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GUEST EDITORIAL: MEDICAL CURRICULA TRANSFORMATIONS – EPBLNET

Guest Editors

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GUEST EDITORIAL

The process of training medical students to acquire suitable skills for clinical or community decision making. The transition from medical school to clinical/community practice is a challenge both for junior doctors and medical schools. Key contributors to this challenge are associated with the significant differences and gaps between the actual requirements of clinical or community practice and the ways traditional medical schools provide skills and preparation to their students during the studies [1].

Many medical schools provide students with extensive clinical clerkship in order to experience real work situations. However, there is no guarantee that students will serendipitously experience the whole range of clinical problems. Populating curricula with electronic resources of interactive character has been typical for many Institution's modernisation strategy. Quite innovatively though, some Medical Schools use the notion of Virtual Patients (VPs) [2] to maximise the value of decision-making and clinical management through scenario based learning activities (SBL), as a teaching/pedagogic method of choice, that provides students with the opportunity to work, think, and take decisions collaboratively.

The aim of this special issue was to bring together education experts, medical teachers, medical informaticians and engineers, academics and health professionals and results stemming from their research and practice on curricula transformations so as to provide a contemporary snapshot of emerging themes. Emphasis is placed upon how new methods of evolving pedagogies like scenario based learning and problem based learning and virtual patients may be used as vehicles to drive curricular changes in medical teaching institutions.

Centred around these concepts was the ePBLnet project [3], the main objective of which was to modernize the medical course curricula in 6 Partner Countries Medical Universities (PCMUs), by implementing Problem-Based Learning (PBL) cases and Virtual Patient cases, which offer rich and memorable settings for learning, as they are built around decision making and enquiry-based collaborative approaches.

The first task in ePBLnet was to review and analyse medical curricula of PCMUs. The comparison revealed some similarities of curriculum structures overall, in particular, for years 1-3, and considered some differences in design, as well as the high number of hours of teaching per week in the lecture-based curriculum. Each PCMU was able to plan their new curricula using the PBL model and the required number of teaching hours per week, based on the coherent sequence of PBL sessions organised into a series of learning weeks, and then the organisation of teaching sessions to fit into those weeks. The outcomes of these steps are new timetables for each partner institution. Where necessary, each of the PCMUs have contacted their local Health and Education Ministries for approval of the change of learning style within their curriculum.

The PBL course implementation included several activities: a. Previewing and reviewing PBL cases provided by SGUL, b. Modelling, c. Adaptation of cases, d. Scheduling, e. Selection of tutors and tutor training, f. Delivery of PBL training in 1st year for testing, g. Delivery of PBL training in 1st year, h. Delivery of PBL training in 2nd year, i. Delivery of PBL training in 3rd year, j. Evaluation

Thus, one of the papers [4] included in this special issue is focused on the evaluation of student and tutor response to the simultaneous implementation of a new PBL curriculum in Georgia, Kazakhstan and Ukraine, based on the medical curriculum of St George's, University of London. This paper's results show that the ePBLnet project has created a solid foundation for the tutors, as well as for the students for successful implementation of PBL and that PBL increases the engagement of the students.

Continuing on this discussion, Shavlakadze et al [5] wonder whether the application of a mixed PBL curriculum in Medicine as a new educational program named "Medicine + PBL" was simply a requirement of time or an innovation. They then explain how PBL was implemented on the faculty of Medicine at Akaki Tsereteli State University (ATSU) in Georgia during the ePBLnet project, with the innovations being the basic medical and clinical disciplines became integrated into the program with other supporting courses and social disciplines.

In a third article of this special issue, Karasmani et al [6] explore the reasons for which VP authors do not use their own VP cases in usual curricula activities. Under what circumstance and for which reasons VP authors avoid VPs' exploitation thereby abandoning their own efforts made through the rigorous process of VPs' creation? Undoubtedly, the embracement of VPs can ptentially upgrade medical education practice. However, according to this study, infrastructural and organizational problems may in fact subvert VPs' utilization during the pedagogic process. Thus, it is important for institutions to strive and resolve such problems in order to facilitate medical education modernization and complete future curriculum transformation.

A final article of this special issue looks at the very important issue embracing the above whole concept of curricula modernisation using PBL and VPs, that is the concept of standardisation in medical education. Vaitsis et al [7] review, collect and select different available standards to address technical and educational aspects in outcome-based medical education. It is proposed that standardisation by means of applied technical standards, the availability of compliant systems and standardized vocabularies should be used for the description of medical and healthcare curricula so that a detailed picture of a curriculum's structure can emerge thereby addressing different technical and educational aspects of Healthcare Education, that may be beneficial for faculty, policy and decision makers. All the latter actors will then be able to better evaluate and measure teaching against the required outcomes, and therefore, institutions will be able to perform structured analyses, compare their curricula with those of other Institutions, while students can better understand their intended learning.

The emerging picture of this special issue lies with the modernisation of medical education. It is evident that classic approaches are no more valid and Institutions should move along well planned transformations. PBL and VPs could be a contemporary way forward, but Institutions should be aware of the need to always evaluate the impact of such modernisations, but also the inherent risks in this prospect, as well as, the potential benefits offered by systems and standards to mitigate such risks. This special issue provides some record for systematic approaches towards curricula transformations, which in the long term will be undoubtedly very useful.

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VIRTUAL PATIENT CASES: TO USE OR NOT TO USE? EXPLORING CREATORS' ATTITUDES AGAINST THEIR USE IN THE UNDERGRADUATE MEDICAL CURRICULUM

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ABSTRACT — Background: *The problems and difficulties in students' education that arise from the existing undergraduate curriculum at the medical school of Aristotle University of Thessaloniki (AUTH) urged the academic staff members to the pursuance of new pedagogic approaches that could revitalize medical education practice. The educational programs "mEducator", "ePBLnet" and "Ariadne" that run at AUTH laid the foundations for the development of a plenty of virtual patient (VP) cases. A VP is an innovative computer simulation method that can motivate students to occupy themselves with their studies and perfect their skills. Unfortunately, despite the indisputable advantages of embedding VPs to the lessons, their utilization is neglected during the educational process at AUTH.*

Objective: *The purpose of this study was to explore the reasons for which VP authors do not use their own VP cases. Why even VP authors avoid VPs' exploitation and in this way they forsake the insistent efforts they made through the rigorous process of VPs' creation?*

Methods: *After study's authorization, 35 academic staff members, who had previously developed their own VPs, signed an informed consent and fulfilled a specially designed questionnaire, mainly consisted of closed questions (answer: yes/no) about the possible causes of VPs' dereliction.*

Results: *Some 77% of participants granted that they do not utilize their own VP cases. Almost 56% of them admitted that the lack of proper infrastructures (computers, projectors) and Internet connection in the lecture rooms impede VPs' use. Specifically, some 33% acknowledged the absence of access to the Internet as the only reason of VPs' abandonment. Almost 52% claimed that they do not have enough time in the courses for covering the great curriculum. Moreover, almost 30% sustained that the great number of students in the lessons enables all of them to conduct a fruitful discussion. Almost 15% asserted that they do not exploit VPs due to the combination of the above two reasons.*

Conclusions: *Undoubtedly, VPs' embracement can upgrade medical education practice. According to this study, infrastructural in conjunction with organizational problems subvert VPs' utilization during the pedagogic process. The institutions should strive for these problems' resolution in order to facilitate medical education modernization and complete future curriculum transformation.*

BACKGROUND

The undergraduate curriculum at the medical school of Aristotle University of Thessaloniki (AUTH) has a duration of twelve semesters (six years) and is divided into the preclinical and clinical courses [1].

The medical students follow the preclinical courses in the first three years of their studies. They attend lectures and participate in laboratory exercises about basic sciences, such as Biology, Genetics, Biochemistry, Medical Physics, Physiology, Anatomy, Histology, Pathology, Microbiology and Pharmacology [1].

Unfortunately, the enormous number of lectures in contrary with the few laboratory exercises have as a consequence that there is no clear correlation between the basic science lessons and their value for the daily medical practice. As a result, students are often unable to use their basic sciences' knowledge in their clinical training [2].

In the following three years, they take the clinical courses, which include Internal Medicine, General Surgery, Urology, Orthopedics, Pediatrics, Psychiatry, Gynecology, Anesthesiology and other medical specialties. In these courses, they attend lectures and they commence having contact with patients, as they are taught about taking a medical history, performing a physical examination, ordering biochemical and radiological exams and making a differential diagnosis [1,2].

The foremost difficulty that all the trainees are called to confront in this period of their studies is the fact that they have to practice their skills for first time on real patients, where there is a very real possibility of harming the patients due to complete lack of clinical experience. Additionally, too many students are responsible for the care of one single patient, because of the great number of them trained at every university hospital. In this way, after their graduation, the new doctors indicate that they do not feel confident about their skills, since they did not practice some of them even once or they did not repeat them enough times in order to hammer them in. During their courses it is, also, highly unlikely to face a variety of medical diseases of all the medical specialties, that are not common or belong to the category of the rare diseases and learn how to recognize and encounter all of them efficiently, especially when their patient's life is jeopardized.

Furthermore, the immense curriculum that has to be studied during both the preclinical and the clinical courses make it impossible for students to remember the significant information that is essential to comprehend and exploit so that they will be effective as students and as doctors later [2].

All the problems and difficulties underlined above created the urgent necessity to attempt to upgrade the providing medical education with the purpose of equipping the students with a diversity of skills. The use of simulation of different clinical scenarios is the most modern alternative pedagogic method which is scientifically proven and acceptable (through many clinical trials and studies) that it increases students' interest in medicine in very important grade and it assists them to assimilate medical knowledge and enhance and finally perfect their skills [3-21].

Nowadays, many types of simulation are utilized during the educational process. For instance, there are simulators, manikins or automatic robots, which simulate human functions such as breathing or responding to stimuli, that are exploited in many medical universities worldwide in order to facilitate students' education [16,19,22].

Another kind of medical simulation is a virtual patient (VP). The definition of a VP was provided by Medbiquitous, which is an international organization, established by John Hopkins Medicine, which aims to the creation of open technological standards for medical education and in which AUTH participates as a member [23]. According to this organization, "a VP is defined as an interactive computer simulation of real-life clinical scenarios for the purpose of medical training, education, or assessment" [24].

Prior work

In Greece, the first VP cases were developed by several medical teachers and their research associates at the Medical School of AUTH under the educational projects "mEducator", "ePBLnet" and "Ariadne", which intended to contribute to the curriculum transformation by embracing the utilization of new technologies during medical students' education [2].

"mEducator – Multi-type Content Repurposing and Sharing in Medical Education project" was sponsored by the eContentplus 2008 programme and carried out by fourteen European partners between 2009 and 2012. The target of this project was to gather educational material and create interlinked data, which can be effortlessly shared and exploited [25].

Many European and Asian medical schools collaborated for "ePBLnet EU project" to promote the use of VP cases, give prominence to the significance of Problem Based Learning and set up a network of Medical Education Centers in Georgia, Ukraine and Kazakhstan [26].

The program "Ariadne" was implemented inside the medical school of AUTH and the participants were academic staff members who were trained in developing VPs. The program's goal was to introduce the new technologies in the medical education and highlight the VP cases as a new teaching approach [27]. An example VP screen from this project is demonstrated in Figure 1.

In general, numerous academic staff members of the medical school of AUTH (professors, assistant professors, lecturers and associate researchers) developed plenty of VP cases, which concern clinical scenarios of Internal Medicine, Pediatrics, Gynecology, Neurology, Oncology, Biopathology, Otorhinolaryngology, Radiology, Urology, Ophthalmology, Dermatology, Cardiology, Forensics, General Surgery, Vascular Surgery, Plastic Surgery and Pediatric Surgery. All the medical students of AUTH have free access to the VPs via Internet and they can practice to them at any time they wish [27].

There is no doubt that the creation of a VP is a thorny process, which requires much time and effort from the authors. All the VP cases were developed in agreement with Medbiquitous VP standards. The Medbiquitous VP standard includes five fundamental components [24]:

- the "VP data", which are information of the medical history and the medical examination related to the scenario and are necessary for the users to complete the VP case successfully.
- the "media resources", which are digital files, such as X-rays, respiratory sounds and are also correlated to the scenario.
- the "data availability model", which specifies how the data are exposed
- the "activity model", which determines the way that the users are able to interact with the VPs and
- the "VP player", which exposes the VP to the user [2,24].

