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Enhancing digital and professional competences via implementation of virtual laboratories for future physical therapists and rehabilitologist

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Abstract. Being popular world-wide, virtual laboratories enter into different fields of education and research and practitioners have to be responsible for choosing the most suitable and then adapt them to particular field. The aim of the present work was to assess the effectivity of the implementation of Praxilab, Labster, and LabXchange virtual laboratories as the powerful digital tool into teaching protocols of "Clinical and laboratory diagnostics" discipline for physical therapists and rehabilitologist. We have carried out the online survey for 45 students enrolled in physical rehabilitation degree program. About 70% surveyed students reported that implementation of virtual laboratories in "Clinical and laboratory diagnostics" discipline met individual learning needs of students, helped acquired digital skills (25%), and supported them to stay ahead of the curve. The virtual lab applications, not only assisted harness students fair against lack of practical skills, but also brought about a new dimension to the classes and helped overcome digital alienation and gain their digital skills and abilities. Indeed, a virtual lab can't completely replace the experimental work and teacher's explanation, but it might support teaching activities of a modern mentor and learning activities of a modern student. Almost all of surveyed students (82%) expected that in near future the virtual laboratories would take the dominant place in the education market due to possibility of students' pre-train the key points of practical activities before real experiments in lab and better understand their theoretical backgrounds. Thus, this study is intended to contribute to utilization of virtual labs by students enrolled in study physical therapy/physical rehabilitation with expected efficiency.

Keywords: virtual laboratory, physical therapy/physical rehabilitation major, digital skills, blended education

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1. Introduction

The COVID-19 pandemic has accelerated the digitization of university education [4]. Indeed, the education system is facing a paradigm shift, which creates and even invents new possibilities into learning environment, stimulates new educational projects led by digital technologies. The acquirement digital skills is the name of the game for many universities due to numerous benefits they can bring in teaching, learning and research. The importance of technological innovations and their relevance in the context of blended education today is indisputable [4, 7, 9]. In the last few years, digital technologies have entered all levels of education, and changes in the profiles of teachers and students have become apparent. However, these technologies make it possible to create an effective creative learning environment in the teaching process, which might lead to important changes in the roles of both students and teachers, promote individualized learning and improve student motivation [12].

Experimental work is one of the most important sources of knowledge. In combination with modern equipment, technical devices, and appropriate tools for the educational process, it contributes to a deeper uptake knowledge, skills and abilities. Regular use of experimental work while teaching and studying natural and life sciences on classes helps to acquire skills and understand mechanisms and phenomena, explains their backgrounds in the context of theories, forms and improves experimental skills and abilities which are very useful in future professional activities, and finally fosters the utmost accuracy to work. The experiment definitely helps to understand the biological and biomedical peculiarities of internal processes, since this is the most important way of realizing the connection between theory and practice by converting knowledge into beliefs.

Practical classes belong to the particular features of degree programs in natural and life sciences at universities. However, these activities need numerous modern equipment and special technical devices to be used. Unfortunately, Ukrainian universities face number of problems with technological purchasing and modernisation of techniques, because lack of money. Even if the laboratory room is fully equipped with the required instruments and materials, real experience requires much more time both for preparation and implementation, and for analysis of the results of work. Virtual laboratory and virtual experiments might be good alternative to the real experimental work [10]. They allow teachers and students to be flexible, pre-train practical skills before real life situations. Also, many students can learn the theory online, but there are some significant limitations when trying to acquire skills online or through traditional methods. Indeed, virtual laboratories can be effective in helping students acquire skills in analytical and diagnostic thinking, develop strong persuasive skills, and make decisions under conditions of uncertainty [2].

Implementation of blended education with components of informal education into physical therapists and rehabilitologist degree programs could be of great benefit. E-learning and distance education allow rehabilitologist and physical therapists to brush up their knowledge, become more familiar with novel protocols, tools and equipment widely used for rehabilitation in EU and in the USA based on the principal of remote learning. The aim of the present work was to assess the effectivity of the implementation of Praxilab, Labster, and LabXchange virtual laboratories as the powerful digital tool into teaching protocols of “Clinical and laboratory diagnostics” discipline for physical therapists and rehabilitologist.

