway is stationed at a particular location while the client node is travelling from one potential landfill (destination) to another. The devices will be tested on the various condition and places. The data is collected and recorded through The Things Network (TTN) and AllThingsTalk.

Arduino must be properly registered with The Things Network (TTN). The LoRa gateway will then retransmits these locations to the TTN server. Registration in TTN is done by choosing an "Application" in https://console.thethingsnetwork.org/. Next "Add Application -> Register Device".

On the next page fills in the "Device ID" field with unique name for the client device. "Device EUI" and "AppKey" are randomly generated here.

Integration between TTN and AllThingsTalk will visualize the current position of our moving truck with mounted marker. AllThingsTalk (ATT) Maker is a developer platform for data collecting and data using.

To enable our data to arrive in ATT Maker, we need to integrate TTN and Maker. Integration set up: in TTN, we select the "Integrations" tab, click "Add integration", select the AllThingsTalk Maker.

In http://maker.allthingstalk.com a new device must be connected: go to Devices, choose "New device" button -> under LPWAN devices, chose "Your own LoRa" -> chose "The Things Network" label. Don't forget to provide an Application ID and a Device EUI from our Device in TTN console and click Connect. The node still can't send its values over TTN to our account in ATT Maker, until we add a "New Asset" for it. We choose a "Sensor", give it some name. For Profile type designate "Location", because want to display geolocation data and click "Create asset".

Now the data sent from our device is received by TTN, which retransmits to ATT Maker. AllThingsTalk visualizes the tracking coordinates on map (Figure 3).

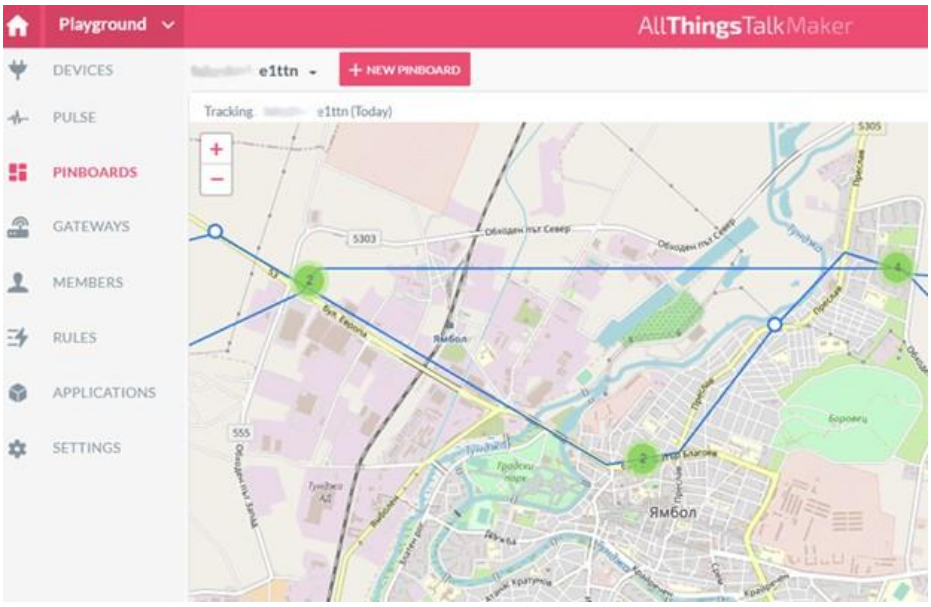

Figure 3. Tracking garbage vehicle with marker on ATT map

Now we can test if the LoRa data arrives in ATT Maker by sending it from TTN console (Simulate Uplink). One of the payload formats ATT Maker understands is CBOR. The message format which AllThingsTalk uses for CBOR is:

{"<asset name>": <value>}, our example: {"Ictte20": { "lat": 42.5027, "long": 26.5281 }}.

4 Discussion

Insufficient studies have been conducted over the past years concerning techniques to transmit, monitor and visualization of remote sensing data for geolocation. Even more, we experimented tracing the route of waste and marking on map waste disposals (potentially illegal).

We compared different research for positioning methods with LoRaWAN.

In this report are considered localization techniques (GPS or GPS-less) and algorithms like TDoA, RSSI. RSSI is preferred to TDoA for this goal because researchers, focused on real devices, explain that not all client devices nor all gateways can provide a proper estimation of the TDoA values.

The RSSI value is shown to measure the signal power received from the client. No matter which method is chosen (LoRa with or without GPS, with RSSI, TDOA or other), the developed prototype must be tested both in urban and suburban areas. This testing, evaluate the performance of LoRa technology in determining the efficiency of its long-range transmission at different settings. We performed such an experiment, supplemented with a simulation. A connection has been made by an end node to GW, connected to TTN.

From static, while the module is in the trash bin, its latitude and longitude will begin to change dynamically.

The end point, at which the garbage truck dumps its contents, is easily recognized by the return of static, unchanging coordinates for a long period of time.

At this point, a team must visit the regulated or unofficial landfill to document the location photographs, and also, if possible (if not buried deep, if no legal restrictions in the access to private areas), to pick up the clients' module installation for the next investigating course.

5 Conclusion

Degradation of soil, groundwater and air can occur in the illegal landfills and surrounding sites. Using live measurements and simulations, we performed LoRaWAN tests that confirm a LoRaWAN client can be accessed inside a steel truck's bowels and successfully to transmit its location data (latitude, longitude, altitude, ToA, etc.) to the LoRaWAN's gateways. Then we visualized and traced obtained coordinates by integrating TTN and ATT Maker.

Our research is divided into two directions: LoRaWAN technology coverage, quality, building, obstacle penetration and at the same time, we considered LoRaWAN's network as a positioning method. The described in this work simple LoRaWAN projects can be used as a cheap, but effective modules for tracing the path of garbage trucks (or other vehicles) and locating the uncontrolled landfills they use as an end point for the waste they carry.

We selected and compared two variants of locating systems – for GPS tracking and Non-GPS tracking, both based on LoRa.

Evaluated their performance and capability in urban and suburban areas. One of the main drawbacks of GPS systems is that they cannot work satisfactorily indoors. When inside, there is often no direct line from the satellite signals to the device, being blocked by thick, solid materials.

The client-vehicle must remain visible in any condition, including in indoor conditions (like underground car parks, city tunnels, routing of heavy vehicles within an industrial environment is another possibility which cannot be covered with a GPS based solution). Since GPS modules are energy hungry and have additional hardware costs, LoRaWAN's builtin geolocation functionality becomes an efficient alternative.

Through trilateration localization algorithm, combined with LoRaWAN channel, the localization of a garbage vehicle, landfill can be obtained within a 40m range.

The main advantage of the Non-GPS LoRaWAN solution is its low cost and clearly the possibility of operating indoors. The resolution of the system is highly depended on the gateway deployment density.

This proposal is based on the use of RSSI of the signal perceived by various surrounding gateways.

We analyzed literature sources, which have measured values of RSS, PDR at LoRa GWs. Simulated tracking of ground positions with dynamic visualization on map online.

There are work and investigations to be done, for better precision can be obtained. It is also suggested to use a smaller module and battery pack to implement a smaller but compact prototype. The proposed tools can be used as methods and methodologies in training of engineers in IoT and low-cost computer networks.

Acknowledgments

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Section Intel® Education
Innovation in Education and Research

Using Conceptual Maps and Free Open-Source Applications for Seismology Studies at High School Level

Fabiola-Sanda Chiriacescu[1,2], Bogdan Chiriacescu[1,2], Cristina Miron[1], Valentin Barna[1], Cătălin Berlic[1]

(1) University of Bucharest, Faculty of Physics, Atomistilor, Magurele, Romania
(2) Theoretical High School "Nicolae Iorga", Nehoiu, Romania
E-mail: fabichiriacescu@gmail.com, b.chiriacescu@gmail.com, cmiron_2001@yahoo.com, barnavalentin@yahoo.com, cberlic@gmail.com

Abstract

Seismic phenomena have a considerable impact on our daily life. In this paper, we show an investigation based learning (IBL) way of study basic knowledge of seismology using as the main instrument the conceptual map. The maps were built by means of Cmap Tools and we attached visual materials, practical applications, animations. The maps and the adjacent materials were built using free and open-source software. The animations were created using Tupi and Kdenlive programs and Whiteboard Animation technique. They illustrate relevant examples and integrate the visual message in the teaching process. Visual materials consisting of images and graphics were realized using the Inkscape program. Practical applications made with Geogebra allows for practical determination of the earthquake parameters. Scientific investigation of earthquakes can be used both in face-to-face classes and online ones while addressing high-school students during Physics classes. It can be successfully employed as an application of mechanical waves or as a standalone subject for optional courses. The presented method is an interactive one and helps to connect theoretical notions with natural phenomena, evoking previous knowledge and linking it with new ones, while developing critical thinking.

Keywords: Physics Education, Conceptual map, Seismology, IBL, Online teaching

1 Introduction

Seismology is a branch of Physics that is less studied at high school level. The lack of scientific-based knowledge can lead to wrong perception of seismic phenomena and unwished reactions in case of earthquake occurrence. Young people can be victims of misinformation and prejudices spread by media or online news if they do not have the basic knowledge for critical analysis of the information (Chiriacescu et al, 2019a; 2019b; Shiba et al, 2020). The need for analyzing these phenomena leads to some educational projects to involve the students in the study of earthquakes, especially in the regions affected by this kind of events (Shiba et al, 2020; Tataru et al, 2016; Saraò et al, 2016). Progress was made

in different countries by integrating seismology in schools through various projects, by suggesting websites that contain useful materials/information from the studied domain.

A conceptual map is a hierarchically organized cognitive structure that allows a logical arrangement of the notions from a certain domain. It is an instrument that connects previous knowledge by visualizing information and organizing ideas, which leads to interactive, pertinent and structured learning. (Aşıksoy et al, 2019). Using a conceptual map allows students to identify and make connections among scientific notions, to organize and summarize information and to create connections between them. (Pangestuti et al, 2017). Literature emphasizes the efficiency in using conceptual maps for Physics teaching. It highly improves the understanding of the notions while developing critical thinking, leading to acquiring of knowledge, creating an IBL based environment. (Hagemans et al, 2013; Dmoshinskaia et al, 2020; Chang et al, 2016). A conceptual map can be used in all the stages of the teaching process: teaching to introduce new terms and correlate with those already known; in learning to adapt the notions to the personal learning style; in evaluation to check the correct understanding of terms and the connections among them. (Hidayati et al, 2018; Gijlers et al, 2013). The conceptual map has two main categories of content: concepts and statements. The concepts are in text boxes and can be represented by words, short sentences, even mathematical expressions. They are linked by lines or arrows that include connection words and that lead to statements. The notions that are included in a conceptual map have a defined hierarchy, starting from the fundamental ones to the secondary ones, examples, applications etc. (Chiriacescu et al, 2019c; Chiriacescu et al, 2020; Kinchin et al, 2019).

In this paper, we mainly employed Cmap Tools software that is a free and open-source program which runs under any operating system (Windows, Linux, MacOS) and provides the possibility to work in the cloud, to share the project and to work in teams. To help a better understanding of the presented notions, the software allows links to a large range of resources: documents, simulations, animations, videos, interactive apps, online resources, even other conceptual maps. (Chiriacescu et al, 2019c; Chiriacescu et al, 2020). The program features allow the use of conceptual maps during online classes - a welcomed opportunity in the context of the sanitary COVID crisis that occurred in 2020 and that requested an increased level of practice for this kind of materials and didactic instruments. Therefore, an accelerated rhythm of construction of this kind of tool is highly benefic. We present a way of studying elementary notions of seismology using an IBL approach. The employed main didactic instrument is the conceptual map, yet alongside it simulations and animations can also be found. The teaching fashion is constructed in such a way to be useful both during face-to-face classes and during online activities as well.

2 Elementary seismology notions presented using a conceptual map

As mechanical waves, seismic waves represent a very interesting domain for the students. They are natural phenomenon with major impact on daily life, especially for those that are living in seismic active regions. In this respect, using conceptual maps is very appropriate since the notions are interrelated and interconnected. The tool allows the logical ranking of the presented concepts and underlying the connections between them. Aside from that, IBL learning is possible. The students can explore the presented ideas in their own rhythm, to

discover and grasp the given information. The teacher becomes a facilitator of the learning process – he/she will have to carefully supervise the learning process, in order to clarify ambiguous things, to provide extra explanations when necessary and to adjust wrong interpretations that can occur due to a superficial approach to the investigation theme.