For the development of the VPs, firstly, the authors had to create the medical scenario. Subsequently, they designed the labyrinth of the scenario by converting educational material to digital form with the assistance of Visual Understanding Environment (VUE). VUE is a software program that was made available by Tufts University [2,24,28]. At the end of the procedure, the authors used the program OpenLabyrinth as a VP player. OpenLabyrinth is a free web application for creating and deploying interactive web based scenarios like VPs [2,24].

Objective

Unfortunately, although the authors had really time-consuming and complicated courses for developing VPs and despite the dedicating and great effort they made, VPs are not extensively used during medical students' practice at AUTH. Hence, the aim of this article is to scrutinize the reasons that even VP authors do not exploit the fruits of their own efforts, the VP cases that they created through laborious work. Why VPs consist such a neglected education approach in the Medical School of AUTH, while they are widely utilized globally and they can ameliorate and modernize medical education practice?

METHODS

After the study's authorization by the Ethics Committee of AUTH, an email was sent to all the VP authors in order to inform them about the conducting survey. Afterwards, the VP creators received another email that contained as attachments an informative brochure, which described minutely the characteristics of the survey, a consent form which had to be signed by all the authors, who would decide to participate in our survey and a specially designed questionnaire about the reasons they might do not utilize their own VP cases.

The form consisted of seventeen questions. The first two questions concerned the participants' experience on computer use and informatics before the VPs' development. Specifically, one question inquired on how familiar the participants were with the use of technology such as Internet, computers and e-learning techniques. The participants had to assess themselves by grading their knowledge with one (no familiarity with new technologies) to five (absolute familiarity). The other question was whether they knew what VPs were. In addition, the participants had to grade their acquaintance with technology after the VPs' creation with one to five and record whether they applied their VPs to their lessons.

In case the authors responded negatively to this question, they were required to reply to a series of closed questions (they had to answer yes or no) which attempted to explore the probable explanations of disregarding VPs' exploitation. They were asked if they do not use VPs due to lack of time for preparing their presentations and embedding VPs in their lectures or lack of time for covering the curriculum during the lessons. Moreover, they were inquired if difficulties in comprehending VPs' way of function, deficiency in proper infrastructure (access to the Internet, computer, projector) or dearth of interrelation between the VPs and the curriculum of every course discourage them from utilizing VP cases. The other questions concerned if the reason they do not take advantage of the VPs is that they believe that the great number of students during the classes does not allow conduction of discussion for the VPs or that the students will face obstacles with VPs' use or they will not pay the requisite attention to this alternative educational method.

FIGURE 1. How does a VP screen look like?

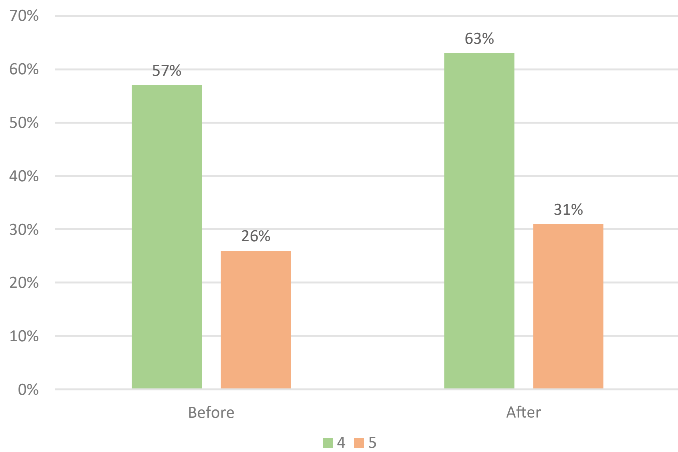

FIGURE 2. Percentage of participants grading their knowledge of new technologies with four and five before and after VPs' development

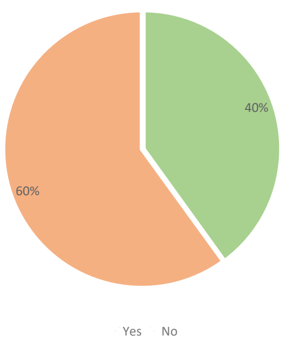

FIGURE 3. Did you know what Virtual Patients were before their development?

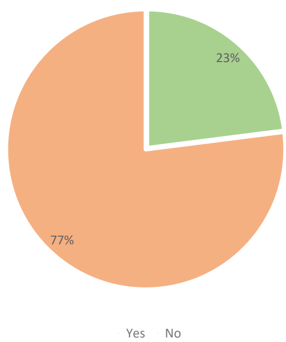

FIGURE 4. Do VP authors exploit their own VP cases?

TABLE 1. Questionnaire

Questions that concern authors' experience before VPs' development	**Answers**
How familiar with technology (Internet, computers, e-learning) did you feel before VPs' creation?	no familiarization: 1-2-3-4-5: complete familiarization
Did you know what VPs were? Answer:	Yes/No
Questions about authors' experience after VPs' creation	Answers
How familiar with technology (Internet, computers, e-learning) do you feel now?	no familiarization: 1-2-3-4-5: complete familiarization
Do you exploit VP cases during your lessons?	Yes/No
If you answered "no" to the previous question: You do not use VPs because:	...
You do not have enough time for preparing your presentations and embedding VPs in your lectures?	Yes/No
You have difficulty comprehending their way of function?	Yes/No
The courses have short duration and you do not have enough time for covering the curriculum?	Yes/No
They do not relate to the curriculum of every lesson?	Yes/No
You do not have the proper infrastructure (computer, projector, Internet connection) in the lecture rooms?	Yes/No
You believe that the great number of students during the lessons does not allow the participation of all of them in conduction of discussion and reaching decisions about the clinical scenarios?	Yes/No
You think that the students will struggle with VPs' use?	Yes/No
You suppose that they will not stimulate students' interest in their studies?	Yes/No
You believe that the students will not pay the necessary attention to this alternative pedagogic method?	Yes/No
You consider that they will not enhance students' performances?	Yes/No
For other reasons?	Yes/No
If you answered "yes", what are these reasons?	Yes/No

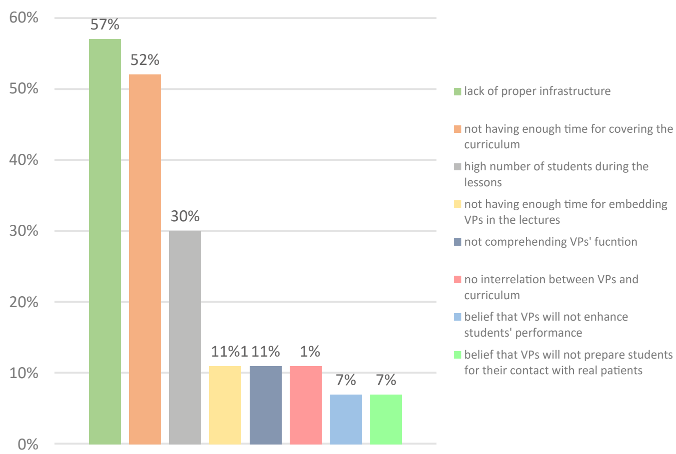

FIGURE 5. Reasons for not using VPs

Furthermore, they were asked if they avoid VPs' utilization because they consider that VP cases are not going to stimulate students' interest in their lessons, improve their performance or prepare them effectively for their contact with real patients. Finally, they were required to answer if there are other reasons except the above that could justify that VP cases remain unexploited. If the authors responded positively, then they had to clarify these reasons. Table 1 summarizes the entirety of the questionnaire that was presented to the participants.

RESULTS

Thirty-five academic staff members responded to our call and they fulfilled our questionnaire. The answers to the questionnaires were statistically analyzed and evaluated. Figures 2 and 3 reveal that some 57% and almost 26% of participants graded their knowledge of new technologies with four and five respectively before the VPs' development, while 40% of them admit that they did not know what VPs were. Almost 63% and some 31% of them graded their familiarity with technology with four and five respectively after completion of the courses they had for VPs' creation.

As Figure 4 demonstrates, some 77% of participants recorded that they do not exploit their own VP cases during their lessons. Almost 56% of them responded positively to the question if they do not utilize VPs because of deficiency in infrastructure, such as proper computers and projectors and Internet connection in the classrooms and amphitheatres. Particularly, some 33% alleged that the lack of access to the Internet during the lessons is the only cause of neglecting VP cases. Almost 52% of them contended that the great curriculum they have to cover during the short courses demoralize them from using VPs. Moreover, almost 30% asserted that the great number of students in the classrooms does not allow the involvement of all of them in the conduction of impactful discussion about the decisions that have to be made about the clinical scenarios. Specifically, almost 15% maintained that they avoid VPs' use due to the combination of the above two reasons. Some 11% claimed that they do not have enough time for integrating the VP cases into their lectures, while also some 11% struggle with comprehending VPs' function or do not utilize them as VP cases do not conform to the educational program of every lesson. Some 7% believe that VPs are not salutary and they are not going to enhance students' performance or prepare them successfully for their clinical training, while there were no positive answers to the question if they think that VPs are not going to trigger students' interest in Medicine. Furthermore, no one answered positively to the questions if they believe that the students will encounter difficulties with VPs' use or they will not give proper regard to this educational method. A summary of these results is visualized in Figure 5.

CONCLUSIONS

Undoubtedly, VP cases are able to revitalize medical education practice as they indubitably spark students' interest in the scientific field of Medicine and conduce to widening their knowledge and optimizing their skills [3-21]. Nevertheless, it has to be emphasized that VPs and generally medical simulation methods do not supersede real patients, but they broaden medical experience that is gained through daily care of patients [29,30].

Despite the indisputable benefits of VPs and the development of a plenty of them at AUTH, their use has not been established yet during the educational process at the Medical School of AUTH. This study designates infrastructural and organizational problems as the most consequential reasons that VP authors do not avail themselves of their own clinical scenarios. Appropriate computers and projectors as well as access to the Internet are unavailable in the classrooms and the amphitheatres of the Medical School. In addition, students are divided into large groups to have their courses and there is an unquestionable disproportion between the courses' duration and the enormous curriculum.

It is of crucial importance that institutions aspire to the solution of these problems promptly. The lecture rooms have to be equipped with modern infrastructure and the educational program should be flexible in order to contribute to the perfection of students' skills.

Policy formers have to attend painstakingly to these infrastructural and organizational problems and surmount these obstacles immediately in order VPs' use to be encouraged at the medical school of AUTH. The adoption of VPs' exploitation as a vital pedagogic method will be conducive to emending and revolutionizing medical education practice and will definitely urge to a radical curriculum transformation that will harmonize with the global educational standards.

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NEW EDUCATIONAL PROGRAM "MEDICINE + PBL" – REQUIREMENT OF TIME OR INNOVATION?!

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ABSTRACT — *Changes that are made in education during last decade is the guarantee of Georgia's integration in the European educational space. Accordingly, medical education must be based on the international standards and must be result oriented to get the competitive graduates on the medical market.*

Within the new medical educational program "Medicine + PBL" a new Problem Based Learning (PBL) teaching method has been implemented on the faculty of Medicine at Akaki Tsereteli State University (ATSU) during 3 years. The innovations are the basic medical and clinical disciplines that are integrated in the program, also their supporting courses and social disciplines. The structure of the program is conditionally divided into three steps: teaching basic, preclinical and clinical subjects and clinical teaching and clinical practicing stages.

Medical Doctor (MD) program is a "hybrid" program, where so called PBL cases are integrated into medical disciplines. In order to reach the learning outcomes, which includes the development of knowledge, practical skills/habits and values, the program is based on "4 spiral" model: the progress of knowledge and awareness, the doctor-patient communication, "public and population health" and "personal and professional growth". PBL teaching method and format strengthens the quality of program integration and provides the Medical Doctor with possibilities of effective achievement of Learning Outcomes (LOs).

INTRODUCTION

New methodologies of medical education are very rapidly developing in the modern world alongside with other fields of science. Modern medicine is inconceivable without the latest technologies, which require adequate knowledge. The process of obtaining and creating the knowledge begins in the medical classes. It is the place, where two main systems: theory and practice should be merged. This is difficult, but not impossible. Various innovative methods are implemented broadly in order to facilitate the processes of Medical Education. The teaching strategies and curricula of high medical schools are based on the recommendations and guide lines worked out by International Association for Medical European Education (AMEE) [1].

