Innovative Higher Education - Opportunities for Applying a Hybrid Curriculum in an Academic Course of Study

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Abstract

The modern theoretical concepts of higher education pedagogy and student learning outline the framework of methodological innovation in the academic environment. Is need for innovative curricula in which students can expand their experience and be able to transfer knowledge into non-standard academic activities. The experience we present in this article shows a didactical potential of a hybrid curriculum include technologically justified model for self-regulating STEM – PBL of an academic course applicable in the specialty of medicine in basic scientific discipline. The model is personal-oriented and supports the building of lifelong learning skills. It is based in a stimulating learning environment, built with the help of STEM project, considers the individual needs of the learners and is relevant to identifying and developing of key competences for lifelong learning such as: knowledge in the field of natural sciences and technology, general learning, communication and teamwork skills. In our opinion, this curriculum is an opportunity, which increase the effectiveness of the training process, and hence the quality of the professional training of future doctors.

Keywords: *higher education, lifelong learning, project-based learning, student-centred learning, independent learning*

1. Introduction

Higher education reforms are increasingly defined by the requirements of professions that are dynamically evolving and require training in order to adapt to the daily challenges. Today, students must form knowledge that will allow them to find their place in society, be able to use and develop their skills, and be ready to learn throughout life. This guides the processes related to modernization of training to specific results (development of knowledge, skills and competences) in response to the needs of employers. That is why there is need for innovative curricula in which students can expand their experience and be able to transfer knowledge into non-standard academic activities. [7] By including a wide range of learning tasks, involving different levels of cognitive activity and the formation and application of study or work skills, students are expected to develop the attributes of self-efficacy, self-awareness, and resourcefulness, and this will manifest itself as learning outcomes in their achievements and self-esteem. In this sense, the formation of motivation for learning and self-improvement is considered an essential component of training. Optimizing the learning process requires that the acquisition of knowledge, skills and competencies be considered as a means of comprehensive personal development, and that their achievement be carried out in a flexible learning environment that includes a variety of learning strategies and thus ensures the development of an appropriate individual learning style for everyone.

Project-based learning is a learner-centered educational strategy that incorporates a dynamic approach in the classroom. Thomas Markham describes project-based learning (PBL) as the integration of knowledge and practice. [5] Replacing all lectures with discussion groups or tutorials, Armstrong says, would only replace one one-sided system with another. The hybrid curriculum, successfully implemented by several institutions, combines traditional teaching strategies (lectures, practical classes) and PBL, offering its students a variety of learning styles. [1]

This article presents a study on the implementation of a hybrid curriculum for academic training in fundamental and specialized disciplines for the formation of subject-specific skills and generic competencies and the student's development of STEM skills. This curriculum includes a generalized, theoretically grounded, person-centered STEM-PBL model of an academic course applicable to various majors in basic science disciplines The STEM-PBL model is implemented as a technology oriented towards self-regulated learning at a university whose effectiveness as pedagogical model is determined by how students learn in specific environment designed to perform project tasks for the development of STEM skills.

2. Materials and Methods

2.1. Materials

The constructed author's model of STEM-PBL in a university course, which can be seen as an integrated conceptual scheme of a hybrid curriculum, demonstrated the application possibilities of PBL in variety of academic training professional fields, unified by common research objects and knowledge. It was applied to first-year students majoring in Medicine (EQD Master's degree), studying in the mandatory course Human Biology (in its Parasitology part) at the Department of Biology, Medical Genetics and Microbiology at the Faculty of Medicine of Sofia University "St. Kliment Ohridski". The Human Biology course is conducted in the first and in the second semester and offers theoretical knowledge on basic and contemporary aspects of medical biology with application in clinical medicine and forms certain practical skills that will serve as a basis for the study of a number of specialized biological sciences such as cytopathology, pathophysiology, biochemistry, pathobiochemistry, medical genetics, medical parasitology and clinical immunology, which are extremely important for clinical practice. Validation of the training model was carried out with Biotechnology Engineering students (EQD Bachelor's degree) in the mandatory courses "Instrumental Analysis in Biotechnology" (third year) and "Bioanalytical Techniques in Medicine" (fourth year), trained in the Department of Biotechnology at the Faculty of Chemical and Systems Engineering of UCTM – Sofia.

2.2. Methods

In terms of learning methodology, distinctions between problem-based and traditional are subject to a description by structuring learning levels which reflect the sequencing of learning and are as follows: (1) Traditional learning: Functional-applied – contextual and (2) Constructive learning: Contextual-applied – functional. Different methodologies are in fact different according to where the emphasis is placed in the process. The traditional didactic approach focuses on the transmission of two functional components – "procedures" and "information" (usually through material handout), and cognitive components are provided by the learner. There are very clearly stated benefits of this approach such as the organizing functions of teaching. The application of constructivist learning through PBL can be understood as a way of introducing democratic elements into the learning system. It is a system in which decisions, processes and behaviors, related to learning, are established through argumentation (discussion) or negotiation (dialogue), voting or consensus (independent or in combination) between them, influenced by the decision at the same time as achievement of learning outcomes, technical and professional knowledge and insights. Participants should in principle be equal with equal rights and feel committed to the values of rationality and impartiality. Today, a number of scientists show that learners in PBL classes receive higher outcomes than students in the traditional system. [6] PBL is a good opportunity to improve the quality of academic work if it manages to make its priority not the transfer of knowledge, but the students' assistance to achieve individual control over the development of their own knowledge, to stimulate their cognitive and professional interests and make them active in their own development. [8] The application of PBL makes it possible to develop and promote several skills that are useful in real life: time management, collaboration and teamwork, communication. [9]