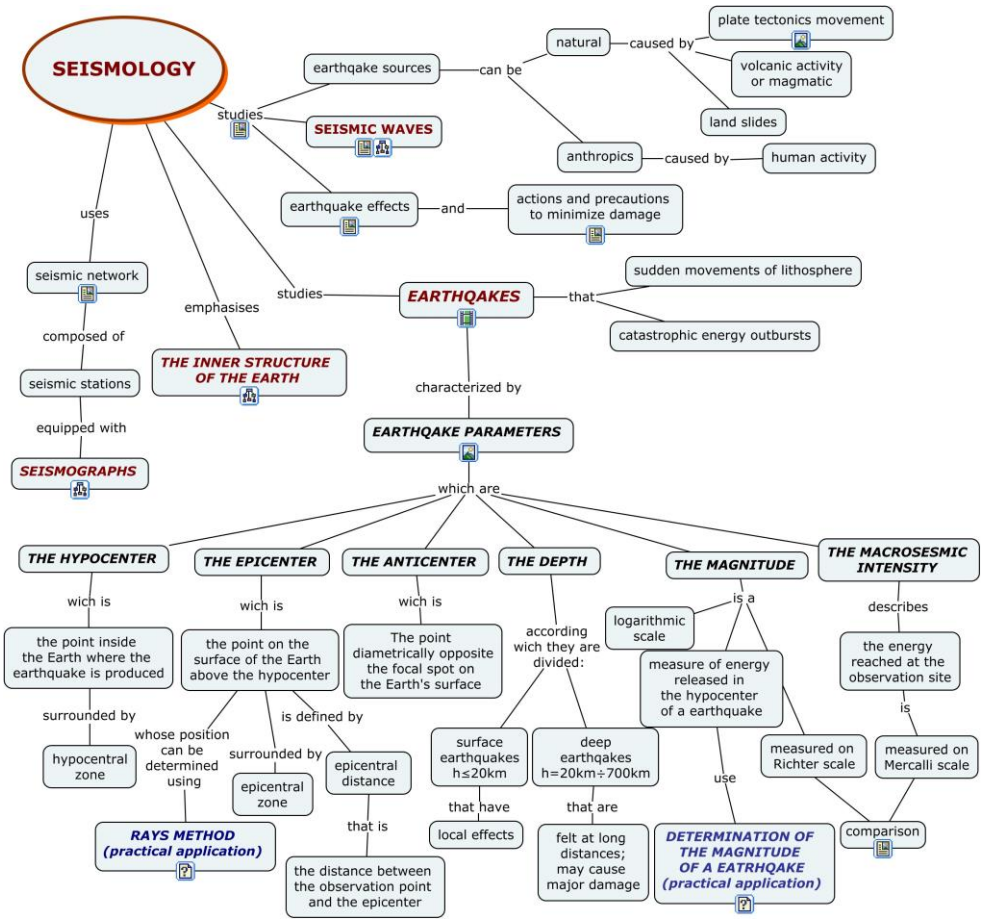
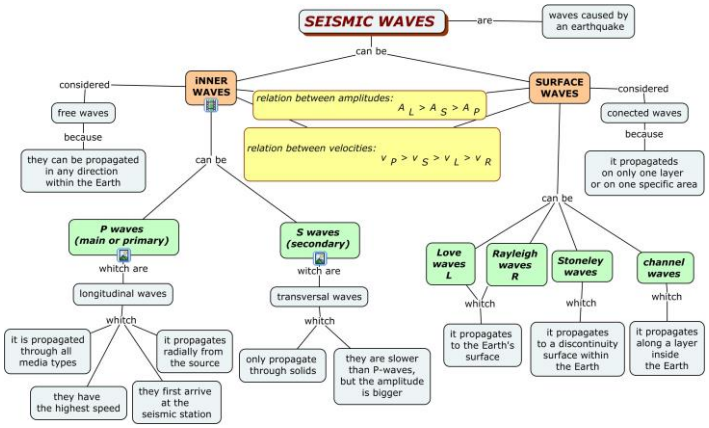


Figure 1. Introductory conceptual map for the study of basic elements of Seismology using IBL

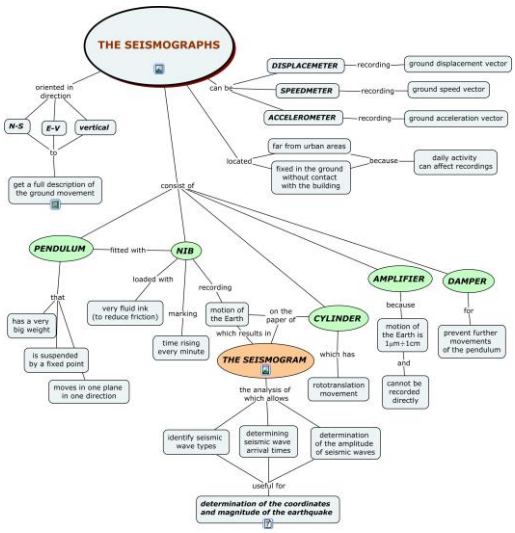
The teaching instrument design is based on a main conceptual map (Fig. 1) that have links to another three secondary conceptual maps, coming with details of specific notions and to other resources that specifically present seismic phenomena. The main map's beginning point is the title "Seismology" and, for start, it defines the main related terms: it shows the purpose of the domain, which are the employed instruments and explains the necessity of studying this domain. The core study subject is represented by earthquakes and, therefore, the characteristic parameters are defined.

For the most common earthquake's parameters, the epicenter and magnitude, two practical applications built with Geogebra software are also attached: *"Using the ray method to find*

the epicenter of an earthquake" (Chiriacescu et al, 2019b) and "*Finding the magnitude of an earthquake*" (Chiriacescu et al, 2019a). These applications make the students to assume the role of seismologists and determine the earthquake's variables.



a)



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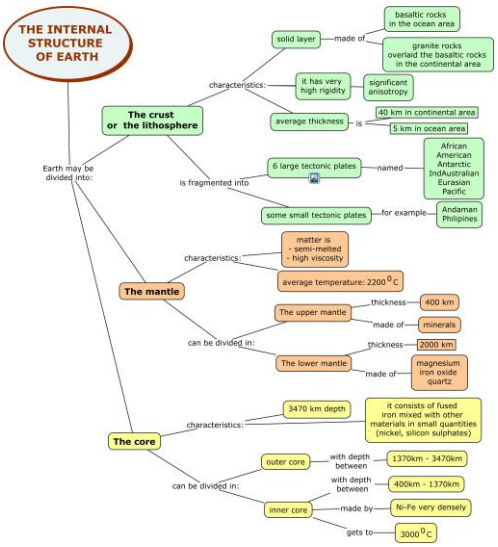

c)

Figure 2. a) Conceptual map that explains seismic waves; b) Conceptual map with information about seismographs; c) Conceptual map detailing the internal structure of the Earth

The seismic waves represent a key notion for the domain. There are many details to explain, as a result, we chose to build a secondary conceptual map, linked with the main one (Fig. 2a). We can find here information about the types and characteristics of seismic waves

alongside with the connections among different seismic waves. Another derived conceptual map is about seismographs (Fig. 2b), the main instruments used to investigate seismic movements. Herein, are underlined different models of seismographs, their components, and their role in a seismic station. Finally, from the main page, we can find a link to a third conceptual map. It illustrates the internal structure of the Earth, as it was determined by studying the seismic waves (Fig. 2c). In each of these conceptual maps, the main one included, we can find links to different materials that help discovering and furthermore explaining the presented notions. There are many categories of resources. Most of them are original materials made by the authors, yet some classical ones can be found as well. The latest are taken and adapted from the specialty literature or from websites of several institutions.

3 Original materials created to explain basic notions

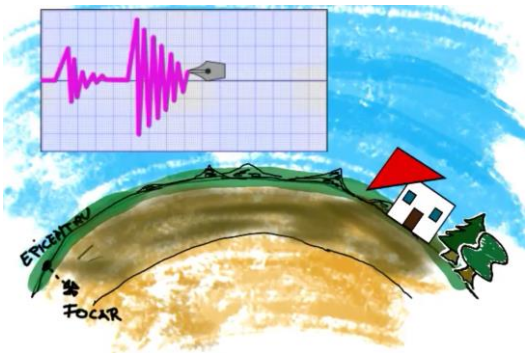

Figure 3 „Earthquake" animation made with Tupi

The "Earthquake" animation was made by means of TupiTube, free and open-source software used for developing 2D animations (https://tupitube.com/index.php?r=dashboard%2Fdashboard). This animation presents the way in which the internal seismic waves travel inside the Earth and reach a certain seismic station. The station's building is affected by the earthquake, showing that the secondary (S) waves have a bigger impact than the primary (P) ones. At the same time, while the seismic waves travel, one can analyse the recording process of the corresponding seismogram. This way, we can correlate the propagation of the seismic waves with the way of recording and the perceptible effects that follow.

More video materials are prepared using Whiteboard animation. They are underlying two important aspects of an earthquake event. One of the animations, "*Measures in case of an earthquake*" (Fig. 4a), shows what should be done before, during and after an earthquake, to increase the persons' safety level. The second whiteboard animation is represented by "*Richter vs. Mercalli*" (Fig. 4b). It illustrates a comparison between Richter and Mercalli scales, the main scales for the magnitude and macro seismic intensity of an earthquake. The purpose of this animation is to give students a clear image of the influence that earthquakes of different magnitudes and intensities can have, while presenting the differences between magnitude and macro seismic intensity.

The animations are dynamic; the visual message is built step by step during the narration of the storyteller. The technique has a high impact, this way, the information being much easier to understand. The animations were made by drawing on a Genius MousePen I608X. During the drawing process, we made a screencast. The narration was recorded using the laptop's microphone, while the video and audio materials were edited using Kdenlive program (https://kdenlive.org/en/).

a) Measures in case of an earthquake b) Richter vs. Mercalli

Figure 4. Animations prepared using the Witheboard Animation technique

The pictures were created using the Inkscape (https://inkscape.org/) vector graphic software. These are both original ones and adapted from literature. Images, such as types of waves, internal structure of the Earth, seismograph and its parts etc. can be found.

The applications built by means of the Geogebra software are designed for students to experiment how to read a seismogram and to find parameters of an earthquake. Two methods are attached:" Finding *the epicentre of an earthquake"*(Chiriacescu et al, 2019b) and *"Finding the magnitude of an earthquake"*(Chiriacescu et al, 2019a). Both applications are interactive and easy to use by the students. They are intuitive and the employed mathematical apparatus is quite basic. Knowing the fundamental principles of finding the earthquake parameters leads to an increased interest in the topic and the study of natural phenomena.

4 Conclusions

Seismology is a complex field of study, even when is reviewed at its basic elements. Specific notions are plenty and tightly interconnected. Conceptual map proves to be a valuable tool for studying this topic since it allows for a graphical representation that helps to underline, rank, and interconnect the studied notions. It also consents to the inclusion of examples and of practical, interactive activities, helps to arrange the information in an intelligible way. Moreover, the scientific investigation approach develops important abilities and competences such as critical thinking, computational competences, and participative study, therefore increasing responsibility to one's learning process. The method is student focused and is an effective alternative to lectures that can be boring and hard to follow because of the large quantity of the delivered information.

Another advantage of the presented instrument is that it can be easily applied both during face-to-face classes and in online teaching. In building the materials, we used free software that is running on many operating systems and devices. In this way, we ensure access to the knowledge without the need for sophisticated and expensive hardware resources. All the applications can be distributed through a cloud system and included in the activities specific to classroom systems. In this way, we ensure easy access for all the students to the materials, regardless of conditions – face-to-face or online teaching – which helps the learning process.