In Medicine it is important to develop not only basic theoretical and clinical science knowledge but also to obtain clinical skills, and to establish ethical values and attitudes very important for the profession [2]. Within the Bologna Process frame, competencies of basic medical education is determined according to the learning outcomes, which are developed according to the TUNING/MEDINE demands.

Nowadays, the result-oriented education is considered optimal in terms of the country's requirements, as it is based on the international standards of medical education, which in fact provides successful and competitive certified doctors.

Faculty of Medicine of Akaki Tsereteli State University was founded 20 years ago. It trains students in three fields: Medical Doctor (one-step high medical educational program), Doctor in Dental Medicine (one-step high medical educational program) and Pharmacist (with the degree of Bachelor / Master).

There are Georgian and English language Medical educational programs. It is one-step program with the duration of 6 years, comprising 360 credits, and equals the second level of the higher education.

The Faculty has a long-term history of cooperation with European partners. This gave us an opportunity to have high qualified teaching staff, which have been trained in the top rated universities of the world, to have in the latest modern electronic classes, to have research laboratories equipped with the newest facilities, all these make it possible to conduct electronic, distance learning with the partner universities.

To provide the quality assurance of medical education we permanently conduct the survey of our employers, graduates and students. For this purpose, last survey was done with total number of 130 from the second (49), fourth (40) and fifth (41) year students. They were asked just two simple questions: Do you like the learning process and what would you change in the educational process?

The results showed that in general, students are content with the educational process and despite positive attitudes, 47% of interviewed complained about the educational process resentment and stated that they would like the following improvements: to get more information from a lecturer (41%), more visual materials (48%) and to discuss more clinical cases (93%). The last request which implies desire and importance to do more case-study learning was underlined by the vast majority of the students (93%).

It should also be mentioned that during the last decades Georgia has been in the atmosphere of permanent changes, and then it becomes easy to guess that something was not done as it was necessary and some additional changes or improvements were required?!

THE GOAL

The quality of basic medical education, as the most important preliminary condition for a successful medical practice, and its relevance with international standards is a major problem of the health system to ensure optimal operation of Georgian healthcare system. The adoption of this in cooperation with foreign counterparts appeared to be more easily achievable.

In cooperation with our foreign colleagues (St George's University of London, Aristotle University of Thessaloniki and University of Nicosia) and with the help of Tempus grant project 530519-TEMPUS-1-2012-1-UK-TEMPUS-JPCR **“Establishment of the Supra-Regional Network of the National Centres in Medical Education, focused on PBL and Virtual Patient (ePBLnet)”** Georgian Universities (David Tvildiani Medical University and Akaki Tsereteli State University, Faculty of Medicine); Ukraine (Sumy State University and Zaporozhye State Medical University); Kazakhstan (Astana Medical University and Karaganda State Medical University) started the modernization of the basic stages of the existing educational programs. The changes were based on the introduction of a new learning method - problem-based learning [3].

Although the problem-based learning, or PBL counts more than 2 decades of its existence and it is the most approved and recommended training method not only on medical but other faculties of the world’s leading universities, it is still “innovative” and strange for the post-soviet countries [4–8].

THE WAY TO ACHIEVE THE GOAL

The ePBLnet group, created on the Faculty of Medicine of ATSU in accordance to the requirements of the Tempus project started working in five different directions: modernization of the curriculum, translation and adaptation of dozens of cases, training of tutors, setting up the online library and creating PBL training infrastructure. What is more, all these had to be done in a short period of time in about 1.5 year. The implemented changes were mainly focused on the teaching / learning methods, in particular, the problem-based learning, as a relevant methodology of a new “study week”. The “PBL Group” of Akaki Tsereteli State University designed quite a new integrated curriculum in the process of modernization of the old one, which, in its turn, caused development of a new training strategy based on a new study approaches, aims, environment, new systems for assessment and evaluation. As a result a new one-step high medical educational program "Medicine + PBL" was created.

RESULTS

A new high medical educational program of ATSU is personalized and competence-based, characterized by vertical integration (of 6 years long) on basic training, pre- and clinical stages. The teaching and learning process of the program is designed in the way, which brings the students to their future medical activities as close as possible.

The basic concept of the educational program implies a student’s deep understanding of a profession. At any stage of training, ranging from basic to clinical sciences, a student analysis obtained information / knowledge in terms of clinical practices. All these became possible through distributing PBL weeks (49 PBL weeks) from I to X semesters.

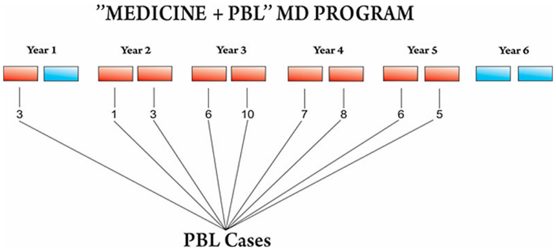


FIGURE 1. Number of PBL weeks in new MD Program and distribution of cases by semesters

New program structure

The program integrates basic medical and clinical sciences as well as their supporting courses (e.g. biophysics), social sciences (e.g. history of medicine, professional aspects, etc.); which is necessary for a modern doctor to receive general professional education / promotion. Thus the program ensures reaching scientific competencies and obtaining clinical skills for the MD students.

Teaching courses are maintained unchanged for II, XI, XII semesters, while the rest of the courses mostly were grouped into 6 main modules: Life Cycle, Life Protection, Life Support, Life Maintenance, Life Structure, Life Control and are adjusted in accordance to issues considered by cases.

Some cases were distributed among various Basic and Clinical courses. Accordingly, new program systematized and integrated them (PBL cases) in accordance to the above mentioned modules, as well as embedding in same Basic (e.g. Microbiology/Immunology) and Clinical Courses.

Particularly, organization structure of the program is conventionally divided into the following stages:

Stage I (semester I–IV) Basic: It focuses on the structure and function of a human's main systems (Anatomy, Histology, Biochemistry, Physiology), which are mostly presented in a modular organization and based on a horizontal integration of the Basic Medical Sciences around the systems (Structure and Function of Organism 1,2,3,4,5,6) (Figure 2). At this stage human development is taught (Human Genetics, Embryology, Cytology) and the most important professional aspects for future physicians are introduced based on the Case (PBL Weeks). At this stage of the study, a student studies the issues focused on the population health which is organized in the special module (Epidemiology, Hygiene, Medical Statistics, Medical Physiology and Sociology), as well as the disease-causing mechanisms and its development (Pathology, Microbiology and Immunology). The name of this phase **The stage of basic medical sciences** is only conventional. It contains a significant part of clinical medicine and population health, which is also supported by PBL training. The basic part of the program and 7 PBL weeks embedded in it, on the one hand, is a good base for teaching the program in PBL format in the future stages. In addition, more issues of clinical "practice" can be discussed and realized. This stage also includes the introductory materials essential for studying the basic and clinical sciences of the human organism systems (human development, the structure and function of an organism, Pathology, Topographic Anatomy and Operative Surgery, Immunology), which, in turn, is the basis for the utilization of the fundamental medical subjects.

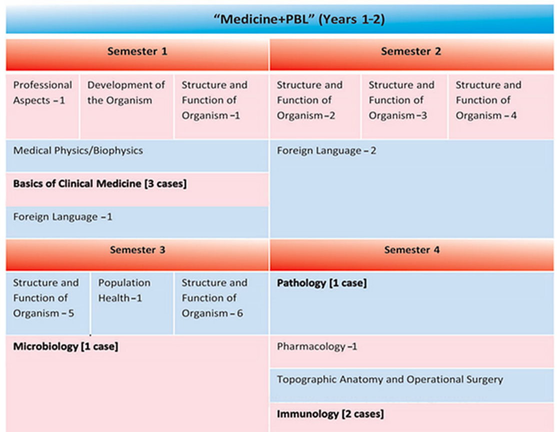


FIGURE 2. Basic stage (semester I–IV) in the new MD Program

Stage II (semester V–X) pre- and clinical stage study, which is mostly organized on understanding of important aspects of Human Health and morbidity as are: Life cycle (Sexual aspects of health and morbidity; Sexual development and health; Regulation of fertility; Preconception and Prenatal Care), Life Structure (Rheumatology and Orthopedic medicine), Life Control (Neurology, Psychiatry, Nutrition), Life Support (Cardiology, Pulmonology, Ophthalmology-,Otorhinolaryngology) and maintenance (Gastroenterology, Nephrology, Urology, Endocrinology), Life Protection (Infectious diseases with parasitology, Virusology, Hematology, Oncology, Clinical immunology-allergology). This phase of teaching is carried out by organizing a number of relevant disciplines in general training modules and respective PBL sessions are participating (compulsory) in the training format. This stage of study also contains non-modular teachings in the disciplines (General Principles of Diagnostics, Pharmacology, General Surgery, Basics of Clinical Investigation, Pediatrics). The most important part of this stage of learning is to organize the contents of the module with involving clinical cases and PBL study week, which enables the integration of knowledge in essential basic sciences determined by the case and the contents of its (the case) clinical "part" (anamnesis, symptoms, researches, interpretation, management, communication with a patient and population health issues, etc.) in such a way that the knowledge obtained at the basic stage of learning contributes to "revise", "understand in the context" and more in-depth study (concepts of basic and clinical sciences and their interrelationship). An important aspect of this stage is also a gradual development of the issues included in the module ("Life Cycle 1, 2" in the 5th semester, "Life Cycle 3" in the 7th semester) which means to move gradually from the linear cases to more difficult branched cases (where the "price" of the decision is very high and in case of wrong choices, the group of "students-doctors" harms the patient). It significantly develops the student's decision-making skills.

Stage III – (semester XI–XII) clinical clerkship for clinical practice, which is mostly a stage of general specialization for clinical practice (for the relevant positions of the certified doctors: an assistant of a doctor, passing exams in residency, etc.), when the students train their clinical skills mostly on a clinical base.

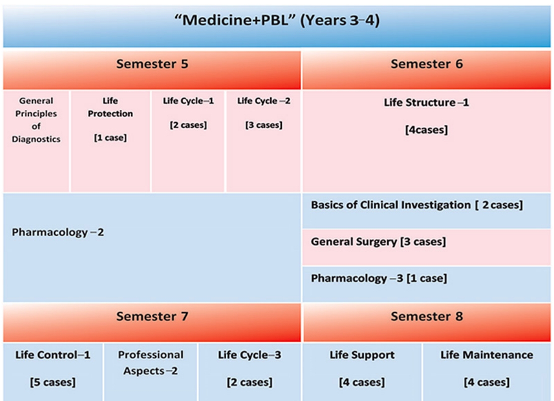


FIGURE 3. Preclinical and clinical stage (semester V–VIII) in the new MD Program

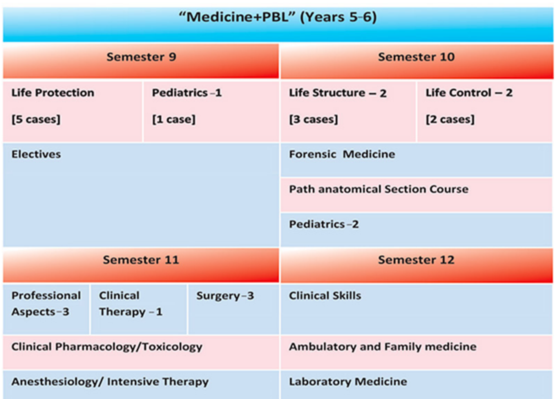


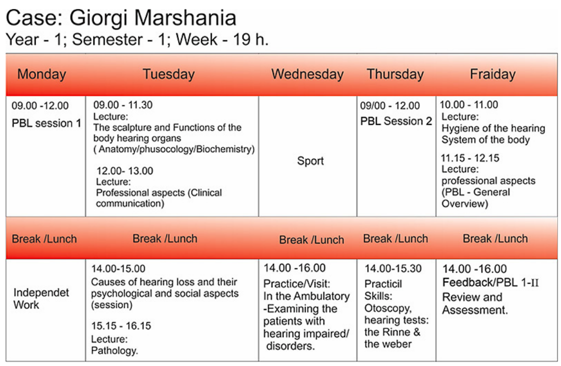
FIGURE 4. Clinical internships stage (semester IX–XII) in the new MD Program

"PBL Week" model/credit/assessment

One credit involves 25 hours of which 15–17 hours are intended for contact and 8–10 hours – for students' independent work.