2. Methodology

Pedagogical experiment and online adapted surveys in terms of google form were carried out at Ternopil Volodymyr Hnatiuk National Pedagogical University (TNPU). The statistical representative sample included Bachelor degree students had enrolled in "Clinical and laboratory diagnostics" supplemented with virtual laboratories. The sample size was determined as 45. A majority (70%/30%) of surveyed students were women and represented young generation. The online course was available on the Moodle platform. Also, Praxilab (https://praxilabs.com/) and Labster (https://www.labster.com/), LabXchange (https://www.labxchange.org) were used to support and enrich proposed disciplines.

Students were welcomed to fill in the questionnaire that had prepared using Google Form in the mid and at the end of learning a subject. It was accessible via link in personal e-mail account and in the students Viber groups and Telegram channels for two weeks. The questionnaire contained several questions namely experience with ICT tools, virtual labs, and educational platforms, learning outcomes (knowledge, skills, satisfaction, perception, attitude, usability), perceptions of courses (content, deep sense of meaning, structure, clarity etc), assessment of perceptions and effectivity of virtual laboratories. In particular, we have asked students about "How helpful in practical and theoretical dimension was the implementation of VR apps in conducted disciplines provided to you?", "Successful integration of VR apps into on-line and face-to-face teaching", "Meeting individual learning needs", "Building skills and knowledge" etc.

Data were tested for the normality and homogeneity of variances using Kolmogorov-Smirnov and Levine test, respectively. For the data deviating from normality or homogeneity of variances, Box-Cox or log10 transformation was used. If the transformations did not result in normal distribution, non-parametric tests were used. All statistical calculations were performed with Statistica 12.0 and Excel 2019 for Windows. Differences were considered significant if the probability of Type I error was less than 0.05.

3. Results

Implementation of IT tools opens great opportunities for the formation of professional competences. Interactive IT tools make it possible not only to increase visibility, support students with information in user-friendly easy-to-understand form, maintain a mentoring function, but also solve didactic tasks that become relevant in the formation of competencies and in connection with the reduction of teaching hours for study of discipline, organization of self-study, concomitant repetition, control, revision, and evaluation of students.

We divided students into two groups namely control and experimental one. Control students studied course materials in classical methodological way when didactic materials and class activities in the experimental one involved virtual laboratories and short videos.

Our students are familiar with virtual educational tools that physical therapists and clinical laboratory technicians can use in their professional activities. They are welcomed to use virtual lab tools before practical classes to simplify understanding of the materials, and then interaction with teacher in class or via Zoom in case of distance or blended education. The most popular virtual lab are Praxilab, Labster, and LabXchange (figure 1). They are free, allow students and

teachers to absorb in simple way new practical knowledge, deeper involve into educational process and offer an easy way for mentor to control track of students.

Figure 1: Interface of virtual laboratory: A – Labster, B – LabXchange, C – Praxilab

The virtual laboratories that we have used on the "Clinical and laboratory diagnostic" classes follow some principals, among them:

1. The principle of interactivity, which based on organizing of interaction between a user, a virtual laboratory, and a computer that acts as an intellectual assistant. The virtual laboratory should lead the student during a process of problem solving, allowing or prohibiting certain types of actions. The teacher should receive all necessary information to estimate the level of formation of professional competences in a very student and all his/her classmates.
2. The principle of modelling is in the need to actively implement computer apps in solving practical problems. The analysis of a problem should begin with the construction of a biomedical model and then a descriptive model of the problem should be built. Finding an

appropriate solution of a problem is working with the initial data of the models. At each stage of modelling (formulating initial data, a solution, an answer), the virtual laboratory must analyze the student's actions, score them and propose appropriate recommendations.