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The Garage Paradox Presented by Means of Whiteboard Animation

Bogdan Chiriacescu[1,2], Fabiola-Sanda Chiriacescu[1,2], Cristina Miron[1], Valentin Barna[1], Cătălin Berlic[1]

(1) University of Bucharest, Faculty of Physics, Atomistilor, Magurele, Romania
(2) Theoretical High School "Nicolae Iorga", Nehoiu, Romania
E-mail: b.chiriacescu@gmail.com, fabichiriacescu@gmail.com, cmiron_2001@yahoo.com, barnavalentin@yahoo.com, cberlic@gmail.com

Abstract

Whiteboard animation is a teaching method that can help explaining complex Physics notions by presenting the fundamental concepts through significant images. The Special Theory of Relativity (STR) is a chapter in Physics that in order to be well understood needs completely new perspectives on notions previously considered invariable: notions as simultaneity, periods, distances, inflexible in the frame of classical mechanics becomes relative in STR. That's why teaching introductory notions of STR at high-school level is a difficult task, a real challenge for the teacher. One must appeal to the students' imagination, creativity, abstract thinking capacity and thinking maturity when thinking out of the box is just at the beginning and, in many cases, just a wish. Therefore, whiteboard animation is, at this point, a useful tool in teaching the STR process: the method comes with simple vocabulary and an image language that can easily be understood by the students, with a catching story for getting the attention, with Physics notions presented conceptually, using intuitive examples. In this paper, we show how one can present the garage paradox by means of a Whiteboard animation. The garage paradox occurs from the difference between dimensions of moving bodies due to Lorentz contraction. Bodies that have the same length in their own frame of reference might be different from another point of view.

Keywords: Physics education, Relativity, Whiteboard animation, Lorentz length contraction

1 Introduction

Since its issue, the Special Theory of Relativity (STR) (Einstein, 1905) was the source of many discussions and paradoxes. The main reason is that our thinking is set on the classical vision of time and space (Ferraro, 2007). Einstein's postulates lead to a series of apparent paradoxes, such as the relativity, simultaneity, or the twin paradox as a consequence of time relativity (Langevin, 2016). Space also is affected by high speeds. To describe space relativity in a flexible way, we can appeal to the car and garage paradox or to its many versions (Rindler, 1961; 1962; Crowell, 2006; Ferraro, 2007; Brown, 2014). To present the

problem simply, we have a rigid body (that can be a rod, a ladder, a car, or a train) that approaches to a garage with high speed. Even though while standing both the body and the garage have the same length, the situation changes when the body is moving with relativistic speed: from the garage point of view, the body appears shorter, so it will eventually fit well inside the garage. On the other hand, from the body point of view, the garage is moving, so it will appear shorter. Due to this effect, the body will not fit inside the garage (its length will be bigger in this situation). This is the core of the paradox. Solving this kind of problem means a completely new approach to the notions, rethinking some things that we are taking for granted due to their daily occurrence. Even though a difficult task, presenting and solving this kind of puzzle leads to an increasing interest of the students for the theoretical study of Physics notions (Brown, 2014). A conceptual approach can be part of the strategy of presenting the theoretical notions. This involves presenting and explaining the ideas by stressing the phenomenological part and using a minimum of mathematical apparatus, just as much as to sustain the conceptual notions. The method for the introduction of these new models to students is also very important. A very efficient and attractive method is Whiteboard animation (Türkay, 2016; Mednick et al, 2016). The method consists of narration on the taught subject, narration that accompanies the filmed process of drawing the story (Air et al, 2015). The camera objective focuses on the drawing hand that reduces as much as possible factors that can distract the public's attention. This step-by-step construction, along with the spoken explanation, helps students to understand what is happening. To achieve this, a simplification of the presented notions and framing in an attractive scenario is required. Among the advantages of using this method, we have: firstly, being a video, it can be easily distributed online, so the students can watch it as many times as needed in their own rhythm. Secondly, during the presentation the video can be put on hold, allowing the teacher to offer explanations, to start discussions, to stress important notions and to develop some theoretical aspects that occur during the animation. Thirdly, being an audio-video material, Whiteboard animation touches simultaneously many senses and addressing many learning styles. Finally, even though the drawings are not necessarily of professional type, Whiteboard animation is a method with a slight artistic shade. This fact can contribute to developing the creativity of the students and their desire to express graphically.

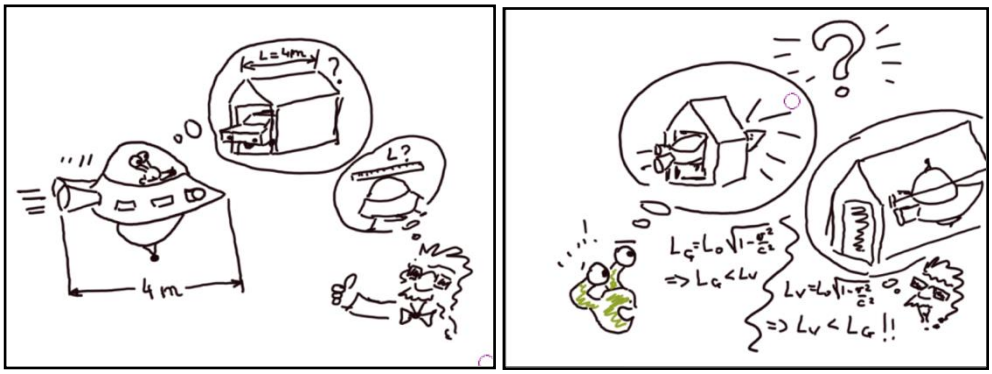
In this paper, we present the garage paradox as a third part of a series of Whiteboard animations made for the introduction of STR to high school students. After the introduction of Einstein's postulates and presenting the relativity of simultaneity (Chiriacescu et al, 2019a), it comes the presentation of twin paradox as illustration of time dilatation (Chiriacescu et al, 2019b), the series now ends with the presentation of the garage paradox that is connected both with length contraction and, again, simultaneity. This series of three Whiteboard animations presents to the students the situation from relativistic point of view and is an essential starting point for further studies of STR. These approaches address to high school students that possess neither developed mathematical skills nor abstract way of thinking. Their purpose is to ease the understanding of the relativistic phenomena at conceptual level, before a more profound mathematical analysis.

2 Whiteboard animation – the making process

There are many ways to make a Whiteboard animation, from drawing on a whiteboard (and that is the origin of the term) and recording the process using dedicated software, e.g. Doodly (https://www.doodly.com/). To create the animation presented in this paper, we employed another method: the drawing was done on a Genius MousePen i608x graphic tablet and, during the process, a screencast was made. The screencast videos were subsequently edited and the sound was then added. For the drawing, filming and editing processes, we used a free open-source software: Krita (https://krita.org/en/) for drawing, Kazam (https://launchpad.net/kazam) for the screencasts, Audacity (https://www.audacityteam.org/) for recording and editing audio files and Kdenlive (https://kdenlive.org/en/) for video editing. The background music was downloaded from a website that provides free music for video editing (https://www.bensound.com/royalty-free-music). All the programs run natively in Linux, but some of them are running under Windows and MacOS also. Here, as Kazam is not running on these operating systems, we can find alternative software. A major difference from the other methods (drawing on a whiteboard or using dedicated software) is that the artist's hand does not appear anymore. Originally, the hand is a kind of a main character, but, in our situation, it is replaced by the mouse cursor provided by the drawing program. Even though the hand was an attraction element, it also can be a distraction for the public. By eliminating this element, the student's attention can be focused more on the presentation and less on elements of form or sensational. Another characteristic of the presented material is that the drawing is not a professional one, but rather simplistic. It is a deliberate option, so that the students would resonate with it and not remain overwhelmed by the artistic quality of the material. In this way, they can easily put themselves in the shoes of the narrator and they will be more receptive to the presented new ideas. We consider that the drawing, in the present form, is intelligible enough and the employed simplifications bring the graphical language closer to the understanding level of the students. It is known that the emotional part affects the assimilation of the contents (Alsop and Watts, 2000). In this way, we tried to be as close as possible to the emotional design concept that leads to a better understanding of the studied notions by the students (Um et al, 2012; Plass et al, 2014).

3 Using Whiteboard animation to present the garage paradox

All the story is about the so-called "garage paradox". In the animation, it is narrated the story of earth-man Geo and his extraterrestrial friend Cosmo. In the beginning, Geo invites Cosmo to a birthday party. Cosmo accepts, but he raises the issue of parking his new and fancy vehicle. As the length of Cosmo's vehicle and the garage are the same, the problem is solved: the vehicle will stay in Geo's garage (Fig. 1a). Once that Cosmo approach with relativistic speed, both heroes acknowledge the Lorentz contraction in their own way: Cosmo sees the garage shorter, so his vehicle will not fit in the garage; meanwhile, Geo notices that the vehicle is compressed, so it will have no problem to enter in the garage, with even some extra space remaining (Fig. 1b). These different points of view lead to the paradox. Who is right and who's mistaking?



a) b)

Figure 1. Presenting of the garage paradox:
1a) comparing the lengths of the vehicle and of the garage in their own reference system, they are the same: 1b) because of Lorentz contraction, the two dimensions appear, paradoxically, different

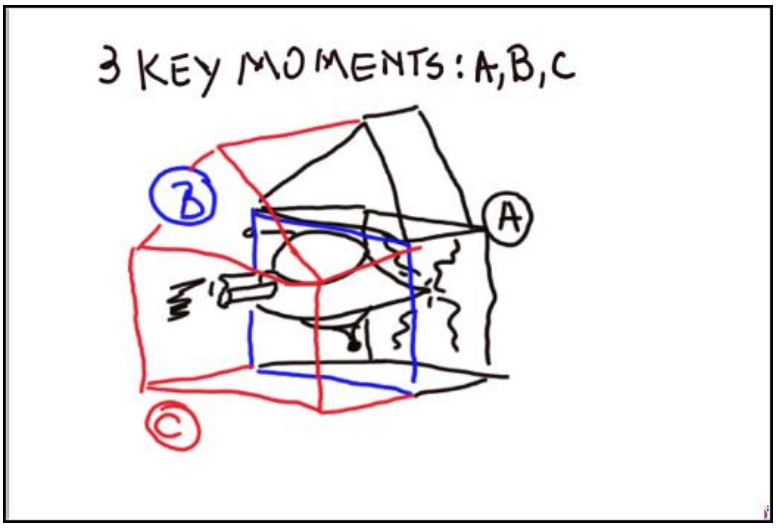


Figure 2. First explanation of the garage paradox, as presented in the Whiteboard animation.

There are many ways to explain this paradox. For the Whiteboard animation, we chose two conceptual explanations. First one (*Crowell, 2006; Ferraro, 2007;* Brown, 2014) refers to the relativity of simultaneity. Indeed, even though the Lorentz contraction

[1] $$L = L_0\sqrt{1-\frac{v^2}{c^2}}$$

implies that, according to the reference system, the garage or the vehicle appears contracted, the reality is a bit different. Taking the reference system of the garage, because of the relativistic contraction, at the moment (A) when the front bumper of the vehicle touches the back wall of the garage, the back bumper is located in the same moment (B) inside of the garage. So, the two extremities of the vehicle are simultaneously inside the garage, and that's because of the Lorentz contraction. But, if we change the reference system and move in to the one connected to Cosmo, the garage will be contracted. So, when the vehicle touches the backside of the garage (state A), the rear bumper is still outside (state C - see Fig. 2).

According to Einstein's postulates, the moments/states B and C are not simultaneous, so the events order is not the same for both reference systems. If we accept the relativity of simultaneity, it means that both heroes are right (*Crowell, 2006; Ferraro, 2007;* Brown, 2014).

A second explanation (Ferraro, 2007) refers to the fact that bodies that are rigid in normal circumstances lose this quality when in relativistic conditions. When the vehicle hits the backside of the garage, the shock wave transmits through the car towards the rear side via elastic waves, with the speed of sound. Therefore, the points that are not reached by the information of the impact will continue to move and that leads to the compression of the vehicle. From the garage point of view, not only that the backside of the vehicle will reach the garage's entrance, but it will continue moving inside it. From the vehicle's point of view, the backside of it enters the garage when the compression is already at an advanced state. It means that its length is not the original one (L_0) anymore (see Fig. 3) If we understand rigidity as the property of the body to transmit instantaneously in the entire volume the information of a deformation applied on its surface, then it's clear that the vehicle cannot be considered a rigid body anymore, due to relativistic conditions. Considering the vehicle as a rigid body leads, in fact, to the paradox that we discussed about.