PBL week is structured as follows 3 PBL tutorials (Monday and Thursday mornings, Friday afternoon – summarizing) + teaching sessions (Tuesday, Wednesday and Friday mornings) + clinical attachment and/or a visit to the skills lab (Tuesday or Wednesday afternoon) + practical sessions; assessment at the end of PBL week and periodically experts forum (**note:** considering a particular case specificity the structure is slightly adjusted).

The assessment of a student in MD program is multicomponental (activity, attendance, daily testing, essay, presentations, PBL, surveys, final exam).The evaluation of the learning in the PBL format is also a part of the ongoing assesment and includes: the assessment of the PBL training level, logical thinking / reasoning, communication (with colleagues / patients) and clinical skills. It (above mentioned) has 10% share in the final evaluation of the student.


Case: Giorgi Marshania
Year - 1; Semester - 1; Week - 19 h.

Monday	Tuesday	Wednesday	Thursday	Fraiday
09.00 -12.00 PBL session 1	09.00 - 11.30 Lecture: The scalpture and Functions of the body hearing organs (Anatomy/phusocology/Biochemistry) 12.00- 13.00 Lecture: Professional aspects (Clinical communication)	Sport	09/00 - 12.00 PBL Session 2	10.00 - 11.00 Lecture: Hygiene of the hearing System of the body 11.15 - 12.15 Lecture: professional aspects (PBL - General Overview)
Break /Lunch	Break /Lunch	Break /Lunch	Break /Lunch	Break /Lunch
Independet Work	14.00-15.00 Causes of hearing loss and their psychological and social aspects (session) 15.15 - 16.15 Lecture: Pathology.	14.00 -16.00 Practice/Visit: In the Ambulatory -Examining the patients with hearing impaired/ disorders.	14.00-15.30 Practicil Skills: Otoscopy, hearing tests: the Rinne & the weber	14.00 -16.00 Feedback/PBL 1-II Review and Assessment.

FIGURE 5.THE PBL week of a patient (G.M.) with hearing impairment

DISCUSSION

ATSU's MD program frame realizes the so-called "Hybrid" Program (integration of the medical disciplines and knowledge into modules with PBL participation /implementation, and without them: certain parts of the program are non-modular); it is important to describe "the way" of reaching the results of the program that describes the "own" spiral in terms of the development of the student's knowledge, skills and values :

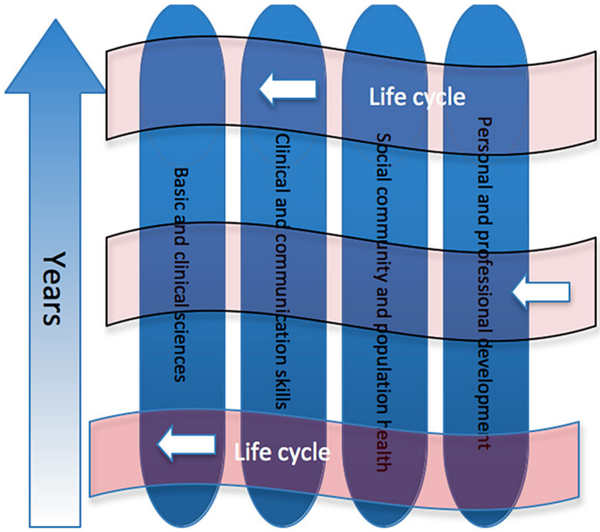


FIGURE 6. Vertical integration – a spiral curriculum

The whole program can be presented as one spiral in terms of the **knowledge and understanding progress**, which is practically continuous from the stage I till the end of the learning process. It involves learning valuable issues of basic medical and clinical sciences and understanding them according to the context: Introduction – a horizontally integrated module (stage I, e.g.: The Structure and Function of an Organism-4 "Cardiovascular") + followed by modules organized on the bases of important issues of human norms and pathology (stage II – pre- and clinical study stage, e.g.: "Life Support – Cardiology"),which ends with a practice in a general specialization (stage III).

II spiral represents a very important part of a future doctor's professional competences, which can be described under the name of t**he patient-doctor communication**, which implies the understanding and training very important aspects (which covers all structure and organization of the program through focusing on PBL, e.g. Professional Aspects 1, followed learning in PBL format, clinical studies and practice.)

III spiral conventionally represents "Social, Community and Population Health". It also begins with a teaching in theoretical and PBL format (Population Heath – 1), develops in context (contexts – specialization and/or child/adult/elderly, epidemiology, etc. These issues are discussed almost in every PBL cases. See PBL week) and creates the possibility to develop the learning outcomes of a certified doctor gradually (in this part).

IV spiral "Personal and professional development" is also developing step-by-step (it is supported by theoretical courses, e.g. Professional Aspects 1) and also promotes the possibility to reach the very important goal of the educational program of a certified doctor – „Doctor as a professional" (MEDINE 2).

So, PBL method and format enhances the degree of the program integration, provides possibilities for effective achievement of learning outcomes of MD program, particularly through spiral organization of the program content.

At last, we can say, that learning progress is an outcome of multiple factors, some directly related to formal courses and some to informal and self-directed learning.

And we can be sure in ATSU a new medical program "Medicine + PBL" is benefit for students: this program increases integration level and complexity, it requires more self-directed learning in unstructured environment; PBL educational format increases their responsibility, reflection, teamwork skills and personal knowledge including increased understanding the "value" of an error and motivates them on life-long learning.

Note: The new medical program "Medicine + PBL" was successfully accredited in 2015 and the enrolment of students officially started in 2016.

ACKNOWLEDGEMENTS

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EVALUATION OF STUDENT AND TUTOR RESPONSE TO THE SIMULTANEOUS IMPLEMENTATION OF A NEW PBL CURRICULUM IN GEORGIA, KAZAKHSTAN AND UKRAINE, BASED ON THE MEDICAL CURRICULUM OF ST GEORGE'S, UNIVERSITY OF LONDON

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ABSTRACT — ***Background:*** *In 2012, the European Commission funded a three-year TEMPUS project, ePBLnet, which set out to replace the traditional didactic medical curricula of 6 Medical Schools in Georgia, Kazakhstan and Ukraine, with a Problem-Based Learning (PBL) curriculum based on St George's, University of London (SGUL) curriculum. SGUL has experience in adapting its curriculum to other language and cultural environments but this adaptation represented a much larger step in complexity and degree of cultural change.*

OBJECTIVES: *To explore the outcomes of the implementation of PBL in 6 Medical Schools in Georgia, Kazakhstan and Ukraine, from the point of view of the PBL tutors and the PBL students in accordance with the initial evaluation plan of the project.*

Methods: *Two surveys were created and distributed amongst the PBL tutors and PBL students to analyze the impact of the PBL methodology. A total of 33 tutors and 144 students from the 6 institutions completed the survey. The surveys were created and distributed online and were available in Russian and English to avoid language and distance barriers.*

Results: *The results show that the ePBLnet project has created a solid foundation for the tutors, as well as for the students for successful implementation of PBL in all 6 institutions. Both the students and the tutors considered that implementation of the ePBLnet project has been of high quality. Furthermore, the data supports the affirmation that PBL increases the engagement of the students.*

Conclusions: *The outcomes of this implementation have been highly successful, and are being used to justify further use of PBL in countries with cultural similarities. Further evidence needs to be collected to explore whether learning is enhanced in comparison with traditional methods.*

INTRODUCTION

Lecture-based learning approaches have been dominant in most classrooms in traditional tertiary education for much of the twentieth century. This was particularly true in the Soviet Union where for several generations, a centrally-controlled content driven approach was used in admission, curricular and pedagogic policies. Training was based on scientific knowledge and specialisation [1] which was regarded as the most efficient and effective approach for preparing students for their future working environments in medicine and healthcare. From this position students would move directly to an apprenticeship phase, in clinical attachments.

Post-Soviet cultures retained a legacy of this didactic teaching and common structure, long after the dissolution of the Soviet Union. This was true in countries as regionally separated as Georgia in the Caucasus, Kazakhstan in Central Asia and Ukraine in Eastern Europe, where the curricula still retained a common traditional structure. However within all these regions it was recognised that conventional methods of teaching often failed to motivate students, or support them as active learners [2]. Teaching methods based on just acquisition of knowledge no longer appear to fully prepare students with the skills and attributes they would require in their future working environments. Gradually, training has moved away from a total concentration on scientific knowledge, towards a greater concentration on clinical management, skills, and practice or team working competencies. Many post-Soviet states followed these developments. In Central Asia, Caucasus and Ukraine, efforts continue to be made to accommodate international standards of medical education, and reforms were assisted by international agencies and promoted by the formulation of regional guidelines [3,4].

Curricula innovations in medicine are more recently built around enquiry-based collaborative approaches to learning, especially with Problem Based Learning (PBL), where students work in teams to explore, manage or solve a problem. Moreover, recent curricula have benefited from technological developments to introduce interactive forms of PBL using 'virtual patients' (VPs) [5].

Many teachers regard the use of PBL as controversial. A systematic review of the PBL in undergraduate, preclinical medical education had shown inconsistent results concerning the effectiveness of PBL relative to more traditional methods [6]. In particular there are concerns that basic knowledge may not be adequately acquired in such a system [7,8]. Moreover, there was some evidence that a learner-directed rather than teacher-directed educational system may bring its own issues to PBL in a previously didactic system.

Despite this evidence, PBL has been largely supported to improve medical curriculum as an active learning strategy alternative to the unidirectional teaching style, improving the quality of Medical Education and specifically team working and clinical reasoning. Both qualities are considered fundamental to clinical practice.

St George's, University of London (SGUL) set out to address both these potential issues, the knowledge concerns, and the motivation to learn. SGUL established a more immersive PBL experience in which students had the opportunity to manage the patient in a more authentic way. Cases were converted into branched VPs which led to the transformation of the traditional PBL into decision PBL (D-PBL) [5,9].

Following this, in a European Commission Tempus-funded project developed by SGUL and coordinated by Aristotle University of Thessaloniki (AUTH), a consortium of 9 universities across Eurasia began the implementation of PBL in 6 medical schools from Ukraine, Kazakhstan and Georgia. The focus was on competence-based learning, built around PBL and VPs using a more immersive form of interactive PBL (or D-PBL). These countries in common with many post-Soviet countries, still shared common curriculum characteristics derived from the former Soviet Union's centrist policies.

This paper evaluates the implementation procedures of the interactive PBL in these post-Soviet countries. This evaluation will be based on the stakeholders at the end-point of the curriculum change: PBL students and PBL tutors. It explores the experience of the students when implementing PBL and considers how the use of technology impact upon the student experience. It analyses the experience of the tutors when implementing PBL, in terms of impact upon the skills required by staff, the effectiveness of staff training and considers whether PBL curriculum alters the facilitation role of tutor, and whether PBL tutors have sufficient technology skills for the new course.

METHODS

The ePBLnet evaluation covered all curriculum development activities and project outputs, aiming to provide a summary of the project progress and capture the experiences of key stakeholders, as well as to identify any unintended outcomes that resulted from the project work. The evaluation report was the foundation for disseminating key findings and recommendations that emerged from the project, this information providing a basis for future work.

We adapted the evaluation plan from an existing methodology for project evaluation [10]. The evaluation was primarily summative, to assess the effectiveness of the project and its outcomes. We used mixed-methods, with quantitative methods to gather feedback from the large student population, and qualitative methods to gather more in-depth opinions from smaller tutor and partner groups.

We initially created a conceptual model of the project, identifying the project inputs and long-term outputs, and mapped the project activities to the key

TABLE 1. Summary of student and tutor stakeholder evaluation questions

Stakeholders	Audience's key values, interests, expectations	Key evaluation questions
Students	Student experience, student performance	Does the use of PBL increase student motivation and engagement? Does the use of PBL increase or decrease student workload? Does the use of PBL affect student performance? In what ways does the use of technology impact upon the student experience?
PBL Tutors	Training requirements	Does the PBL curriculum impact upon the skills required by staff? Have teaching staff been given sufficient training? Does the PBL curriculum alter the facilitation role of staff? Will PBL tutors have sufficient technology skills?

short-term outputs and deliverables. This provided a clear overview of the project, and enabled the key stakeholders and evaluation questions to be identified, the questions relating to students and tutors are shown in Table 1. The conceptual model was primarily created by a member of the project team (LW), and the stakeholders and key evaluation questions were derived from this model. The nature of the questions were based upon experiences of a previous curriculum transformation project, the JISC-funded (Joint Information Systems Committee) project Generation 4 [11].