3. The principle of providing a logical conclusion based on special algorithm of a virtual laboratory that should receive new information based on the available initial data.
4. The principle of compliance of the components of professional competences with the capabilities of a virtual laboratory. A virtual laboratory should be focused on the formation of all components of subject competence.

The main indicator of the effectiveness of the implemented methodology was an increase in the number of students who completed the interim and final test, showed high-quality skills of experimental work including pipetting, carried out step-by-step protocols for general blood test, analysed materials and maid valuable conclusions. We have observed that in the experimental group the number of students with high scores significantly exceeded the number of students in the control group.

We carried out the survey among the physical therapy degree program students to evaluate 1) the effectiveness of blended education and implementation of virtual laboratory into "Clinical and laboratory diagnostics" and 2) the level of students' satisfaction in terms of gaining knowledge, improving practical skills and theoretical backgrounds but not limited too. A total of 45 students of Bachelor degree took part in this survey. Due to survey results all of these virtual laboratories helped harness students fair against lack of practical skills while blended education. As an example, when we compare the responses of surveyed students, 25% of them emphasized that "Clinical and laboratory diagnostics" discipline enriched with modern ICT tools (e.g. virtual laboratory apps) had enhanced their digital performance (figure 2). They also emphasized that using of virtual labs on classes can help overcome digital alienation and gain their skills and abilities in the field of ICT.

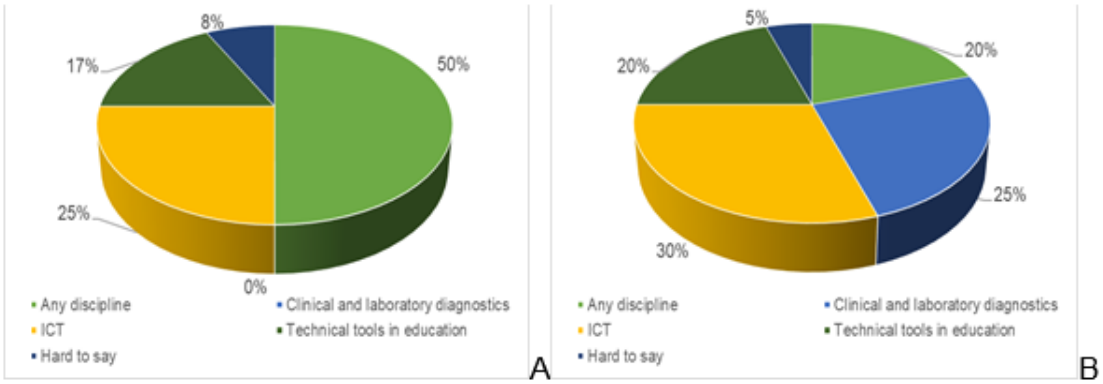

Figure 2: The rate of effectiveness of disciplines regarding acquirement digital skills in students of "Physical rehabilitation" major. A – control group, B – experimental group which was used virtual laboratories while studying "Clinical and laboratory diagnostic".

We also observed that the most of surveyed students had positive perception towards using virtual laboratories and they were basically satisfied with theoretical backgrounds and practical

skills which they were imbibing while face-to-face and blended education (figure 3). They also emphasized the merits of presentations, short videos and materials that had been downloaded and permanently appeared in the Moodle platform. Almost all of them (82%) expected that in near future the virtual laboratories would take the dominant place in the education market due to possibility of students' pre-train the key points of practical activities before real experiments in lab and better understand their theoretical backgrounds. Indeed, university managers also may well find benefits in virtual laboratory using not only in "Clinical and laboratory diagnostics", but also in other Natural and Life Science disciplines, because save money for reagents and suppliers as well as for modern expensive equipment. Due to insufficient funding, many laboratories in Ukraine equipped with old machines that can affect the results of experiments and pose a potential risk to students.