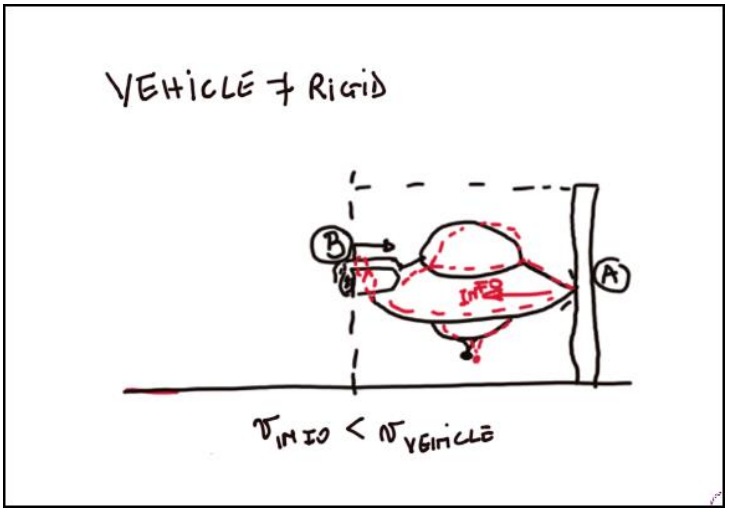


Figure 3. Rigid body relativity, as shown in the Whiteboard animation movie.

The story ends with the understanding that, as in the case of the relativity of simultaneity, both sides have a correct perception of the situation. The divergence resides in the different conditions of the reference systems. Therefore, for avoiding conflicts, Cosmo's vehicle will be parked in the alley in front of Geo's house (Fig. 4).

There are also other interpretations of situations like this, such as the apparent rotation of bodies caused by relativistic movements (Penrose, 1959; Terrel, 1959), but explaining it involves superior knowledge from the auditorium, greater flexibility in thinking, a more profound understanding of the subtle ways of STR. That is why, considering the target public for the Whiteboard animation, we did not illustrate it herein.

Figure 4. Solving the paradox problem, as illustrated in the Whiteboard animation.

4 Conclusions

Even though understanding STR means a completely new vision of the world, with the help of the Whiteboard animation and conceptual approach this obstacle can be over-passed, and these concepts become accessible to students. Understanding the fact that paradox occur when we try to look at the STR phenomena from classical Mechanics point of view represents the first step to the acceptance of the new ideas brought by this theory. In this respect, Whiteboard animation can become a good instrument, adapted to the student's level of understanding and that speaks their language. Of course, that for a more profound knowledge other approaches will follow, but for the introductory part we do believe that the employed method kindles the interest in study by conceptual approach.

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Experimenting Seppo for Problem-Solving on a Mathematics Course for Future Preschool and Primary School Teachers

Iuliana Zsoldos-Marchiș, Edina-Timea Opriș,

Babes-Bolyai University
1, Str. Kogalniceanu, RO-400084, ROMANIA
E-mail: iuliana.marchis[at]ubbcluj.ro

Abstract

The online teaching due to the Covid-19 pandemic required rethinking the methods used for practicing mathematical problem-solving during university courses. To motivate students and ensure their active involvement, gamification was used through the Seppo platform. In the 2020-2021 academic year two games were implemented. There were some differencies between these games. The first game took the students to a city, where they met different persons who required help in solving different problems from everyday life strongly related with the story. In the second game a fairy garden map gave the place for the story, the problems were not correlated with the story, they were purely mathematical ones.

The goal of our research was to study students' opinion about the games developed in Seppo. The research tool was an online questionnaire with both closed and open questions which was filled by 41 students.

The results show that most students liked the games. The students preferred more the story, the tasks, and the feedback of the second game, and the board (map) of the first game. Students participated more actively and were more motivated for solving the tasks, the story helped them to be more involved in the problem compared to solving a problem sheet. Students immersed themselves in the story, felt the spirit of competition. The story and the game details didn't distract them from the problem-solving. The best motivation for the students during the game was that they could follow their progress, they could choose the order in which the tasks would be solved. Collecting points and collecting badges made the game more meaningful to them.

Keywords: Gamification, Seppo platform, Teaching mathematics, Pre-service teachers

1 Introduction

Teaching university level mathematics courses online required rethinking the methods used for practicing mathematical problem-solving. As the focus of Mathematics learning is on developing mathematical problem-solving competency, the methods used for this purpose are influencing the results. During face-to-face teaching the problem-solving was mainly

done using collaborative methods to ensure active involvement of each student and intensive communication about the problem-solving process. During online teaching the collaboration for solving mathematical tasks is more difficult to be implemented as the view of the copybooks is more complicated to share, the explanations without visual support are hard to understand. In this way students are tempted for passive participation. To motivate students and ensure active involvement, one of the methods which can be used is gamification.

Gamification is "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems (Kapp, 2012, p. 24). Game elements which could be used in gamification are story, board (map), goals, levels, scores, leaderboard, badges, immediate feedback, avatar, etc.

Gamification is more frequently used in higher education for teaching Computer Science related disciplines (for example, De Byl, 2012; O'Donovan et al., 2013; Laskowski, 2014; Barata et al., 2017; Kovácsné Pusztai, 2021). There are also experiments of using gamification during mathematics courses (for example, Faghihi et al., 2014; Molnar, 2019; Lanuza, 2020; Zsoldos-Marchis, 2020).

Gamification has many advantages, as motivating students for learning (López Carrillo et al., 2019; Hari and Zsoldos-Marchis, 2020; Opriș, Bálint-Svella, and Zsoldos-Marchis; 2021; Yildiz, Topçu, Kaymakci, 2021), higher course attendance (O'Donovan et al., 2013; Laskowski, 2014; Barata et al., 2017; Zsoldos-Marchis, 2020), active participation (Opriș, Bálint-Svella, and Zsoldos-Marchis; 2021), decreasing the percentage of students who fail or withdraw a course (Molnar, 2019), improving achievement (Zsoldos-Marchis, 2020), having an emotional and social impact on the students (Domínguez et al., 2012).

In this paper an experiment of gamification on the Seppo platform is presented. The games were used during the mathematics course for Primary and Preschool Pedagogy (PPP) specialization students. The aim of the research is to find out students' opinion about gamification in Seppo.

2 Methodology

The research was carried out during February-March 2021 at Babeș-Bolyai University, Romania.

2.1 Research questions

This research tries to find the answers on the following questions:

1. How students compare problem-solving with problems given on a problem-sheet to problems integrated in a game?
2. Which one from the two experimented games students liked more?
3. Which gamification elements have motivated students for problem-solving?
4. How students felt during the games?
5. Do students consider that gamification could improve their achievement?
6. What is students' opinion about gamification in Seppo?

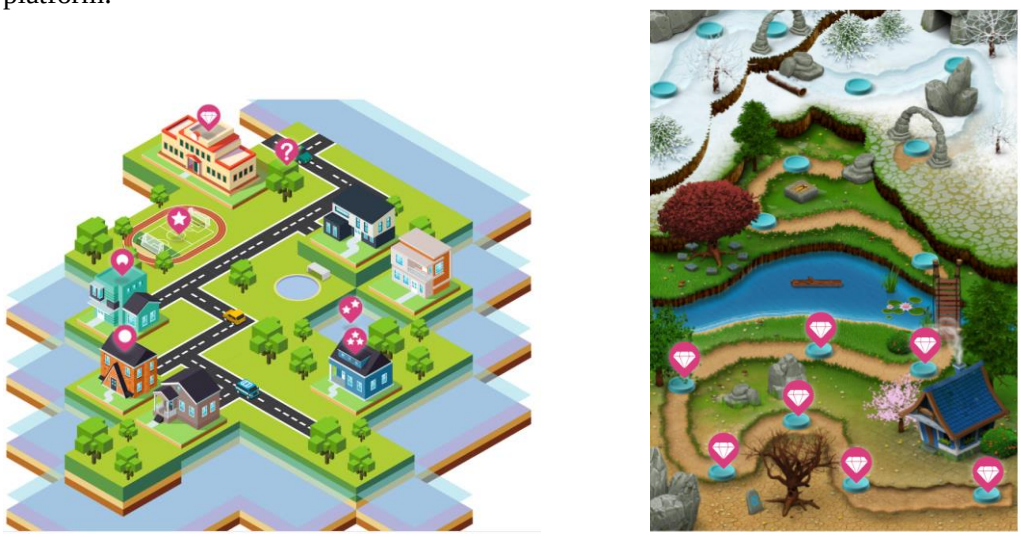
2.2 Research instrument

The instrument was a questionnaire developed specially for the purpose of this research and based on some other gamification experiments from the literature (Sillaots, 2014; Ab.

Rahman, Ahmad, and Hashim, 2018). It contains 15 questions: 4 demographical and 11 related with the research topic. There are 13 closed and 2 open questions. Among the closed questions related with the research topic there are multiple choice, checkbox, scale, and Likert-scale type items.

2.3 Description of the two games in Seppo

In the experiment two games for mathematical problem-solving were developed by the researchers and played by the participants. These games were designed on the Seppo platform.



Game 1 Game 2

Figure 1. Boards (maps) of the two Seppo games

Game 1. The first game has as board a city map with some buildings and parks (Figure 1). The story of the game is the following: The player is looking for his/her friend in this city. On his/her way around the city the player meets different people who need help in solving different everyday problems in which they need to use mathematics, so the given problems were strongly related with the story. For each correctly solved problem the player gets a piece of a puzzle. These puzzle pieces are pieces of a map which helps the players to find out where his/her friend is waiting for him/her. The results of the problems are asked in a multiple-choice item to be able to give immediate feedback to the player. For some problems the players must upload a photo with their solution only for the help of the lecturer to see what difficulties students had in case of incorrect problem-solving, but the player didn't get feedback on the detailed solutions. Beside feedback on the correctness of the solution players also got some messages: congratulations for correct answers and encouragements for incorrect answers.

Game 2. The second game has as board a fairy tale garden (Figure 1). The story of the game is the following: The players got the map of a fairy tale garden; they must reach the dwarf's bridge. During their journey they must solve mathematical problems, and for each correct solution they got a shiny gem. The mathematical problems were not correlated with

the story, their text was pure mathematical. The results of the problems are asked in a multiple-choice item to be able to give immediate feedback to the player. For some problems the players must upload a photo with their solution only for the help of the lecturer to see what difficulties students had in case of incorrect problem-solving, but the player didn't get feedback on the detailed solutions.

Each game was used during a seminar for a two-hour play.

2.4 Participants

In the research 41 Primary and Preschool Pedagogy specialization students have participated. They were in their second year of the studies. The age of the participants was between 19 and 21, with an average of 20,37 and mode 20. All the participants are female. 58,5% of the participants lives in rural area.

2.5 Data collection and analysis

The data was collected in March 2021, after participants experimented both games. The obtained data was quantitatively (closed questions) and qualitatively (open questions) analyzed. For quantitative analysis frequencies and percentages, means and standard deviations were calculated. Paired and two-sample t-test was used for comparing related respectively unrelated datasets. For analyzing the answers given to the open questions categorial analysis was performed.

3 Results and discussion

3.1 Comparison of problem-solving with problems given on a problem-sheet to problems integrated in a game

Table 1 contains means (M) and standard deviations (SD) for the affirmations measured on a 5-level Likert-scale for comparison of a problem sheet with gamified problem-solving.

Table 1. Students' comparison of a problem sheet with gamified problem-solving

Affirmations	M	SD
I participated more actively than in case of the problem-sheet.	4.04	1.11
I could immerse deeper in problem-solving than in case of the problem-sheet.	3.90	1.22
Trough the story I got deeper into the problem-solving than in case of the problem-sheet.	3.63	1.27
I was more motivated for problem-solving than in case of the problem-sheet.	3.87	1.26
Because of the game I could concentrated less on the problem-solving than in case of the problem-sheet.	1.73	1.11
I solved the problems more superficially than in case of the problem-sheet.	1.80	1.16

Students participated more actively in the problem-solving with gamification and were more motivated. The game didn't prevent students from concentrating on problem-solving or from giving detailed solutions.

3.2 Comparison of the two experimental games

Students liked both games, the average obtained on a 5-level scale is 4.02 in case of both games, the standard deviation being 0,97 in case of Game 1 and 0,92 in case of Game 2. Participants were asked to choose in which game they liked more the story, the board, the problems, respectively the feedback given. The number of students selecting Game 1 respectively Game 2 in case of each element is presented in Table 2. The story, the problems, and the feedback was more liked in Game 2, the board in Game 1. In Game 2 the problems were mathematical problems, in Game 1 everyday life problems for which solution mathematics was needed. It is surprising that students liked more the problems from Game 2.This could be explained by the fact that in some cases it is more difficult to solve a problem taken from cotidian life, because the problem need to be translated into mathematical language first, then solved, and translated back into the context of the problem.