Having identified the key stakeholders and evaluation questions we devised a strategy which would ensure that we were able to collect sufficient data to evaluate the project effectively. This strategy was heavily informed by practical concerns, and two key difficulties were identified in the data collection and data analysis stages of the project; the geographical separation of the partners and the barriers caused by language differences represented a significant challenge.

To address this, all data collection was performed using online tools, and instruments tailored to the requirements of both that particular evaluation activity and the target stakeholder group. The use of online tools for data collection negated the challenge represented by the geographical location of partners, as all data was stored in a central online repository. The evaluation instruments were developed with the collaboration of all project partners. The responsible partner for the evaluation activity developed a first draft for the questionnaire/interview question stem, and solicited feedback from other partners. Evaluation instruments were adapted from an existing validated resource [12] designed as an evaluation instrument for VP activities. It was agreed that the instruments would limit the use of free-text response questions, ensuring that the challenge of data analysis across multiple languages was reduced. Where translation was required, partners would be responsible for translating responses into English as a common language for analysis.

Evaluating the project from the perspective of students and PBL tutors required the gathering of data from a relatively large sample of participants, for which we used an online questionnaire developed using SurveyMonkey [13]. The choice of tool was due to the clear advantages offered over paper responses; the ability to store response data in a single online location thus reducing lost or incomplete responses, provision of mandatory questions, and data validation which ensures correctly formatted and legible responses. The questions were written in English, with a Russian translation provided directly below each question. Questions were predominantly closed-ended and represented using Likert items and multiple choice questions, thus limiting the impact of the language barrier for both analysis and completion by minimizing the number of free-text responses required.

The PBL tutor online survey was formed by 9 questions that were to be completed by the tutors after the implementation of the interactive PBL and carrying out the PBL sessions. The questions were built to give answer to the key research questions mentioned above.

The student online survey was formed by 16 questions that were to be completed by the students at the end of the implementation of the changes in the curriculum and carrying out the PBL sessions. The questions were built to give answer to the key research questions mentioned above.

TABLE 2. Summary of student and tutor stakeholder evaluation questions

Participant (evaluation focus)	Data collection methods	Evaluation instrument
Students (student experience)	Online	Student experience survey
PBL tutors (tutor experience)	Online	Tutor experience survey

TABLE 3. Distribution of student responses per institution

Name of the institution	Number of students
David Tvildiani Medical University (DTMU)	6
Akaki Tsereteli State University (ATSU)	4
Sumy State University (SSU)	2
Zaporozhye State Medical University (ZSMU)	7
Karaganda State medical University (KSMU)	5
JSC Astana Medical University (AMU)	9

We analysed quantitative data collected from the online surveys using SurveyMonkey online tools. These tools provided aggregated responses, calculated means and percentage response rates, and also constructed tables and charts for visual analysis and confirmation of trends in the student and tutor experience. Bar charts were used for visual analysis, but results were primarily presented in frequency tables since these provided the most complete view of the data. We used descriptive statistics to summarise the data; means were calculated to reflect the central tendency of responses, and standard deviation was calculated to provide an indicator of the variability of the responses. We provided full frequency data and the use of means and standard deviation in line with evidence that this would provide a full picture of the responses, and that the use of parametric methods was appropriate for ordinal Likert-type data [14,15].

A process of manifest content analysis was conducted to analyse the limited number of open-ended responses. Three researchers (AS, EP and CS) identified a schema of codes based upon the conceptual model and key evaluation questions identified in the evaluation plan. Each reviewed the open-ended responses, coding for quotations that addressed the areas classified in the codes. Having done so individually, their analyses of the data were compared and merged, with discrepancies agreed by discussion. This process allowed key quotations in the open-ended responses to be identified that provided additional context to the findings in quantitative data.

RESULTS

Students

A total of 144 students from 6 partner institutions of the ePBLnet project completed the online questionnaire. The distribution within the Partner Institutions (Ukraine, Kazakhstan and Georgia) is shown in Table 3. For ease of analysis, and based on identified areas/directions of research, the 16 survey questions were collated into 5 thematic groups: engagement, improving performance, workload, use of technology, quality and overall evaluation (shown in table 4). Likert responses were classified numerically from 1 (strongly disagree) to 5 (strongly agree) for purposes of generating descriptive statistics.

TABLE 4. Results of the survey developed to evaluate student response

	Answer options	Strongly disagree (1)	Disagree (2)	Not sure (3)	Agree (4)	Strongly agree (5)	Mean	Standard deviation
	ENGAGEMENT							
Q1	I felt I had to make the same decisions a doctor would make in real life	1	3	10	78	47	4.2	0.722
Q2	I felt I were the doctor caring for the patient	1	3	25	74	36	4.0	0.768
Q3	I was actively engaged in gathering the information I needed to characterize the patient's problem	0	0	4	66	69	4.5	0.554
Q4	I was actively engaged in revising my initial diagnosis as new information became available	1	1	7	67	63	4.4	0.680
Q5	I was actively engaged in creating a short summary of the patient's problem using medical terms	0	3	15	74	47	4.2	0.705
Q6	I was actively thinking about how the details of the case supported my differential diagnosis	1	1	11	77	49	4.2	0.685
	IMPROVES FUTURE PERFORMANCE IN REAL LIFE							
Q10	I feel better prepared to confirm a diagnosis and exclude differential diagnoses in a real life patient with this complaint	1	4	11	69	54	4.2	0.771
Q11	After completing the cases I feel better prepared to care for a real life patient with this complaint	1	1	15	71	51	4.2	0.720
	WORKLOAD							
Q13	Participating in interactive PBL was a heavy workload	8	28	42	40	21	3.3	1.118
	USE OF TECHNOLOGY							
Q14	The use of technology in interactive PBL was effective and worked well	1	2	12	78	46	4.2	0.708
Q15	The technology in interactive PBL was easy-to-use and reliable	0	2	27	81	29	4.0	0.678
	QUALITY AND OVERALL EVALUATION							
Q7	I felt that the cases were at the appropriate level of difficulty for my level of training	2	12	33	61	31	3.8	0.939
Q8	The decisions I needed to make while working through the cases were helpful in enhancing my diagnostic reasoning	1	2	7	58	71	4.4	0.718
Q9	The feedback I received from the case was helpful in enhancing my diagnostic reasoning	1	1	8	57	72	4.4	0.699
Q12	Overall, working through the cases was a worthwhile learning experience	1	1	3	50	84	4.5	0.648
Q16	I would be keen to participate in further interactive PBL sessions in the future	1	0	5	56	77	4.5	0.639

In general the students felt both engaged and motivated while participating in the PBL sessions. The majority of students considered they were making the same decisions a doctor would make in real life (m: 4.2, SD: 0.722), and felt as if they were doctors caring for the patient (m: 4.0, SD: 0.768). The students also reported they felt engaged while: a) gathering information to characterise the patient's problem (m: 4.5, SD: 0.554); b) reviewing the initial diagnosis (m: 4.4, SD: 0.680) c); creating a short summary of the patient's problem using medical terms (m: 4.2, SD: 0.705); and d) developing the differential diagnosis.

Students believed after participating in the PBL sessions they were better prepared for real life, in terms of delivering a differential diagnosis in the PBL cases (m: 4.2, SD: 0.771), and in caring for a real patient (m: 4.2, SD: 0.720).

The students were satisfied with the implementation of the PBL considering the following areas: use of the technology, decisions to be made during the PBL, and the feedback received. Students reported that technology was used in an effective manner (m: 4.2, SD: 0.708) and that it was reliable and easy to use (m: 4.0, SD: 0.678). Students also reported that the decision making and the feedback received were helpful to enhance their diagnostic reasoning (m: 4.4, SD: 0.718 and m: 4.4, SD: 0.699 respectively). The results also indicated students thought that "working through cases was a worthwhile learning experience" (m: 4.5, SD: 0.648) and they "would be keen to participate in further interactive PBL sessions" (m: 4.5, SD: 0.639).

The students showed imperceptible disagreement regarding "the adequacy of the level of difficulty (of the PBL cases) for their level of training". This item has received a lower score in its grouping with mean score of 3.8 and a higher standard deviation (SD: 0.939).

The lowest mean score amongst all the questions within the survey was given to Question 13 (Q13) which was anticipated since the question was phrased to be from a negative perspective. The results of this question indicate that the students consider that "participating in interactive PBL has required a very high workload" (m: 3.3). The standard deviation show a low consistency among the responses in that item (SD: 1.118).

Tutors

A total of 33 PBL tutors from the partners institutions participating in the ePBLnet project completed the online questionnaire. The response rate from each institution is shown in Table 5.

TABLE 5. Distribution of tutor responses per institution

Name of the institution	Number of tutors
David Tvildiani Medical University (DTMU)	6
Akaki Tsereteli State University (ATSU)	4
Sumy State University (SSU)	2
Zaporozhye State Medical University (ZSMU)	7
Karaganda State medical University (KSMU)	5
JSC Astana Medical University (AMU)	9

Based on identified areas/directions of research, 9 questions were collated into 6 thematic groups: student engagement, learning objectives, difficulty of tutor facilitation, use of technology, tutor training and resources, and willingness to further use PBL.

The majority of tutors believed "the group found the interactive PBL sessions engaging" (m: 4.3, SD: 0.575), and the "PBL sessions provoked high-quality discussion amongst the group" (m: 4.3, SD: 0.527).

The responses suggested that the tutors agreed on the technology supporting PBL was effective (m: 4.1, SD: 0.354), reliable and easy to use (m: 4.0, SD: 0.707) and agreed they were given the necessary resources (m: 4.0, SD: 0.811) as well as the appropriate training and support to implement PBL effectively (m: 4.2, SD: 0.497). Furthermore, most tutors felt that the PBL "met all required learning objectives" (m: 3.9, SD: 0.732).

An important finding from the tutor responses is the lower mean score obtained in Question 4 (Q4) "the use of interactive PBL made tutoring the session difficult" (m: 2.3) as well as the higher standard deviation (SD: 0.026) which reflects the differing opinions amongst tutors. However, the tutors would be willing to continue tutoring further PBL sessions (m: 4.5, SD: 0.500).

DISCUSSION

Since the first introduction of PBL in the 1960s, many studies have been performed to analyse the premise that PBL methodology results in enhanced learning. This study does not set out to add to that data, but rather to explore the impact of implementing PBL within the 6 institutions. Sharing of existing curriculum and PBL cases is common, and SGUL itself adapted its own curriculum from the University of Flinders [16] and will have faced such challenging circumstances, with all changes carried out at the same time across a range of culturally-distinct institutions.

This study is focused on the evaluation of the PBL experience as reported by students and tutors, and assumes that the repurposing of the PBL cases has been

TABLE 6. Results of the survey developed to evaluate tutor response

	Answer options	Strongly disagree (1)	Disagree (2)	Not sure (3)	Agree (4)	Strongly agree (5)	Mean	Standard deviation
	STUDENT ENGAGEMENT							
Q1	The interactive PBL sessions provoked high-quality discussion amongst the group	0	0	1	23	14	4.3	0.527
Q2	The group found the interactive PBL sessions engaging	0	0	2	21	15	4.3	0.575
	LEARNING OBJECTIVES							
Q3	The cases met all the required learning objectives	0	3	4	26	5	3.9	0.732
	DIFFICULTY OF TUTOR FACILITATION							
Q4	The use of interactive PBL made tutoring the session difficult	5	21	7	4	1	2.3	0.926
	USE OF TECHNOLOGY							
Q5	The technology used to support the interactive PBL was effective	0	0	1	33	4	4.1	0.354
Q6	The technology used to support the interactive PBL was easy to use and reliable	0	2	4	25	7	4.0	0.707
	TUTOR TRAINING AND RESOURCES							
Q7	I was provided with all the resources I needed to tutor the interactive PBL sessions effectively	0	3	4	22	9	4.0	0.811
Q8	I have received appropriate levels of training and support to be able to tutor the PBL sessions effectively	0	0	1	26	11	4.2	0.497
	WILLINGNESS FURTHER USE PBL							
Q9	I would be happy to tutor further interactive PBL sessions in the future	0	0	0	19	19	4.5	0.500

successful during the implementation of the ePBLnet project. The research has shown that the repurposing of VPs from other culture and language is effective, not only because it improves the cost effectiveness of the results, but also because it has been considered by the case adaptors as a learning process for the creation of VPs, for use in their more general teaching [17]. Further research has shown that repurposing VP from a different culture and language doesn't imply a significant difference between the exam scores, compared to students that used cases that had been originally created in the same language and culture [18].