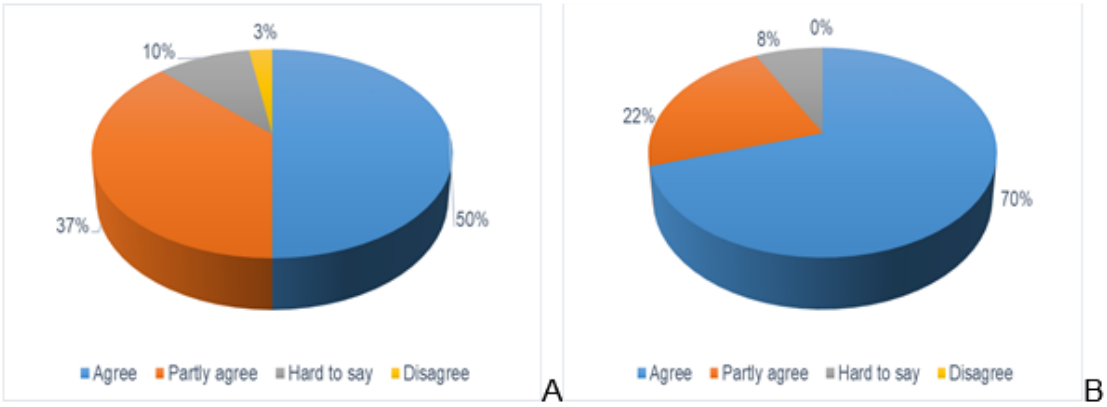

Figure 3: The rate of effectiveness of degree program regarding acquirement digital skills in students of "Physical rehabilitation" major. A – control group, B – experimental group which was used virtual laboratories while studying "Clinical and laboratory diagnostic".

Our students are very welcomed to enroll in some online courses stands for massive open online course platforms, e.g. Coursera. Massive open online course aims to provide real time education online with the help of various educational tools like short videos, lectures, concept notes, quizzes and online exams and also tries to make it more efficient and flexible than face-to-face education. Massive open online courses also provide interactive discussion sessions for the user which are likely to be very helpful regarding analytics, data analysis and valuable conclusions based on synthesis of initial data. Student who was enrolled for one course pretends to be the candidate for credit transfer within one class or even module. Due to our observation that makes students more open-minded and creative and totally corresponds to study outcomes and this option has to be included as one of the key elements of rigorous blended education environment (figure 4).

4. Discussion

Due to our knowledge not too much is known about implementation of digital tools while face-to-face and blended education of future physical therapists [5, 11]. This study called on

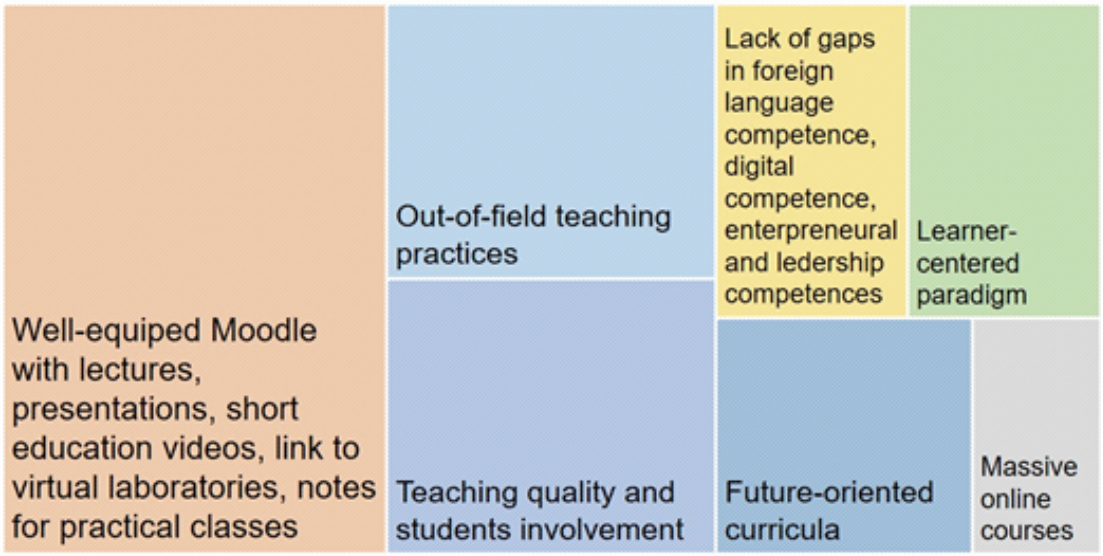

Figure 4: The key elements of rigorous blended education environment.