Table 2. Comparing the game elements of Game 1 and Game 2 (frequencies)

	Game 1	Game 2
Story	11	15
Problems	12	15
Board	16	13
Feedback	7	10

3.3 Impact of different game elements and rules on students' motivation

Table 3 contains means (M) and standard deviations (SD) in case of affirmations measured on a 5-level Likert scale related how much different elements and rules influenced students' motivation.

Table 3. Different game elements and rules impact on students' motivation

Affirmations	M	SD
I could follow my scores.	3.80	1.00
I could follow how much time I still have.	3.04	1.37
I could see where I was in solving the tasks (which task I solved, which is in progress, and which still needed to be solved).	4.09	0.88
A flash question appeared during the game (additional points).	3.36	1.49
I was able to choose the order of solving the tasks.	4.41	0.66
I was able to return to the solved tasks and check.	4.41	0.77
I could immerse myself in the frame story.	3.19	1.45
I was able to collect badges (e.g., puzzle pieces, gems).	3.97	1.10
Collecting points was more motivating than finding the correct solution.	2.75	1.28

The results show that students were motivated by the fact that they could choose the order of solving the problems and they could return to a solved task to check it. Another motivating element is the fact that they could see any time which problems they have already solved, and which still needed to be solved. Comparing with other experiments, seems that progress bar is usually liked by the students (O'Donovan et al., 2013; López Carrillo et al., 2019). These three rules (choose the order, revisit a problem, progress-bar)

also apply for a paper-based problem-sheet given for evaluation. During problem-solving in the classroom in many cases the order of the problems is fixed for more reasons: the problems are arranged increasingly by difficulty, after solving a problem the solution is discussed frontally, etc.

Badges were more important than following the score. This result is in contradiction with previous research (O'Donovan et al., 2013; López Carrillo et al., 2019), where badges are considered not so motivated or even unsuitable for university level. Badges could hinder the intrinsic motivation (Deci et al., 2001) as they shift the internal desire for learning into a collection of tangible rewards.

It is also interesting that the story of the game was not so important for students. The narrative created around a task usually increase motivation (Clark and Rossiter, 2008).

3.4 Emotions experienced during the games

Table 4 contains means (M) and standard deviations (SD) in case of affirmations measured on a 5-level Likert scale related with students' emotions during the games.

Table 4. Students' emotions during the games

Affirmations	M	SD
I felt like time was running faster than usual.	3.97	1.17
I forgot about my everyday worries.	3.70	1.34
I was worried about my performance.	2.92	1.38
I got immersed into the game.	4.12	1.12
I could feel the competitive spirit.	3.63	1.29

The most intensely felt emotion is the immersion into the game. Students also felt that the time is running faster during the game, they forgot about everyday worries, these also shows that they were deeply concentrated on problem-solving.

3.5 Impact of gamification on students' achievement

Table 5 contains means (M) and standard deviations (SD) in case of affirmations measured on a 5-level Likert scale related with the impact of gamification on students' achievement. The results show that the scoreboard had an important influence on the participants' achievement.

Table 5. Impact of gamification on students' achievement

Affirmations	M	SD
The points earned depended on my knowledge and contribution.	3.80	0.95
The scoreboard encouraged me to achieve more.	4.02	1.10
Using the online gaming system improves my learning performance.	3.73	1.11
Using the online gaming system increases my desire to achieve the desired result in learning.	3.73	1.11

3.6 Students' opinion about gamification in Seppo

Students have to evaluate the Seppo platform on a 5-level scale. The obtained average was 4,26, with standard deviation 0,50. This result shows that Seppo was liked by the students participating in the research.

41,5% of the participants affirmed that they used other gamification platforms before, and as examples they gave Wordwall, Kahoot, Learningapps, and Minecraft. Dividing the respondents in two groups: students, who already used gamification and students, who haven't used gamification before, and comparing the means obtained for evaluating the Seppo platform, those who already used gamification before scored lower the Seppo platform, but the difference between the groups is not statistically significant (Table 6).

Table 6. Comparison of scores given for the Seppo platform by students who already used other programs for gamification and who haven't used other platforms using two-sample t-test

Groups	M	SD	t	p
Students who used other platforms for gamification	4,11	0,78	-1,11	0,13
Students who haven't used other platforms for gamification	4,37	0,64		

4 Conclusions

The results show that most students liked the games designed in Seppo. They participated more actively and were more motivated for solving the tasks, the story helped them to be more involved in the problem compared to solving a problem sheet. Students immersed themselves in the story, felt the spirit of competition. The story and the game details didn't distract them from the problem-solving. The best motivation for the students during the game was that they could follow their progress, they could choose the order in which the tasks would be solved. Collecting points and collecting badges made the game more meaningful to them.

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Current Experimental Methods in Physics Using the Smartphone Sensors

Marilena Colt[1,2], Mihai Popescu[2], Florentina Loredana Dragomir[3]

(1) University of Bucharest, RO-077125, Bucharest-Magurele, Romania
(2) "Ion Luca Caragiale" National College, Ploiesti, Romania
(3) Carol I National Defence University, Bucharest, Romania
E-mails: enachemarilena2007@yahoo.com
Dragomir.loredana@unap.ro

Abstract

In addition to the fact that the smartphone can be used for documentation, thanks to its integrated sensors, it can be used successfully in physics experiments. One of the old drawbacks of experimental physics, the long time it takes to process data, has been overcome. The laborious calculations made earlier are realised extremely quickly by a smartphone with the Phyphox application installed. The paper presents three physics experiments from the upper cycle of high school: the first in the field of acoustics, determining the speed of sound in air, the second in the field of optics, calculating the wavelength of infrared radiation in the diffraction phenomenon and the third studies the uniform motion. These experiments were performed using, in addition to real experimental devices, the smart sensors that the phone has: the speaker, the microphone, the phone camera and the magnetic sensor.

Key words*:* Phypox app, integrated sensors, interdisciplinarity, Physics Education.

1. Introduction

A new paradigm in the field of education, called "mobile learning", has appeared with the spectacular development of mobile telephony. Different definitions have been given for m-learning. Some consider this method of education based only on the internet. Others include the ability to learn anywhere without a connection to cable networks (Georgiev and al, 2004). This type of learning has been defined as the use of mobile technology to facilitate learning (Hwang and Tsai, 2011). But technology is not the most important factor that determines this type of learning (Dragomir and Postolache, 2017). The factor affecting mobile learning is the perception of mobility (Kurtz and al, 2015). One form of mobile learning is the use of applications in the form of programs, which can be downloaded to tablets or smartphones, with accessibility through a wireless network. Through these devices students have access to learning resources and it is also possible to share between students when it comes to educational information (Ali and Arshad, 2018).

Compared to traditional education, mobility is the strongest feature of mobile learning. M-learning can offer its users a multitude of benefits, including interactive learning

activities, because students have access and can exchange information whenever they need and from anywhere. Learning becomes self-managed, personalized, and collaborative through interaction (Dragomir, 2017). It is an effective method of sending and receiving knowledge (Liu, 2011; Bidin and Ziden, 2013; Jeong and Hong, 2013; Martin and Ertzberger, 2013). The presence of mobile devices helps to achieve interaction and improves the accessibility of learning materials (Liaw and al, 2010). Through this interaction (Dragomir, 2018), students can exchange and share information, knowledge and ideas and this allows the learning process (Dragomir et al, 2017) to become more attractive (Kuo and al, 2014).

Physics is not a popular subject among high school students and the mobile device, the smartphone, can make it more attractive. The experiments are limited to the teacher's demonstration due to the lack of many specific equipment. Smartphones can solve this problem thanks to the increasingly high-performance sensors they have. New teaching strategies have emerged with the advent of state-of-the-art technology-based devices that allow you to install additional applications that connect to your computer or other mobile devices. The role of the microphone is to convert air pressure variations from a sound wave into an electrical signal. The speaker converts an electrical signal into an audible signal of the same frequency as the electrical signal. Another sensor of the smart phone is the ambient light sensor. The data from this sensor is used by the phone software to automatically adjust the brightness of the display. But it can also play an important role in conducting physics experiments with experimental devices in laboratories. The magnetometer can make measurements on objects made of ferromagnetic material that are in translational or rotational motion. Recently, several works have been made and published that have described the use of this sensor in education. Magnetometers in smartphones use the Hall effect to record. Most phones contain three magnetometers, one for each space direction (Arribas Garde and al, 2015; Septianto and al, 2016; Arabasi and Al-Taani, 2016; Setiawan and al, 2017). These sensors are easy tools to use in physics experiments in high school labs. The open source software ”Phyphox”, is an application designed for the study of physics. Limiting the phone from becoming inaccessible during experiments is removed by the Phyphox app. If a Wi-Fi connection is available, students will be able to track real-time graphics by accessing a URL, with the Phyphpx application generating a private IP address (Götze and al, 2017; Goertz and al, 2017; Pendrill, 2020; Carroll and Lincoln, 2020). The experimental data processing step has been removed from this application, but they can be exported for further processing. Both teachers and students can become inventive and create unique experiments (Howard and Meier, 2020; Pierratos and Polatoglou, 2020).

This paper proposes three physics experiments, presented in a modern manner, that can be realized in the upper cycle of high school. The first is part of the acoustic field and consists in the experimental determination of the speed of sound in air. The second belongs to optics and involves the calculation of the wavelength of radiation, which students can not see, infrared radiation. The wavelength is obtained starting from the law of the diffraction phenomenon. These experiments were realized using, in addition to real experimental devices, the smart sensors that the phone has: speaker and microphone,

accessed via the Phyphox app for the first experiment, the ambient light sensor for the second experiment and the magnetometer for the third experiment.

2.Theoretical backround

2.1 Sound Speed in Gas

The speed of sound in a gaseous medium depends on the properties of the propagation medium, its density and elasticity and temperature (Kinsler and al, 1982). In gases, the sound deformation of the elastic medium according to relation [1] participates in the propagation of sound:

[1] $v_s = \sqrt{\frac{K}{\rho}}$ where $K = -V\frac{dP}{dV}$ is the modulus of elasticity of volume, adiabatic and ρ is the density of the gas. Also, in gases, the speed of sound also depends on temperature, as seen in relation [2]:

[2] $v_s = (331{,}5 + 0{,}607 \cdot t)\frac{m}{s}$ where t represents the air temperature in the room where the experiment was performed (Hristev,1984) t = 22.5^{0}C. Relation [2] results from the linear approximation of the first two terms of the Taylor series of the function:

[3] $v_s = 331{,}5 \cdot \sqrt{1 + \frac{t}{273{,}15}}\frac{m}{s}$, $331{,}5 \cdot \frac{1}{2 \cdot 273{,}15} = 0{,}607$

2.2 Light Diffraction

In a broader sense of the term, diffraction means any change in the spatial distribution of the intensity of the light wave produced as a result of the encounter of environmental inhomogeneities. The use of diffraction grids in experiments determines the increase of the intensity of the main maxima, its becoming narrow and separated by practically dark spaces. If a parallel beam of monochrome light is incident on the diffraction grating making the angle i with the normal to the diffraction grating, the secondary waves, emitted at angle ∝, are focused by a lens at a point on the screen. The result of the interference of these waves is determined by the path difference δ, the same for two successive slots, path difference indicated by relation [4]. The path difference between the incident waves is $\delta_1 = l \cdot sini$ and the path difference between the emerging waves is $\delta_2 = l \cdot sin\alpha$, where l is the constant of the diffraction grating.

[4] $\delta = \delta_1 \pm \delta_2$, $\delta = l(sini \pm sin\alpha)$,

Relationship [5] represents the law of diffraction. The necessary condition to obtain a maximum light intensity is:

[5] $l(sini \pm sin\alpha) = K\lambda, K \in N$, where K is the diffraction order (Loewen and Popov, 2018).

2.3. Rectilinear and Uniform Motion

Starting from the definition of the instantaneous velocity vector:

[6] $\vec{v} = \lim_{\Delta t \to 0}\frac{\Delta \vec{r}}{\Delta t} = \frac{d\vec{r}}{dt} = \overrightarrow{r'}(t) = \dot{r}$

in the rectilinear and uniform motion $\vec{v}$ = constant and so we can write:

[7] $d\vec{r} = \vec{v}dt, \quad \vec{r} = \vec{r_0} + \int_{t_0}^{t} \vec{v}dt = \vec{r_0} + \vec{v}(t - t_0)$

Equation [7] is the vector form of the law of rectilinear and uniform motion (Hristev, 1984). If the Ox axis is chosen right on the right of motion, then we obtain:

[8] $x = x_0 + vt$

3. Experimental setup and methods

3.1 Determination of Sound Speed in Air with Phyphox Application

The value of the speed of sound in dry air at pressure $p = 101325\,Pa$ and temperature $t_0 = 0^0C$ it was calculated over time by different methods and the value was obtained $v_s = 331{,}29\ \frac{m}{s}$ (Pierratos and Polatoglou, 2020).