Given the previous assumption, this article has been constructed around the data during the implementation of the ePBLnet project, but before the longer-term success of this new curriculum project can be tested. It is therefore deliberately focused on the data reported from the students and the PBL tutors as the final end-point of that curriculum change. Though the process of creation is critical, at this stage the acceptability of change within the institution is measured chiefly by the experience of the students on the course, and the staff who run it.

The most significant and supported result of this article is the statement that the participation in the PBL sessions has been an engaging experience for the students, which can be considered an indicator of the effectiveness of the interactive PBL. Both students and tutors have stated that.

Bearing in mind that the students come from didactic educational cultures, it is perhaps surprising that both the tutors and students consider that the students have been highly engaged during their participation in the interactive PBL. The tutors reported that PBL provoked a high-quality discussion which can be considered as an indicator of the student's engagement. The students reported feeling better prepared for the real life clinical situations after participating in PBL sessions. These two aspects (engagement and feeling better prepared for real life) are the most relevant and positive aspect of the results for the institutions, who have changed their curricula at considerable cost. The responses of course reflect a subjective opinion of the students, and cannot be extrapolated to suggest improvement of the performance in real life situations.

Some students reported that participating in interactive PBL lessons had implied a heavy workload and tutors consider that the interactive tool may require personal and professional qualities that are not normally used in contact with students. There was some suggestion that the original educational level of the case may not be perfectly matched in all cases to the level of the student's current year of academia. Nevertheless, they consider this tool to be effective, and were willing to continue using it.

Tutors reported that they were provided with the necessary resources and training to be able to implement the interactive PBL training and achieve the learning objectives in their own culture and language. Both tutors and the students considered that the use of technology to implement the interactive PBL was effective, reliable and easy to use.

In summary, the ePBLnet project has created the solid foundation amongst tutors and students for the successful implementation of PBL, and this foundation is largely supported by the engagement and motivation of the students, despite some increase in workload and the increased difficulty reported by the tutors.

Further collection of evidence is needed to prove whether the increased motivation has any benefit in terms of the acquired knowledge compared to traditional methods. Future research is necessary to show whether there is improved performance in real life situations from the students that participated in PBL, compared with the traditional curriculum.

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CONFLICTS OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article

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STANDARDIZATION IN MEDICAL EDUCATION: REVIEW, COLLECTION AND SELECTION OF STANDARDS TO ADDRESS TECHNICAL AND EDUCATIONAL ASPECTS IN OUTCOME-BASED MEDICAL EDUCATION

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ABSTRACT — ***Background:*** *Modern medical and healthcare curricula represent a highly complex mixture of different disciplines, specialties and pedagogical approaches, the nature of which can be difficult to communicate to key stakeholders. This issue is exacerbated when considering curricula beyond individual institutions at a local, national or international level. To date, there is no standardised way of describing and reporting curricula within Outcome-Based Medical and Healthcare Education.*

Methods: *We conducted a state-of-the-art review of available technical standards in medical and healthcare education, and identified those most relevant to the field. Based upon this initial pool of standards, we applied a set of selection criteria to identify those standards that were both required and best suited to developing a standardised model for describing medical and healthcare curricula. In concert with this, we conducted a review of common systems in the field to identify the levels of support and compliance with these standards.*

Results*: We identified standards and specifications from mEducator and MedBiquitous as being most suitable for inclusion in this model. In particular, the MedBiquitous Curriculum Inventory standard, as well as related specifications, are described in detail and proposed for use in best practice implementations.*

Conclusions*: We propose a standardization approach involving the use of technical standards, compliant systems and standardized vocabularies for the description of medical and healthcare curricula. Such an approach can provide a detailed picture of a curriculum's structure and address different technical and educational aspects of Outcome-Based Medical and Healthcare Education. The benefits include for faculty, policy and decision makers being able to better evaluate and measure teaching against the required outcomes, institutions to perform structured analyses and being able to compare their curricula, while students can better understand their intended learning.*

BACKGROUND

In recent years, medical and healthcare higher education institutions are placing more emphasis on creating graduates who are able to deliver high-quality patient-centred care and follow evolving and constantly increasing demands of health care systems. The profile of future health professionals relates closely to a well-structured curriculum that properly combines theoretically focused and clinical-based courses [1,2]. Curriculum designers usually construct their educational programmes in accordance with selected pedagogical approaches suitable for teaching and assessing medical and clinical knowledge and skills. However, balancing courses across the range of medical disciplines (such as Surgical Sciences, Internal Medicine, Diagnostic Sciences, and Theoretical Sciences) represents a significant challenge, due to the variety of medical educational contexts and the multi-faceted character of medical education [3,4].

A unified way of structuring, reporting and expressing the structure of a medical curriculum is required to better understand and communicate that structure to key local, national and international stakeholders. To our knowledge, such a unified way of structuring a medical curriculum is rarely realized or seen at an institutional level within the context of Outcome-Based Medical and Healthcare Education (OBMHE). There is great amount of variation in medical programmes at institutional, national and international levels; different education data formats, levels of detail, description styles, learning outcomes and competencies definitions. This makes it challenging to construct a general, 'big picture' overview of OBMHE.

At this level, curricula are supported technically and educationally by individually selected Learning Management Systems (LMS) and thus cover these needs without mechanisms for addressing more than a few perspectives. A different approach, based on data standardization, unification, and common educational content parameterization principles, would allow for the bridging of individual health educational contexts, especially in an era where the mobility of health professionals increases constantly in an international level [5]. With a health professions curriculum as the main tool and by using a common language of understanding progress can be made towards innovations in medical education that promote improved transparency and comprehensibility of educational programmes [6].

The aim of this study is therefore to identify and suggest a standardization approach consisting of a set of technological standards and best practices from standard compliant systems. We anticipate that this approach could be used in an OBMHE context to address: (a) technical needs; as it can be applied in a Curriculum Management System (CurrMS) to allow the educational data to be previewed, extracted and reported in a structured and sophisticated way; and (b) educational needs; as the structured extracted data can be analysed to better understand the educational content and to communicate the reported data for comparison and benchmarking purposes between different OBMHE contexts.

METHODS

To accomplish our aim, we reviewed the range of existing standards and specifications in the medical and healthcare education domain. We investigated the standards' suitability for meeting the above-mentioned needs by constructing a set of criteria to facilitate and support a selection process. Having identified those standards which satisfy the criteria, we described in depth the selected standards by analysing and presenting their structure, functionality, information flow, terminology used, and the requirements for a successful adoption with practical guidelines, along with reflections on their ability to be expanded and implemented in the European outcome-based health education context. Finally, we discuss and address the challenges of transferring and adopting this standardization approach into the European context of health education and the opportunities arising from such an endeavour, thus setting a base for the presented approach to be considered for adoption in outcome-based health educational programmes outside Europe.

Review method

We approached the review and collection phases with the goal of identifying a solution which allows technical standards and medical terminologies to work in concert, and when adopting and applying best practices from standard-compliant systems is suitable for implementation into a CurrMS. Currently used medical terminologies and the challenges of adopting a specific vocabulary that standardizes medical information adequately, were identified in a previous study [7].

To identify the technical standards and standard-compliant systems, we conducted a state-of-the-art review as described by [8]. This method is commonly used to provide an overview of the current knowledge in the field under question and offer new perspectives for future investigation and research. A drawback of this method is that it may distort the overall view of the examined field by only considering developments that took place within a specific time period. We considered that this factor would not materially affect our review because our focus is on a contemporary OBMHE context only, and would therefore only need to consider standards that are in current use or development. Legacy standards, or those that would require repurposing in order to be transferred to a modern health education context would not therefore be suitable for inclusion. Given this, we limited the number of reviewed standards to those specific to health education and constructed a set of selection criteria for both the technical standards and compliant systems. We subsequently chose only those standards which have the ability to work in concert with each other, and which are able to address the technical and educational needs of an OBMHE. Depending on purposes of our study, the attention was paid on up-to-date and reusable solutions, which make access to learning agenda, measurement of improvements and curricula understanding much easier. Based on the selected state-of-the-art review method, we explored those medical and healthcare education standards and specifications published by international professional medical societies, namely the specifications from mEducator Best Practice Network and standards from MedBiquitous Consortium. There are also several other projects active in this particular research area, which unfortunately don't meet requirements on stable standardised framework (for example: Project Management Curriculum and Resources https://pmiteach.org/teaching-pm/knowledge-module, Scottish Doctor project http://www.scottishdoctor.org), CanMEDS project http://canmeds.royalcollege.ca/en/framework etc.)

Technical standards selection criteria

Our standardization approach attempts to address both technical and educational aspects in medical education. Therefore, the standards must allow the curriculum data to be technically standardized so they can be further reported in a structured format to allow high level analysis for better understanding of the educational content but also to be communicated for comparison and benchmarking purposes. Also, a necessary precondition to this is that the CurrMS where the standards will be integrated must already be used to map [9,10] a health professions curriculum while it incorporates the philosophy of a standards compliant system in an OBMHE context.

Upon initial review of the available data standards relating to healthcare education, we have identified those from mEducator and MedBiquitous as the most appropriate for further examination. Both sets of standards have been developed and used in health education for purposes such as sharing, communication and dissemination of medical curricula [11–13] and are more frequently found to be integrated in LMSs. MedBiquitous standards are widely used in an OBMHE context in medical schools in the United States and Canada. Hence, from the available MedBiquitous standards we will select the ones that are suitable and relevant while we will exclude the standards that are not suitable or appropriate from the final standardization approach based upon specific criteria (Table 1). Criteria C1 to C4 are the ones that can be used to adequately address the needs of structuring, reporting and comparing a curriculum and therefore standards that satisfy one to all of them will be included while standards that satisfy criterion C5 will be excluded as non-appropriate.

TABLE 1. Criteria for selection of standards

Criterion	Description
C1	The standard can be integrated into a CurrMS.
C2	The standard can be used to standardize the entire curriculum.
C3	The standard can be used to report and communicate the entire curriculum.
C4	The standard can be used to standardize a specific part of the curriculum (competencies, learning objectives and outcomes, learning activities and assessment) and is associated and/or works in concert with other standards that satisfy the criteria C1, C2 and C3.
C5	The standard is used to report a variety of educational and administrative procedures and processes other than those in criterion C4, does not satisfy the above criteria and/or it is not associated to other standards that satisfy the criteria C1, C2 and C3.

Standards-compliant system selection criteria

The CurrMSs overview is based on a set of predefined criteria, which help to systematically identify the fundamental standard-compliant system's characteristics: (i) License type describes the software use and redistribution conditions. We sort systems mainly into two license categories – open-source and commercial; (ii) the ability to support integration of MedBiquitous standards and specifically the ones that satisfy the most criteria in Table 2; (iii) the ability to support integration of the mEducator specification.

RESULTS

Overview of Standards and Systems

Technical Standards: mEducator Best Practice Network

The outputs of the mEducator [14] project are a framework, a software toolbox, guidelines, best practice recommendations and content, which solves the problem of content sharing for medical education. It is based on linked data principles and semantic web technologies. The most important component of mEducator is the standardization schema, namely, the mEducator schema or specification. The mEducator schema makes it possible to discover, retrieve, use, rate, re-use and re-purpose medical educational content irrespective of any LMS usage. Following is a more detailed description of mEducator.

The mEducator project was managed to achieve a number of objectives that focus directly to the development and adoption of the universal description of medical educational content, using modern web technologies: (i) provided tools for medical content publishing, discovery, and retrieval; (ii) analysed policies and mechanisms for content evaluation, rating, renewal, and repurposing; (iii) elaborated on intellectual property rights for digital educational material; (iv) tested the impact of true interoperability, repurposing, enrichment, and embedding of a variety of highly attractive and up-to-date learning resources; provided guidelines and recommendations on how to implement interoperable educational content discovery and retrieval networks; (v) implemented and extended specifications and standards on a critical mass of medical educational content types and provided recommendations for standards adoption and promotion across Europe; and (vi) supported the efficient and seamless sharing and use of formal, specialized, state-of-the-art, and pedagogically sound medical educational content across Europe.