bringing some knew knowledge and practical experience in digitalisation of physical therapist and rehabilitologist classes via virtual lab implementation.

The rapid changes in Industry 4.0 demand change in education and teachers are expected to bring technology-based innovations to achieve success in learning [2]. Nevertheless Ukrainian universities own equipment, some of them are pretty old, because as low income country our Universities obtain not too much money for renovation as well as for suppliers. Using virtual laboratories in combination with real lab experiments belongs to the possible solution. It has been recently shown that virtual laboratories which based on 4D model (Define, Design, Develop, and Disseminate) can help students learn an object that cannot be presented in the classroom and they supported learning and transfer of knowledge in practical learning, especially during the COVID-19 pandemic [2]. Also, it was proved that students who were exposed to virtual lab in terms of pre-laboratory interventions showed lower level of anxiety and higher level of "experimental self-efficacy" [6]. This finding broadly supports the work of other studies in this area pursuing the idea that students being highly scored while using virtual lab on classes and have positive perception towards virtual lab implementation as pre-training option.

Not only in the field of Physical rehabilitation and Physical therapy, but also in areas of biochemistry, chemistry, molecular biology via virtual lab implementation we are allowed to simulate and display processes, which flow is fundamentally impossible in laboratory conditions. Modern computer technologies make it possible to observe processes that are difficult to distinguish in real conditions without the use of additional equipment, for example, due to the small size of the observed particles. Also virtual lab implementation into experimental-oriented disciplines might help students to penetrate into the intricacies of processes and observe what is happening in precise time point, which is important for processes that take place in a second or on the contrary, last for several years. The next important benefit of virtual lab is the safety

in cases where tools and/or material being compulsory for tasks realization should pose risk for human being, for example, high voltages or chemicals.

Being controlled by a computer, it becomes possible to quickly conduct a series of experiments should realize in a minute in virtual room with different values and input parameters. In that way we can simply find out correlations between output parameters and input ones. Finally, a separate and important advantage lies in the possibility of using a virtual laboratory in distance learning, when, there is no possibility of working in the laboratories at universities, as an example lock- or even shut-down in time of COVID-19 pandemic.

Blended or even online learning has not been very popular in physical rehabilitation and health care education. Nevertheless, some existed references support their effectiveness and emphasized that blended learning delivered in health care education is at least as effective, and could at times be more effective, than traditional face-to-face instruction [1, 3]. At the course level, many studies pointed that online learning of specialists in health care has equal or even better learning outcomes and supports higher student satisfaction [1]. However, successful implementation of online learning into the curricula of physical therapist and health care majors requires a deep-discussed and analysed strategy [8] which could be enriched with practical virtual cases and modern ICT tools (virtual laboratories and simulation apps as the examples).

5. Conclusions

All in all, the application of the virtual educational laboratories for studying natural sciences disciplines significantly improves the effectivity of the learning process, makes it more meaningful, profound, promotes the development of digital skills and abilities in students and staff, improves the quality of education, and simplifies distance education and/or blended education is becoming very popular while COVID-19 pandemic. Indeed, a simulator can't completely replace the experimental work and teacher's explanation, but virtual laboratories might support teaching activities of a modern mentor, learning activities of a modern student, improve professionalism, open new horizons and, most importantly, allow to strengthen the motivational component of learning through an active dialogue between the student and the computer, by orienting the student towards success and mastering the basic knowledge of natural sciences, including clinical and laboratory diagnostics.

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