The experiment called ”Sonar” in the Phyphox application is part of the category of acoustic phenomena. The smartphone uses two sensors: the speakerphone and the microphone. Short sounds are sent through the speaker and echoes are recorded by the microphone. According to the theory, the phone can perform this experiment alone. But it is almost impossible to interpret all the echoes generated in any room. The ceiling, the floor, each of the walls and each object in the room contribute to the final result. It turns out that all those uninteresting directions need to be protected by the speaker and microphone. A cavity was built in which the telephone was inserted and a part was left open to receive the echoes. On this side a strong reflector was used which was a simple flat metal tray. The smartphone is inserted into the protected cavity and placed on the opposite side of the reflective surface so that the sound propagates perpendicular to it.

In order to control the experiment and to obtain results as close as possible to reality, it is necessary to use a remote interface, from a second device: tablet, laptop or a second smartphone. This is because the phone is not easily accessible in this construction. The phone was positioned so as to record only the echo that interests us and the experiment began. A click sound is heard, the data and a graph are obtained. Several picks from irrelevant echoes will be observed, but if a reflective flat surface is used, a corresponding peak will be observed. The sound of the phone is not just a simple click, it is like the chirping of a bird. In addition, a weighting function is applied to have a smooth start and end of the chirp. The chirping is then repeated five times at a time interval of about 30 ms, as shown in Figure 1a). The amplitude of a single ”chirp” emitted by the phone's microphone is presented in Figure 1b). The experimental setup used to determine speed sound in the air using a smartphone is presented in Figure 2. The time t on the Ox axis is multiplied by the speed of sound v_s gives the distance between the place of noise emission and the place of echo reception, according to relation [9] and as seen in Figure 3.

[9] $D_d + D_m = v_s \cdot t$

Obtaining several random peaks can be mentioned as problems and resolutions. This can be caused by a background noise loud enough to be perceived by the smartphone. The experiment should be performed in a quiet environment.

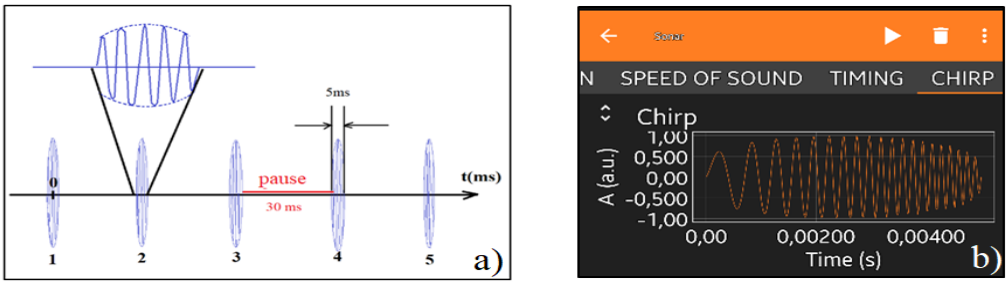

Figure 1. a) The five noises from the phone's speaker; b) The amplitude of a single "chirp" emitted by the phone's microphone; screenshot PhyphxApp

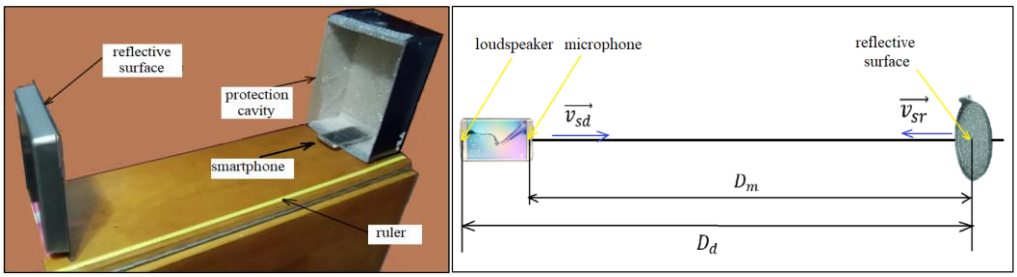

Figure 2. a) The experimental setup used to determine speed sound in the air using smartphone microphone and speaker (left); b) The distances between the speaker and the microphone and the surface reflectors in the experimental setup used; the speed of the direct wave and the reflected one (right)

If several peaks are observed in fixed positions, which are always at the same distance, while the phone remains in the same place, the shielding should be improved, as they come from echoes obtained from other objects that reflect sound.

The experiment can be used to measure distances between objects if the known speed of sound is considered, or the speed of sound in the air can be found if the distance between transmitter and receiver is measured.

According to relation [9] the value of the speed of sound in air in the room where the experiment was realized, at a temperature $t = 22.5℃$ was $v_s = 344{,}85\frac{m}{s}$. The value obtained experimentally, is $v_s \approx 351{,}65\frac{m}{s}$, as seen in Figure 3. The relative error was ε=1,9%. After processing the raw data, exported in .xls format, the students obtained the graph in Figure 3b), which indicates the distance between the transmitter and the object on which the sound is reflected via time after which the transmitter receives the echo. The graph in Figure 3b) showed a sound speed value $v_s = 341{,}66\frac{m}{s}$. The relative error in this case was ε = 0,92%.

3.2 Experimental Determination of the Wavelength of Infrared Radiation

The purpose of this experiment was to determine the wavelength of the radiation that starts from the remote control of a TV, using the camera of a smartphone.

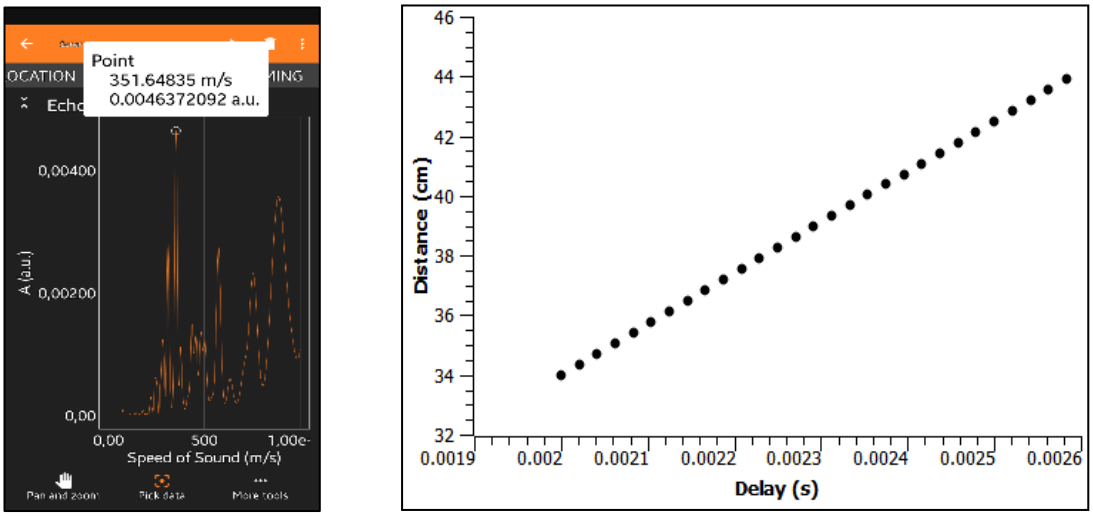

Figure 3. a) Screenshot Phyphox App with experimentally obtained sound speed value; b) Location of the object on which the echo occurs, relative to the transmitter, via the time elapsed between the emission and reception of the sound from raw data for echolocation

The experimental device is shown in Figure 4a). It is a centered optical system consisting of an infrared light source, a lens, a diffraction grating and a smartphone located on an optical bench. There is a ruler on one side of the stand on which the devices are attached.

The infrared light source is the remote control. The beam of light emitted by it passes through a lens and falls on a diffraction grating, perpendicular to it, so that the angle of incidence i = 0. Instead of the usual screen from the physics kit, on which students could see nothing, the camera of a smartphone is positioned, as seen in figure 4a). However, the experimenter can view the diffraction images on the smartphone screen, as seen in figure 4 b). The students were able to observe the bright central strip on both sides of the light and dark fringes, ie the maximums and minimums of light intensity. In Figure 4 the image was the one obtained on an optical grid with n = 100 lines per millimeter, which is equivalent to a optical grid constant $l=10^{-5}$ m. Once the photo has been taken, the wavelength of the optical radiation emitted by the remote control can be calculated by geometric measurements, as seen in the figure 4c). In the case of the experimental device used:

[10] $sin \propto = \frac{k\lambda}{l}$

The geometry of the experiment shows:

[11] $\frac{X}{Y} = \frac{x}{y}$

From relations [10] and [11] we get for the wavelength:

[12] $\lambda = \frac{l \cdot Y}{K \cdot X}$.

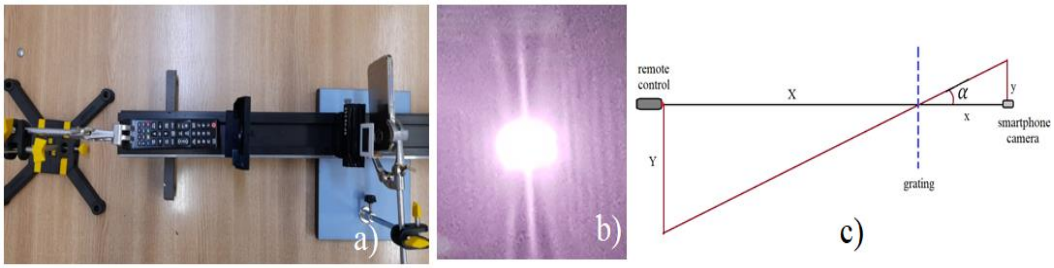

Figure 4. a) The experimental device, seen from above, used to determine the wavelength of infrared radiation; b) Difraction image produced by the infrared radiation on the diffraction grating, viewed on the smartphone screen; c) The geometry of the experiment required to calculate the wavelength

In the relation [12], the numerical values are introduced: the distance from remote control to the optical grid X = 65.8 cm, the distance from the optical grid to smartphone camera x = 9 mm and the distance from the central maximum to the maximum of the first order is y = 1mm. Following some calculations, the value of the wavelength of the infrared radiation emitted by the remote control was obtained $\lambda = 1068{,}6$ nm (for k = 1). The value of $\lambda \approx$ 1069 nm, obtained for the wavelength of the infrared radiation, is in the range 900 nm - 1200 nm, emitted by the diodes used at the remote controls (Tsai and Hamblin, 2017).

3.3 The Study of Rectilinear and Uniform Motion Using Phyphox App

This experiment determines the speed of a object in rectilinear and uniform motion, using the magnetic sensor of a smartphone and a number of nine magnets. The magnets must be chosen so that they are strong enough to produce a magnetic field of induction greater than the induction of the Earth's magnetic field, around 42μT, but not to damage the compass function of the smartphone. For this purpose, a single magnet is slowly approached to the smartphone, the Phyphox application is opened and the values indicated by the magnetic sensor are monitored. Magnetic induction values between 100 μT and 1mT meet both of the above conditions.

The path is configured, the magnets being placed in a straight line at fixed intervals of 30 cm from each other, at the same height from the ground. The smartphone attached to the toy must be at the same height from the ground as the magnets. The distance between the magnets must be entered manually by the experimenter, in the case of this experiment 30 cm. The phone's magnetic sensor detects every stronger magnetic field it passes. The phone moves at a constant speed. After the phone is fixed to the object, whose movement is being studied, the connection is made with a second device. Phyphox opens from the second device. Wireless connection between smartphone and laptop can be seen in the Figure 6b).

The variation of the induction of the magnetic field squared and filtered can be visualized in Figure 6a). Observe the nine picks corresponding to the nine magnets whose magnetic fields are detected by the magnetic sensor of and the smartphone.