The mEducator target user audience includes three main types of users: (i) medical educators (clinical/non clinical, in academia); (ii) medical students (under- and post-graduates); and (iii) residents and specialized doctors (continuing medical education). One of the main achievements of the mEducator project is the creation of the metadata description scheme and reference model called the mEducator schema. Initially the consortium generated the conceptual model, a process which included an analysis of Healthcare Learning Object Metadata (HLOM) [15], the evaluation of other specifications and standards, a description of the requirements related to repurposed content, along with the respective incorporation of extensions for repurposed content, the refinement of educational aspects and the inclusion of companionship of resources.

During the project, the consortium considered the benefits of Linked Data and the Semantic Web [16], which allow resources to be interoperable with other data sets by reusing and linking to existing knowledge. The mEducator metadata description schema uses ontologies to describe fields, and provides formal naming and definitions for data types, properties, and interrelationships. The full metadata description of each learning object is exposed using the Resource Description Framework (RDF) [17]. RDF was identified as the most appropriate framework to be used for the treatment of the metadata model, since it offers a metadata scheme compliant with the linked data principles. The conceptual model was transformed into an RDF model, which in turn was serialized in eXtensible Markup Language (XML) to be machine-readable. Attention metadata was also considered and the Atom Activity Streams [18] mapping in RDF vocabulary has been extended for full user activity tracking. Using the SPARQL Protocol and RDF Query Language [19] queries can be executed and advanced reasoning performed on the available datasets. Each query can be distributed to multiple SPARQL endpoints (e.g. different web sites that implements the mEducator schema). The complete metadata description schema addresses the requirements and needs for sharing mEducator educational resources. Figure 1 shows the conceptual model.

Technical Standards: MedBiquitous Consortium

The MedBiquitous Consortium [20] is an American National Standards Institute [21] (ANSI) accredited developer of information technology standards for healthcare education and quality improvement. MedBiquitous uses XML specifications to create a blueprint of required technology for advancing continuous improvement and lifelong learning for the health professions while maintaining an open process of standards development. The MedBiquitous standards are used to ensure that curricula data concerning competencies, learning and assessment activities, learning objectives and more are structured in a way that can be reported, shared and communicated across health professions education. The standards are focused in all three medical education levels; undergraduate, postgraduate and continuous education of health professionals. We describe below the existing standards with additional information for each of them in the provided references.

Activity Report [22] (AR) provides a standard format for digitally tracking health education and certification activities concerning learning and performance improvement. The standardized data can be used

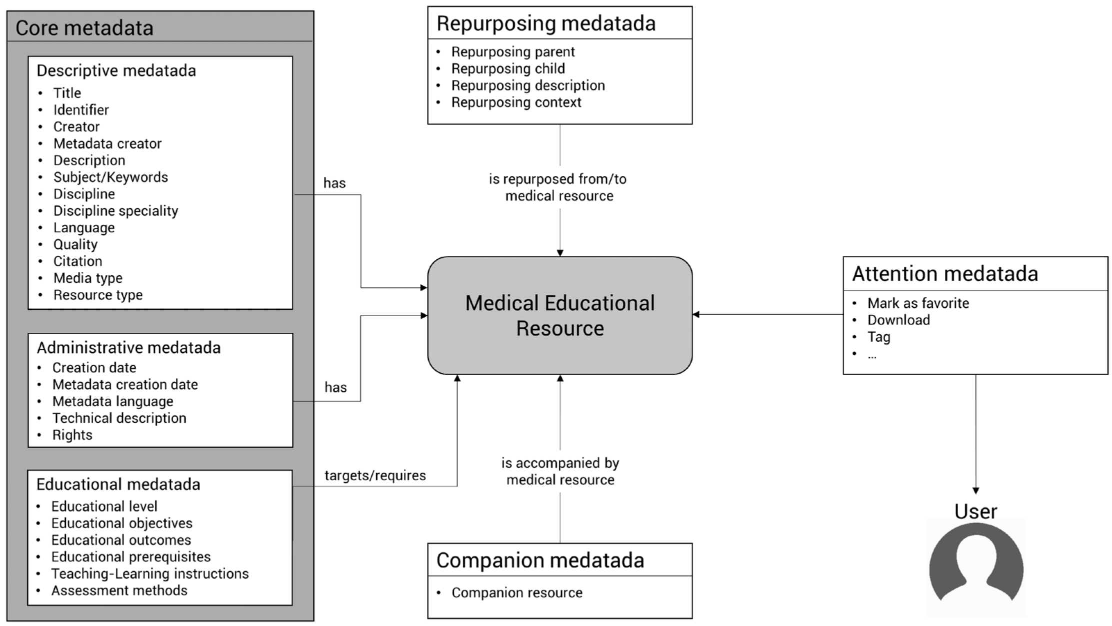

FIGURE 1. Graphical illustration of the mEducator conceptual framework

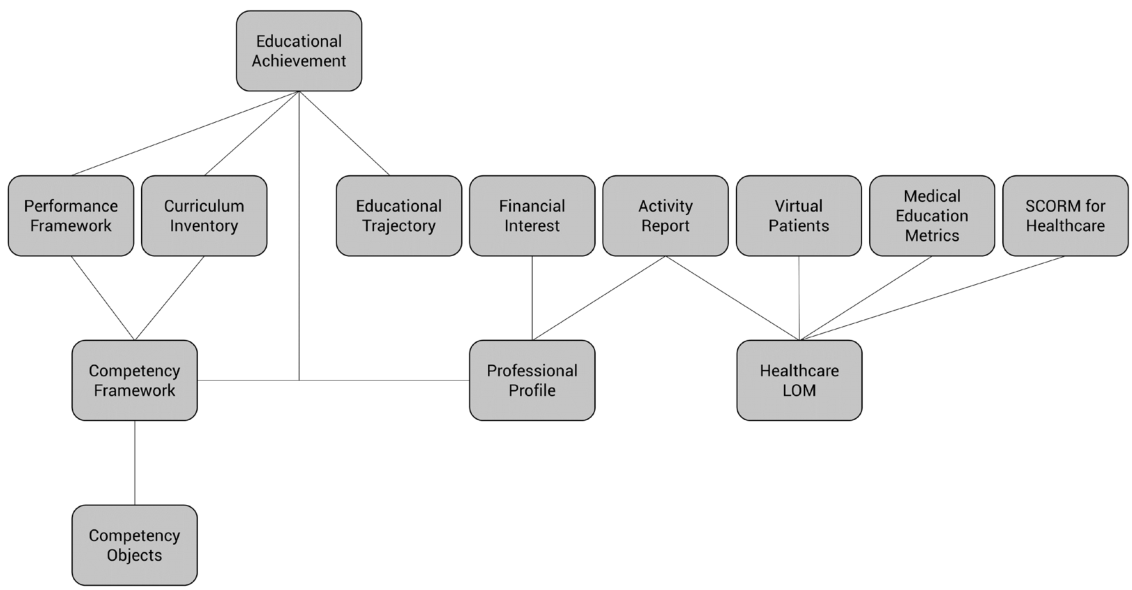

FIGURE 2. MedBiquitous standards architecture [31]

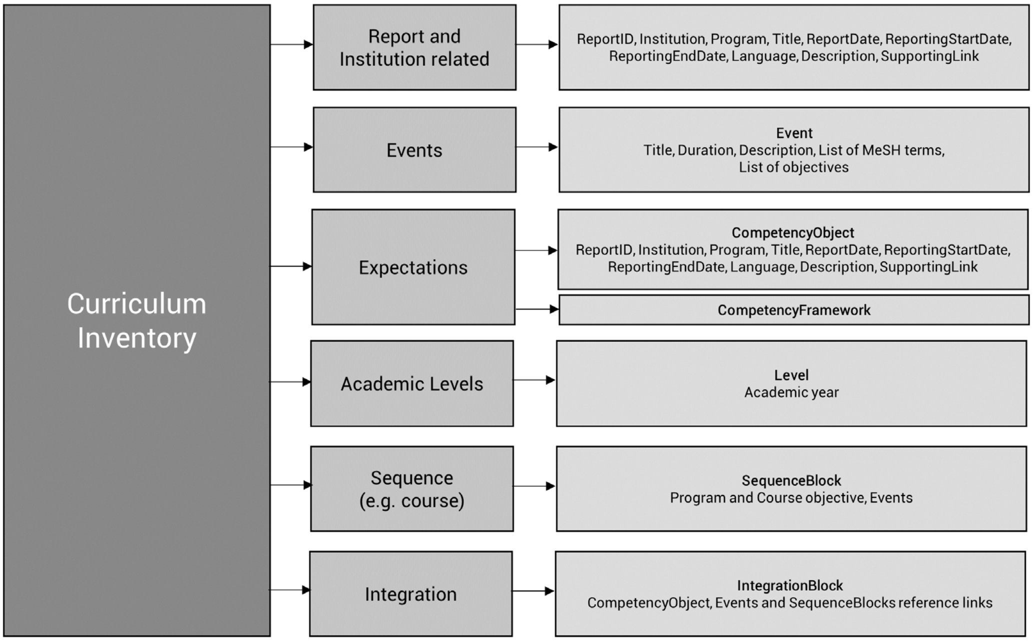

FIGURE 3. Curriculum Inventory diagram

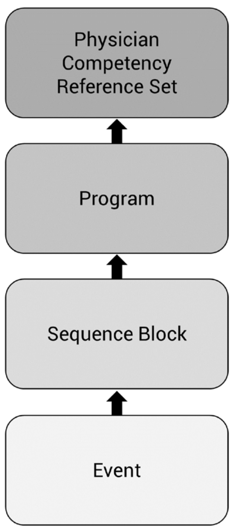

FIGURE 4. Hierarchy of mapping in CI standard

to provide easier and faster document certification, lower administrative time for clinicians and to represent a full picture of health professionals' accomplishments during the course of their career. **Competency Framework** [23] (CF) provides a standard format for representing a set of desired competencies. The purpose of the CF standard is twofold; for organizations that publish competency frameworks to do so in a standardized format so it can be integrated into educational systems such as a CurrMS, and for medical and other health professions schools to map their curriculum data to a specific and common set of competencies, enabling a competency-based view of the curriculum and education in general. **Curriculum Inventory** [24] (CI) provides a data structure that allows one to represent an entire health professions curriculum in a standard format. The purpose of this standard is to promote aggregation and exchange of curriculum data and allows for extensions so that it can be easily communicated. CI uses the CF standard and Competency Object specification (described below) to describe its different components. **Healthcare Learning Object Metadata** [25] (HCLOM) provides a standard way to describe learning activities and content so as to make it easier to locate, share and integrate learning resources into portfolios and personal health records. **Healthcare Professional Profile** [26] (HPP) provides a standard format for data concerning the profiles of health professionals. This is useful for accurate updating of credentials data, delivering credentials data to regulatory bodies, institutions and the public and for developing systems to utilise credentials data. **MedBiquitous Medical Education Metrics** [27] (MEMS) provides a standard format for Continuing Education (CE) outcomes data. The standard is particularly useful for collecting validation data for standardized survey items. A companion specification allows CE providers and outcomes companies to post standardized survey items to a central database. **MedBiquitous Virtual Patient** [28] (MVP) provides a data structure that describes a Virtual Patient (VP) activity. It is meant to facilitate the creation, implementation and reusing of VPs. **Performance Framework** [29] (PF) provides a standard format for representing expected levels of performance tied to a specific competency. **Competency Object** [30] (CO) is a specification that allows discrete competencies, learning outcomes, objectives and other types of educational goals to be represented in a standard format. It is used in concert with the CF standard.

The above listed standards are summarized in Figure 2, in which the MedBiquitous standards architecture is depicted through the associations between the different standards. The associations (connections) are XML Schema Definition (XSD) dependencies/import statements.