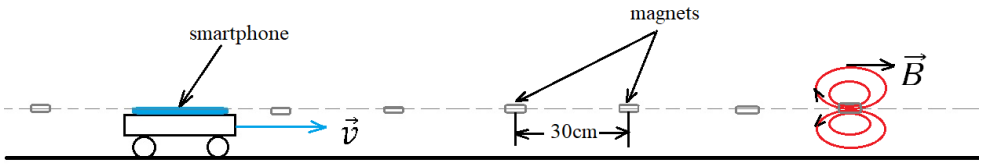

Figure 5. The experimental set-up for the study of uniform motion

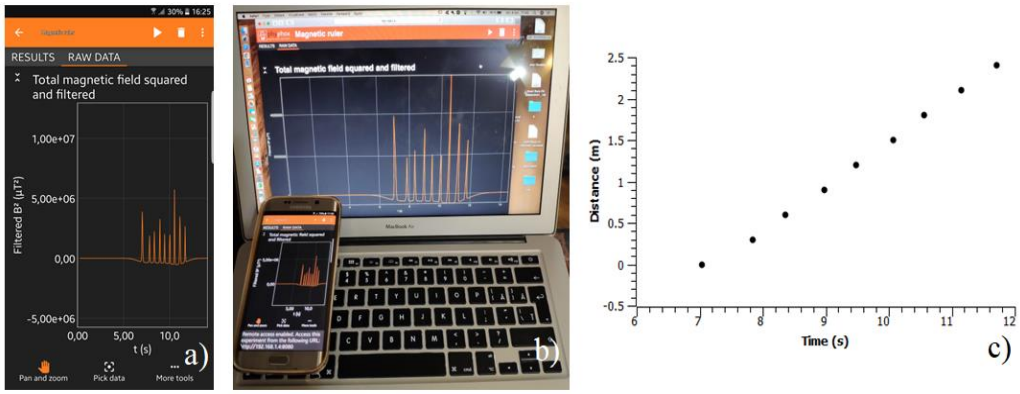

Figure 6. a) Wireless connection between smartphone and laptop; b) The total magnetic field squared and filtered the magnetic field detected by the smartphone's sensors during the experiment; c) The distance traveled by the smartphone trolley system via time obtained from the raw data processing

The traveled distance can be obtained from the processing of raw data, resulting the graph in Figure 6c). Students obtained, through experiment, a first degree function, a function that represents the law of uniform motion. The mathematical form of this law is indicated by the relation [12].

From the slope of the line in the graph in the figure 6c) the students can determine the speed of movement. The calculated value is $v = 0.5\frac{m}{s}$.

4 Conclusions

The use of the mobile phone in the experimental physics classes that can be done in the upper cycle of high school is a simple alternative to experiments that require expensive equipment. Teachers can integrate the two experiments into face-to-face lessons or be presented at a distance, thus creating interactive courses in online learning due to the COVID 19 pandemic. The concepts, better understood, can be used later in solving problems.

The data taken from the sensors, within the first experiment, can make connections between definitions, mathematical calculations, graphical representations and the experiment performed in authentic situations. This data, obtained in real time, could be

presented to the whole class, using a specific function of the Phyphox application. From the second experiment, the students were able to conclude that the smartphone's camera can also be used to observe the effects caused by radiation, invisible to the human eye, when it encounters certain obstacles. In the first and last experiment, the students processed raw data, demonstrated skills to use software that processes scientific data by making graphs. From the interpretation of these graphs they were able to obtain conclusions regarding the studied physical phenomena. All three experiments have added to traditional learning, which involves real experimental devices, a modern part of mobile learning, the mobile phone being indispensable in these experiments and being used in various ways. It leaves the way open to other topics that can be treated interdisciplinary through a smartphone.

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Freeware Applications in Experimental Physics at the High School Level

Marilena Colt[1,2], Mihai Popescu[2], Florentina Loredana Dragomir[3]

(1) University of Bucharest, RO-077125, Bucharest-Magurele, Romania
(2) "Ion Luca Caragiale" National College, Ploiesti, Romania
(3) "Carol I" National Defence University, Bucharest, Romania
E-mail: enachemarilena2007@yahoo.com
Dragomir.loredana@unap.ro

Abstract

The current dependence on technology is a notorious fact. A pro argument regarding students' access to school with mobile phones is its use, obviously with the appropriate applications installed, in collecting and processing experimental data in physics at any level. Determinations of physical quantities, using laborious calculations some time ago, are now done in a few seconds using a smartphone. To get to our own house or to climb our luggage in the hotel room most of us use the elevator. The smartphone in your own pocket is a device suitable for studying the movement of the elevator due to the intelligent, increasingly high-performance sensors that this device has. Thus, the elevator trip becomes an interesting subject for high school students. The paper aims to perform three experiments, using four of the integrated sensors of a smartphone: the accelerometer, barometer, and gyroscope through the open-source application Phyphox.

Key words*:* smartphone sensors, Phyphox app, interdisciplinarity, Physics Education.

1 Introduction

In high school, physics is not a popular subject. Except for a few enthusiasts, students associate this subject with often abstract concepts and discouraging mathematical equations. Theoretical physics does not attract high school students. Usually the experiments, if performed, are limited to the demonstration performed by the teacher due to lack of access to specific equipment. Smartphones can get around this problem because they have a lot of built-in sensors. Capturing students' attention by introducing technological devices, by the simple effect of novelty, has been demonstrated very often lately (Hochberg et al, 2018). The smartphone has become a multifunctional tool in elementary experimental physics thanks to internal sensors with their advanced functions (Pili et al, 2018). Although when buying a phone, we do not give much importance to integrated sensors, they play an important role in everything a smartphone can do. The

availability of sensors varies from device to device, and this is because Android sensors have been introduced during several launches of operating systems (Dragomir and Postolache, 2017). Downloading the application ”Sensor Box for Android” on the smartphone Samsung S6 edge, I found out which are the sensors built into the phone with Android 7.0 operating system that was used in the experiments.

Gravitational sensors are devices that can measure acceleration (rate of change of speed) using a smartphone. The accelerometer can detect changes in orientation and can tell the screen to rotate. This sensor is one of the most used features of smart mobile phones. The phone coordinates (on the x, y and z axes) are calculated continuously. By using the gravitational sensor of the smartphone, the value of gravitational acceleration was directly determined, an important concept in elementary kinematics (Berrada et al, 2020). Even complex movements have been studied using the smartphone’s accelerometer (Pendrill, 2020).

The gyroscope is the sensor that provides orientation information, but with very high accuracy. The feature of the Android Photo Sphere camera can show in which direction and how much a phone has been rotated, thanks to this sensor. It was originally developed as Google Sky Map and is now open source. It can detect the 3D position of any object. A system of handwriting recognition has even been proposed based on 3D gyroscope (Kim et al, 2014). The sensors mentioned above are promising and easy to use tools in conducting physics experiments in the classroom, in the laboratories of high schools or colleges (Vogt et al, 2011). Lately, many experiments have been done that involved the use of a smartphone that made physics, especially the mechanics chapter, tangible for all those interested. Sometimes, during experiments, the phone becomes inaccessible so data must be analyzed from another device. An application designed especially for physics, a discipline whose understanding involves various experimental activities, is free software ”Phyphox”, developed by Physikalische Institut der RWTH Aachen University, Germany (Götze et al, 2017; Goertz et al, 2017; Hütz et al, 2017; Schleer et al, 2018). It offers the same set of features on iOS or Android, it is free, and it is useful even for distance learning (Staacks et al, 2018; Stampfer et al, 2020). The limitation that the phone becomes inaccessible during experiments is removed by the above-mentioned application. It also offers some advantages in presenting the notions of kinematics in high school physics teaching because it sends the data wirelessly, which can be analyzed on another device. The application eliminated the need for the data processing stage by students, a rather demanding stage for high school students. The application is also open source and should not be limited to certain experiments. Both teachers and students can be inventive and can perform unique experiments (Pierratos et al, 2020; Monteiro et al, 2020).

We are in a time when the amount of the experimental data (Dragomir et al, 2018) that can be taken has increased exponentially. To obtain the most accurate results, it has become very important to be able to extract useful information from this data (Babić and Cetina, 2020; Dragomir, 2017).

Using the mobile phone in high school physics classes mean a simple alternative to experiments that require expensive equipment (Pedroso et al, 2020).

2 Experimental Setup and Methods

The objects encountered in everyday life have very different movements and the description of these movements involves considerable difficulties. Because some theorems in geometry such as Mozzi, Chasles, Euler that show that, in the plane or in Euclidean space, the transition from an initial to a final position of a geometric figure can be obtained by composing translations and rotations of that plane of space are almost impossible to understand at high school level, high school students not having the notion of tensors, an experimental approach to the subject seems to be much closer to the level of understanding of students.

2.1 Determination of the Rolling Speed of a Rigid Solid on an Horizontally Plane

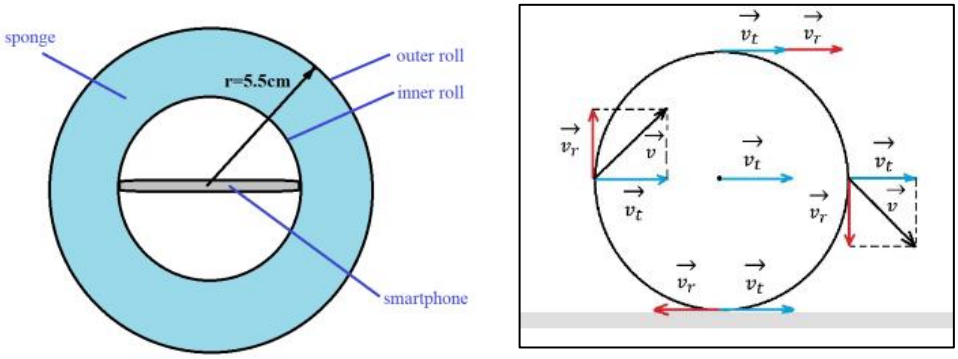

Figure 1. Mobile phone fixed inside the cylindrical box; horizontal movement (left); linear and tangential velocities (right)

I needed a cylindrical roller whose inside diameter was about equal to the width of my cell phone. It was inserted and then fixed inside the roller so that it rotated around the longer part, as in Figure 1. I also needed a second device such as a laptop, a tablet or another mobile phone which received the data, and which had an updated web browser. We did this by entering the URL, from Figure 2 a), on the second device and then we made sure it worked.

As the phone became inaccessible inside the roller, I activated the remote access. I opened Phyphox and, in the mechanics section, I looked for ”Roll”. The roller radius must be entered by the user. For as high an accuracy as possible, I measured the radius of the roller with the caliper and introduced it in the application, its value being r = 5.5 cm.

The first device was centered inside the roller, having the active display and, without changing the settings, it was fixed with two sponges. The Phyphox application commands the gyroscope of the phone to measure its angular velocity $\omega = \dot{\theta}$ and calculates the tangential velocity v according to the relation [1],

[1] $v = \omega \cdot r$,

where v is the speed of the roller.

The roll was given with an initial impulse and then left free on a horizontal plane with a length of 200 cm. The angular velocity, expressed in radians per second, is measured by the gyroscope directly. The graph of the dependence v(t) and is shown in Figure 2 c). From the graph from the Figure 2 it is observed that the initial given speed was $v_0 = 1.18 \frac{m}{s}$ at the initial moment $t_0 = 5.48s$ and the final speed was $v = 1.07 \frac{m}{s}$ at the final moment $t = 6.86s$, when the roll is stopped because it would fall off the surface. The roller has a uniformly braked motion. There is a little oscillation (Figure 2 c) of the speed which is determined by the asymmetrical weight distribution of the phone in the roll. Instead of running smoothly, the roller shakes because the phone is hardly centered inside the roller. From the slope of the line from Figure 2c), students can determine the angular acceleration $\varepsilon_{||}$ according to the relation [2].

[2] $$tg\ \alpha = \varepsilon_{||} = \dot{\omega} = \ddot{\theta}$$

The acceleration of the center of the mass is $a = -8.87 \cdot 10^{-2} \frac{m}{s^2}$ and in our case the value of the angular acceleration was $\varepsilon_{||} = -1.67 \frac{rad}{s^2}$.

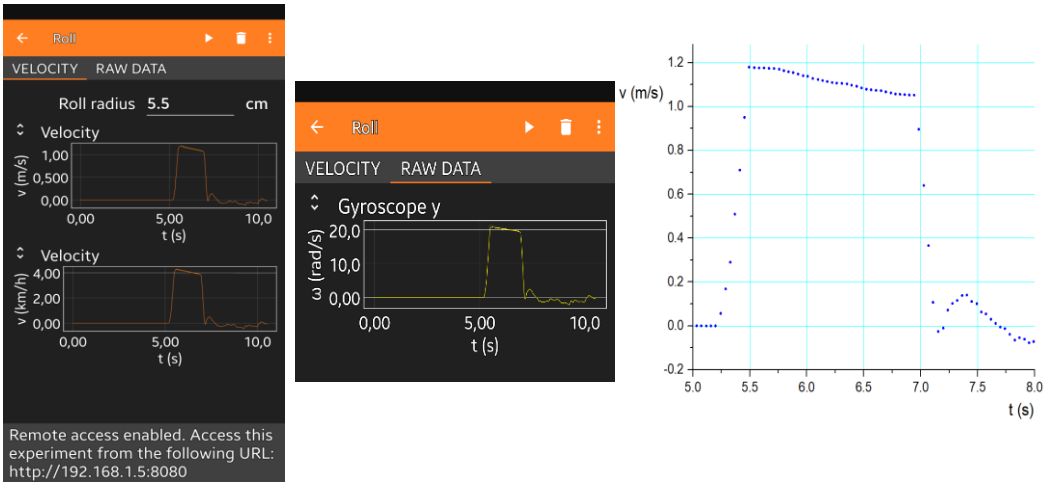

Figure 2. a) The values of the speed of the center of mass of the roller versus time and the URL address; screenshot of the Android Phyphox app; b) Dependence of the angular velocity versus time; c) Time dependence of the speed of the center of mass of the roller, obtained from the raw data

2.2 Determination of the Rolling Speed of a Rigid Solid on an Inclined Plane

The configuration can also be used to highlight accelerated movement on an inclined plane. I placed the roller on an inclined plane. I also measured the angle of the plan with the help of my smartphone, using the Phyphox app.

To do this, in the ”Tools” section we opened ”Inclination”, an experiment that was designed to render the angle of inclination of the phone placed on a plane inclined to the horizontal as seen in Figure 3. I placed the phone at rest on the inclined plane, and the

indicated value of the angle was $4^0 23'53'' = 0.0768$ rad. I left the roll free at the top of the inclined plane. The radius of the roller in this experiment was r =5.5 cm. Again, the gyroscope of the phone indicates the angular velocity and obtains the tangential velocity according to relation [1].

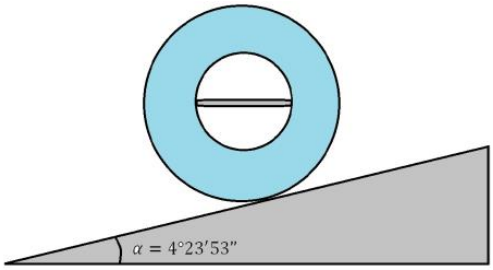

Figure 3. The inclined plane, the roll and the smartphone position in the roll

The time interval in which the roller descended on the inclined plane was $\Delta t = 2.76s$. The initial and final values of the speed of the center of the mass of the roll and the time moments corresponding to the beginning and the end of the movement, respectively, can be seen in the Figure 4. Using the experimental data, so after processing the raw data, students were able to obtain values of the acceleration of the center of mass. Figure 4 b) shows that the corresponding points are distributed along a line. The students can get the value of the acceleration of the center of mass on the slope: $a \approx 0.42 \frac{m}{s^2}$.

Having the value of the acceleration of the center of mass and the radius of the roller, it was possible to calculate the angular acceleration, according to the relation [3]. In this experiment its obtained value was $\varepsilon = 7.56 \frac{rad}{s^2}$.

[3] $\varepsilon = \frac{a}{R}$

Approximately the same value is indicated by the slope of the line given by the is shown in Figure 4b).

2.3 Kinematics of Accelerated Rectilinear Motion, Uniform Motion and Braking Motion of an Elevator

Open the Phyphox application and then search for the elevator. This experiment involves using the pressure sensor to measure the speed and distance traveled by a moving elevator. No initial configuration is required.

The user just gets in the elevator, presses the start button and starts the experiment. When ascending or descending an elevator, acceleration is measured using an accelerometer.

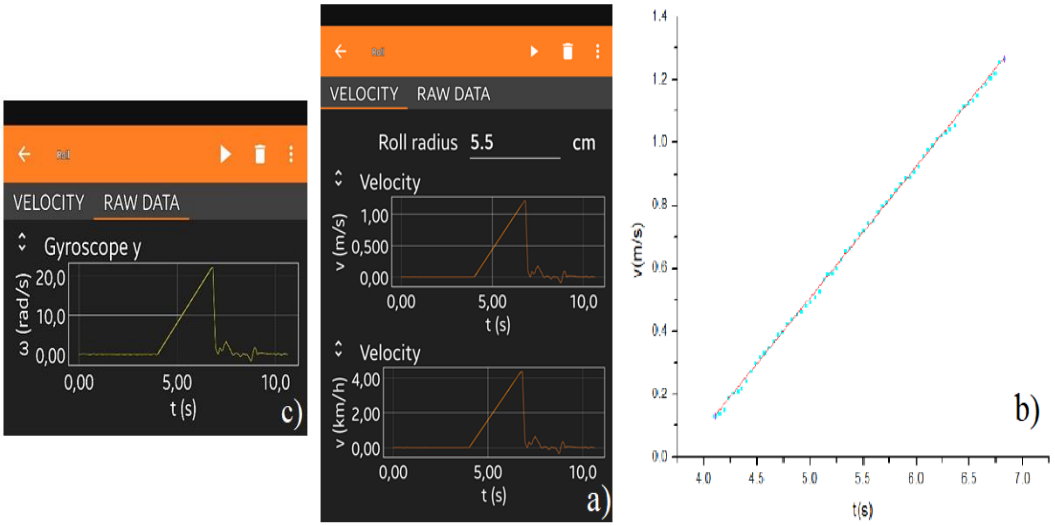

Figure 4. a) The velocity versus time graphic of the center of the mass of the roll on the inclinated plan; screenshot of the Android Phyphox app; b) Dependence of the linear speed of the of the center of mass of the roller versus time obtained from the raw data; c) The angular velocity versus time from the gyroscope of the smartphone; screenshot of the Android Phyphox App

The smartphone barometer can detect the difference in altitude even in places where the GPS does not work. Acceleration is measured using the Oz-component of the accelerometer, perpendicular to the front of the phone, from the screen to the user. The Ox and Oy axes are in the plane of the phone oriented on the width, respectively the length of the screen. For a correct measurement of the acceleration, the phone must be placed horizontally on the floor of the elevator, the sensor detecting changes in atmospheric pressure during the ascent or descent of the elevator.

Barometer readings are averaged per second. The difference of consecutive averages is converted into an altitude difference and the altitude difference divided by the time difference represents the vertical speed. The results can give a better interpretation of the types of movement if the elevator moves a distance of more than three floors.

The barometer is designed to determine the vertical position of the experimenter and is very accurate. The application considers the first reading of the sensor as zero dimension. To obtain height changes use the barometric formula [4], sufficient to determine relative changes in ground level:

$$[4] \quad p = p_0 \cdot e^{-\frac{g\mu(h-h_0)}{RT}}$$

where p is the air pressure at altitude h, p_0 is the air pressure at the reference level h_0, μ is the molar mass of air, R is the universal gas constant and T is the absolute temperature.

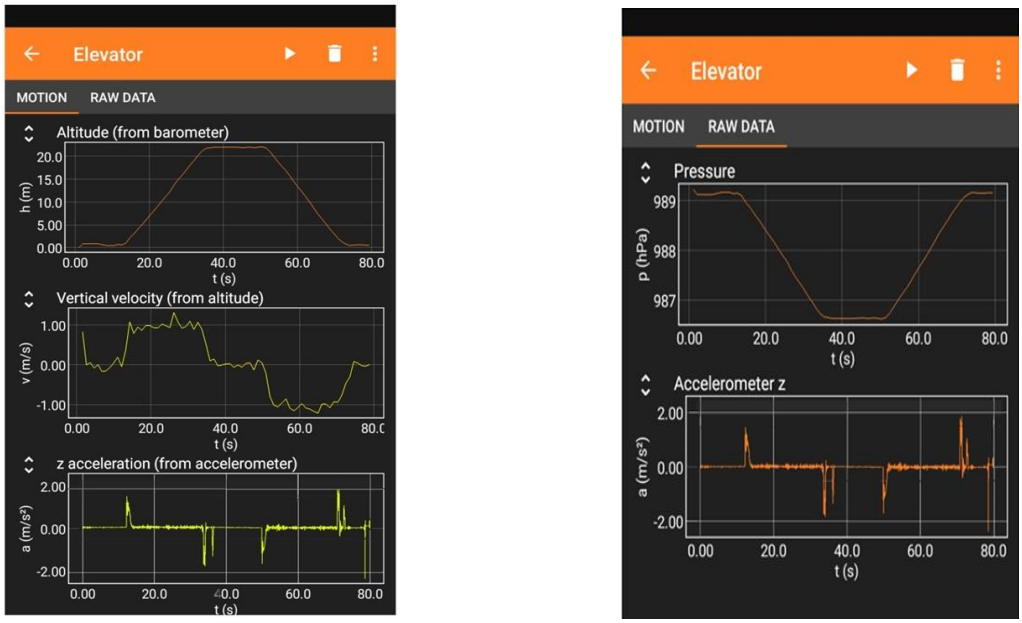

Figure 5. a) The graphs of altitude, velocity and acceleration versus time during the movement of the elevator (left); b) The graphs of pressure versus time during the movement of the elevator (right)

The speed of the elevator is calculated as the derivative of the space y in relation to time, according to the formula [5].

[5] $v = \frac{dy}{dt} = \dot{y}$

Figure 5 showed the variations of data taken from sensors. Figure 5 and the raw data show that the experiment took place over a period of 28 seconds. From the data provided it can be seen that in the first twenty seconds, when the elevator goes up to about twenty meters, the speed graph indicates the uniformly accelerated motion, the speed increasing from the initial speed $v_0 = 0$ to the value $v \approx 1\frac{m}{s}$ in $\Delta t_1 = 4.34s$, continued with a uniform motion for a time interval $\Delta t_2 = 16.19s$, and at the end we observe the slowed motion in which the speed decreases from the value $v \approx 1\frac{m}{s}$ to zero in $\Delta t_3 = 5.39s$. A time interval $\Delta t_4 = 9.69s$ the elevator was at rest on the top floor, after which the descent began, the speed increases in mode, but the speed vector changes its direction as shown by the negative values of speed in the graph indicating dependence v(t) also from Figure 5a). In the graph showing the dependence of a(t) a positive value of the acceleration during the accelerated movement and a negative value of the acceleration during the braked movement are

observed. These accelerations appear as picks because the time required for acceleration or braking is very small.

The maximum value of acceleration on ascent was $a_{max} = 1.5 \frac{m}{s^2}$ at the time $t_1 = 18.5\ s$ and at braking $|a| = 1.8 \frac{m}{s^2}$ at the time $t_2 = 35.5\ s$. The pressure varied between $p_{min} = 989.17\ hPa$ at the lowest point of the elevator trajectory and $p_{max} = 986.63\ hPa$. It can be concluded that between the ground floor of a block and its last floor there is a pressure difference $\Delta p = 2.54\ hPa$.

Through this experiment the students studied the three types of elevator movements between two successive stops: accelerated motion, uniform motion and braked motion.

3 Conclusions

The use of mobile phones and the Internet by students in the learning process is interesting for them and at the same time the tasks set by the teacher can be done quite easily. Students become more motivated and enjoy learning.

The experiments can be performed both in a laboratory and in a classroom and even at home, they can be done at any time and can be repeated as many times as needed. Passionate students can create their own research investigations. After performing the experiments, it is not necessary for students to make an analysis of the raw data obtained in the form of a spreadsheet. These data, obtained in real time, could be presented to the whole class by using a specific function of the Phyphox application.

By eliminating the time necessary for the processing of experimental data, it is possible to insist on some essential aspects of the presented mechanical phenomena. However, students were able to obtain information on experiments performed from the availability of raw data, were able to export these data in the form of a spreadsheet and were able to process them later.

The results of these experiments can improve the understanding of some concepts in the dynamics chapter and can be used later in solving problems, allowing an interaction between experiment, theory and their use in other situations. Data taken from sensors can make connections between definitions, mathematical calculations, graphical representations and the experiment realized in authentic situations. Variation is a necessary condition to help students learn new concepts (Kullberg et al, 2017) and the application Phyphox involved performing experiments different from those traditionally used in class.

Teachers can integrate experiments into face-to-face or distance lessons, thus creating interactive courses.

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Authors Index