Standard compliant systems overview

In the last decade, quality improvement of medical education and training has been emphasised as a concept across higher education institutions due not only to the advent of scientific methods such as data analytics [32], but also due to the need for high quality patient care and elimination of medical errors [20–22]. Various standards, which are usually incorporated into CurrMSs, are created in order to enable quality improvement through tracking of professional achievements, access learning, more effective measures of improvement including the entire curricula comparison, performance and interoperability [6]. To date, standardized frameworks implemented in medicine and other health professions vary in the way they delineate but also in the language used to describe specific learning outcomes and competencies. In this review, we provide an overview of the existing institution-developed as well as commercial CurrMSs, which are specifically focused on medical and healthcare education. Especially, our attention focuses on CurrMSs supporting mEducator specification and MedBiquitous standards.

Ilios [36] is an open-source web-based curriculum management system. It provides features such as managing the curriculum data, sharing materials and outcomes among programs, curriculum mapping and other. Another open-source standard-compliant system is **OpenTUSK** [37]. It is built on a common web framework called **LAMP** [38]. Commercial CurrMS **4iQ Solutions platform** [39] is interesting because of its Standard integration tool, which allows for the integration of various MedBiquitous standards and the mEducator specification. The **Entrada** [40] open-source system consists of seven pillars (major functionalities) – curriculum mapping and reporting, academic scheduling, LMS features, assessment and evaluation features, facilitated learner ePortfolio, faculty accountability, community social integration. The **MedSIS 3C** [41] from Knowledge4you has a set of modules for managing a curriculum and creating reports in a standard-compliant form. It is offered under commercial license. The **MedHub system** [42], **OASIS** [43] and **one45** [44] allow reporting of data to AAMC using the Curriculum Inventory standard. The last system which is considered in our overview and is also standard-compliant is **LCMS+** [45], which provides the possibility of integrating many external systems and tools. The last two CurrMS (**OpalQM** [46], **itsLearning** [47]) are not standard-compliant but represent effective tools for managing teaching. We present all the above-mentioned systems and their main differences in Table 3.

Apart from these systems, we have identified more LMSs which mainly support one of the mentioned standards, but provide more or less management of training and educational material services (eMed [48], eMedley [49], E*Value [50], Schoology [51]). These systems have been excluded from consideration because they do not directly support the complex curriculum management effort for delivery and audit of miscellaneous study programmes.

Inclusion/exclusion of technical standards

The selection of standards is described in Table 2. The symbol '✓' indicates satisfaction of a criterion and symbol '-' indicates the criterion has not been met.

Once successfully adopted and implemented, the combination or exclusive usage of the above included standards can support a set of actions to standardize and express a health education's curriculum. These are: (i) integration into a CurrMS (CI); (ii) use data structures with terminology and vocabulary able to standardize an entire medical curriculum (CI+CF+CO); and (iii) report and communication of standardised curriculum data (CI). CF and CO are referenced from CI and mainly used to standardize a specific part of a curriculum. Therefore, we present here the CI standard.

Curriculum Inventory

Using the CI standard the curriculum data is reported and represented through an XML file. The XML file is structured through its elements and sub-elements representing the curriculum's different parts. Other parts of the CI standard are used to specify and make it easier to identify the hosting institution, programme etc. and other to map and express the main curriculum data such as learning activities, learning objectives and courses. All these pieces are put together in CI to provide an overview of how the curriculum is semantically integrated. In Figure 3, follows a diagram of the different entities in the XML CI schema and how they are related to each other to build a CI report. The diagram is adapted from MedBiquitous CI Schema specifications document [52].

A complete example [53] shows CI's structure along with the referenced CF [54] and CO [55] standards.

Curriculum Inventory: implementation guidelines

For a successful implementation of the CI standard (and its associated standards CO and CF) into a CurrMS that would enable a proper mapping and subsequent communication of the mapped and standardized curriculum, a set of rules must be followed. The rules [56] are distinguished into core (prerequisites) rules that the CO and CF standards must follow and rules that the CI standard itself must follow to be structured accordingly. The CI standard is currently used and mainly implemented by medical and other health professions schools in the US and Canada but the terminology that it provides is mostly universal and can be used to standardize a medical curriculum in different healthcare education settings such as the European or other OBMHE context. However, the standard must be adapted to local settings since the same Events or Expectations can be named differently in different contexts. CI is designed to be flexible and provide the necessary for localisation providing the previously mentioned rules are satisfied. For example, using CI the Expectations are mapped hierarchically. This means that there are Expectations that can be mapped in the lowest level of an Event, Expectations that can be mapped to the next level, the Sequence Block, and Expectations that can be mapped to the entire medical programme. Events and Sequence Block Expectations

TABLE 2. Inclusion/exclusion of standards

Standard	C1	C2	C3	C4	C5	Decision
Activity Report (AR)	-	-	-	-	✓	Exclude
Curriculum Inventory (CI)	✓	✓	✓	-	-	**Include**
Competency Framework (CF)	✓	-	-	✓	-	**Include**
Healthcare LOM (HCLOM)	-	-	-	✓	✓	Exclude
Healthcare Professional Profile (HPP)	-	-	-	✓	✓	Exclude
Medical Education Metrics (MEM)	-	-	-	-	✓	Exclude
MedBiquitous Virtual Patient (MVP)	-	-	-	-	✓	Exclude
Performance Framework (PF)	-	-	-	-	✓	Exclude
Competency Object (CO)	✓	-	-	✓	-	**Include**

may be mapped to each other or to Program Expectations or not at all. This information, necessary for the mapping, is pulled from the CurrMS where the CI is to be applied. The map completes when the Expectations from the highest level of the medical programme are mapped to a respective set of competencies, which are provided by the relevant higher education authority under which the medical programme is conducted. For reporting and comparison reasons, CI reports are sent to Association of American Medical Colleges [57] (AAMC). AAMC uses Physician Competency Reference Set [58] (PCRS), which is a unified set of competencies frequently updated. The PCRS competencies are practically used from the CF standard in order to map in the CI the programme level competencies to PCRS and complete the map. Schematically the hierarchy of objectives and competencies mapping in the CI is shown in Figure 4. The Physician Competency Reference Set represents a reference list of common learner expectations in medical and healthcare study programs. Each program contains various sequence blocks, which define an organisational component of the curriculum, such as a course, a module, a learning unit or a learning block (e.g. Anatomy I – Lecture). Finally, each sequence block covers a set of events describing information about educational and assessment sessions that make up the curriculum (e.g. Abdominal Radiology).

Of course, instead of PCRS (and mainly for localization purposes) any other set of competencies provided by the respective higher education authority can be used within the CF standard to map the CI programme level competencies to a higher level as long as it is structured accordingly. Nevertheless, for higher possibilities to maximize the outcomes of implementing the CI standard it is preferable to adapt and match local terminology to the default CI standardized terminology. In this way, the final product, the CI report, can be transferred and communicated more easily outside the borders of one country or continent depending always on the purposes of applying this standardization approach. The full implementation guidelines of the CI standard [59] and the full implementation toolkit containing all the necessary components of CI [60] are accessible on the official MedBiquitous website.

Selected standard compliant systems

Table 3 shows the comparison of selected curriculum management systems in alphabetical order. The majority support at least one of the MedBiquitous standards and specifically the CI standard. On the other hand, fewer systems are compliant with the mEducator specification.

TABLE 3. Standard compliant systems comparison

System name	License type	MedBiquitous standard support	mEducator specification support	Outcome-based education support
4iQ Solutions platform	Commercial	CI	Metadata description scheme	Yes
Entrada	GPLv3	CI, CF	NA	NA
Ilios	MIT	CI, CF	NA	Yes
itsLearning	Commercial	NA	NA	NA
LCMS+	Commercial	CI	NA	NA
MedHub system	Commercial	CI	NA	NA
MedSIS 3CKnowlege4You	Commercial	CI	NA	NA
OASIS	Commercial	CI	NA	NA
one45	Commercial	CI	NA	NA
OpalQM	Commercial	NA	NA	NA
OpenTUSK	ECLv2, GPLv3, LGPLv3	CI	NA	NA

NA – not available

DISCUSSION

In this study, we present an approach for standardizing medical and healthcare curriculum data. In an outcome-based education context such as the European OBMHE, the focus is on the final product - the learning outcomes/objectives, competencies - which in turn determines how the medical curriculum's content is structured and organized in order to adequately address them [61]. We suggest the present standardization approach, which places outcomes/objectives and competencies in the centre, and comprises three unique features to complete the standardization picture: (i) the chosen technical standards; (ii) the best practices from standard compliant systems; and also (iii) the necessary vocabulary for standardizing medical terminology used in medical and healthcare education [7].

Firstly, the selected technical standards (CI, CF and CO) take over the role of providing a way to structure and weave together all related curriculum educational content. That creates a blueprint of activities, objectives and resources, and all its interrelations including: all learning and assessment activities along with teaching and assessment methods; the learning objectives of a single activity (lecture, seminar, written examination etc.); the learning objectives of the parent course where the activity belongs; the parent learning objectives for the entire programme where the courses belong; the parent competencies provided by a higher educational authority for each of the programs; and all learning materials. In this way, the content can be viewed from different perspectives serving different educational needs of involved higher education institutions stakeholders such as decision makers, policy makers, faculty management, teachers, administrators, and students. For example, decision and policy makers as well as faculty management can instantly evaluate if/how the desired higher education board competencies are addressed through the realization of the respective objectives for the entire medical program. Teachers can easily verify whether what they teach is aligned to the curricular objectives and students can see a clear description of their intended learning. Next, a standard compliant CurrMS is required to provide the necessary ground for the standards to be applied. A precondition for a successful standards implementation is that the curriculum data within the CurrMS must be already mapped towards also a standardized medical vocabulary [62]. Thus, having in place a CurrMS that standardizes educational content according to this approach, we can address technical needs by applying high level data analysis to the content using different techniques such as data mining, analytics and visualization techniques [63] for different purposes such as supporting decision making [64] and quality improvement of medical and healthcare education [32].

To the best of our knowledge, within the European OBMHE context, such a standardization effort that addresses these aspects holistically it is not yet in place. The use of this approach has the potential to support research and benchmarking activities, such as systematically and structured analyses and evaluations of health education programmes, and comparisons against other medical curricula that use the same standardization approach. This could support the creation of a unified way of structuring and understanding medical education within the context of European OBMHE or other OBMHE and "shift curriculum mapping and reporting from a somewhat disjointed and institution-specific undertaking to something that is shared among multiple medical schools and across whole medical education systems" [13]. We adopt this approach within the context of the Medical Curriculum Innovations (MEDCIN [65]) project, in which we apply all these concepts in a European OBMHE context in an effort to address these educational and technical aspects. In future studies we will report the challenges and opportunities arising from such an effort setting thus the base for structuring and unifying European OBMHE.

CONCLUSIONS

In this paper, we present a comprehensive overview of contemporary technical standards and standard-compliant systems. We recommend an approach in which standards and systems work in concert to address technical and educational needs within the European OBMHE context, applicable to any similar educational context. We select the components of the standardization approach based upon criteria that promote managing, structuring, understanding, reporting and communicating a curriculum and its elements such as learning objectives/outcomes, competencies and learning and assessment methods.

The ultimate outcome of the approach is twofold. At first, it enables medical and general health professions educational programmes to benefit at an individual level by structuring and organizing their curriculum and by being able to systematically describe, model, and store it in standard-compliant structure. Subsequently, it offers the opportunity to communicate the curriculum outside the boundaries of a single institution in a national and international level for sharing, comparison and benchmarking purposes between medical schools and entire health professions educational systems using the same standardization approach. This study is the first in a series of studies that will build and report on the progress of adopting and implementing this approach in the European OBMHE.

LIST OF ABBREVIATIONS

AMC: Association of American Medical Colleges
ANSI: American National Standards Institute
AR: Activity Report
CE: Continuing Education
CF: Competency Framework
CI: Curriculum Inventory
CO: Competency Object
CurrMS: Curriculum Management System
HCLOM: Healthcare Learning Object Metadata
HPP: Healthcare Professional Profile
HLOM: Healthcare Learning Object Metadata
LMS: Learning Management Systems
MEDCIN: Medical Curriculum Innovations
MEMS: MedBiquitous Medical Education Metrics
MVP: MedBiquitous Virtual Patient
OBMHE: Outcome-Based Medical and Healthcare Education
PCRS: Physician Competency Reference Set
PF: Performance Framework
RDF: Resource Description Framework
VP: Virtual Patient
XML: eXtensible Markup Language
XSD: XML Schema Definition

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