The pedagogical bases of the developed model are to be found in the ideas of Constructivism. [2] As a conceptual framework, constructive alignment has a significant influence on modern educational theory and practice and this is widely reflected in the literature. [4] It influences learning in higher education and provides a qualitative measure for a good educational program. Building the model integrates the following three approaches: learning, summary and social All components in the teaching system, curriculum and planned results, teaching methods, evaluation tasks used, were constructively consistent with each other. [3] The PBL model applies a direct project method. Its main objectives are the competent use of knowledge, processes, decision-making and analysis/synthesis of supervised content. The learning activities are addressed in the context of the desired learning outcomes. In the realization of the methodology of the PBL is applied 3P model of Biggs: Prediction – Process – Product, [2]

2.3. Hybrid Curriculum Model

The design of the fundamental academic course of Human Biology, part "Parasitology" for medical students and "Instrumental Methods for Separation and Analysis of Bioproducts" for bioengineering students allows to create a learning model that integrates activities for accumulation of course knowledge and methods for implementing that knowledge in professionally oriented activities, including such activities that support the improvement of personal and interpersonal skills. The effectiveness of the professional training of future specialists within a university course in a PBL environment is determined by the overall design of the hybrid curriculum as a single construct, including teaching methods, tools, interaction between participants in the learning process; increasing the degree of personalization of training (adapting the learning content based on the specific preferences, needs, interests and learning style of each learner), the specifics of the educational environment, as well as the relationships of the elements of the system between them.

2.3.1. Elements of Experimental Design and Relationship between Them

From the first to the sixth week of the semester, students are trained according to the program provided in the curriculum. Project work is included within the curriculum for practical exercises in the relevant academic discipline for medical students and for biotechnological engineering students. In week 6, the teacher presents the STEM PBL design to the students.

In the constructed structural-functional model of a hybrid curriculum with STEM-PBL included, the following components have been developed according to their pedagogical function in the learning process: In the developed structure-functional hybrid curriculum with STEM-PBL model according to its pedagogical function in the training process, the following components were developed: preparation, organization, STEM-project, presentation and evaluation. (Fig.1.) The design allows to create a training model integrating activities for the development of subject knowledge and their application into professionally oriented activities, including those that support the improvement of personal and interpersonal skills and provide learning outcomes measurable as: technical - biological and chemical, personal competences and experience.

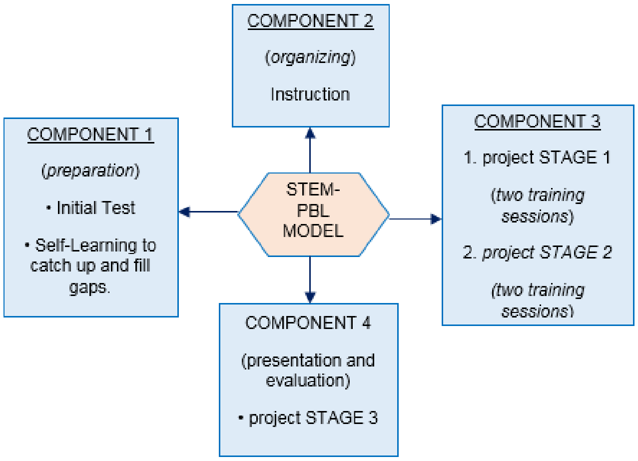


Fig. 1. Components in the structure of STEM-PBL experimental model

- Functions and general characteristics of COMPONENT 1: includes Initial Test to assess the level of knowledge, skills and agility of students and Self-Learning to make up for any gaps.
- Functions and general characteristics of COMPONENT 2: for organizing groups; for providing instructions to students (1) on the PBL process and (2) for authorship and non-plagiarism; contains an intensive part for group work with the teacher who serves as a mentor (facilitator).
- Functions and general characteristics of COMPONENT 3: to solve the authentic task, i.e. to implement the STEM-project. The project's subject-matter allows each of the educational stages – STAGE 1 and STAGE 2, to function as a system of questions related to a real medical case or to the application of a particular instrumental method in medicine and diagnostics, which serves as a starting point for acquiring the necessary knowledge from the relevant educational content.
- Functions and general characteristics of COMPONENT 4: consists of design STAGE 3, which, like STAGES 1 and 2, is educational in nature but focuses (1) on the presentation of the project product; and (2) on product evaluation and on presentation and following discussion (reflection).

In learning environment setting, learning knowledge (biological objects and chemical processes, object of assimilation) undergoes repeated external and internal transformation, determined by the objectives.

2.3.2. Elements of Experimental Design and Relationship between Them

The input COMPONENT 1 was implemented by examination of past experience in two centers – (a) level of formed concepts as a result of the training so far under the relevant learning discipline and (b) students' views on assessment criteria. Based on these theoretical statements, we engineered the Initial Test, which includes tasks for checking and assessing the level of knowledge of the important concepts at the start of the project work. The Initial Test is an element of the model which additionally ensures its flexibility. COMPONENT 2. In order to be well spent, the time allotted to introduction to this learning format (hybrid curriculum – PBL in combination with traditional format) needed to be well organized, more flexible regarding education and the appropriate student involvement. Part of the success of this change in the learning process required the teacher to plan several options for implementation in the project work and thus provided his students with a different view, a different starting point (motive) for participation in the project.

On Fig. 2. the structural parts of COMPONENT 1 and COMPONENT 3 of the experimental model are presented, as well as the links between them.

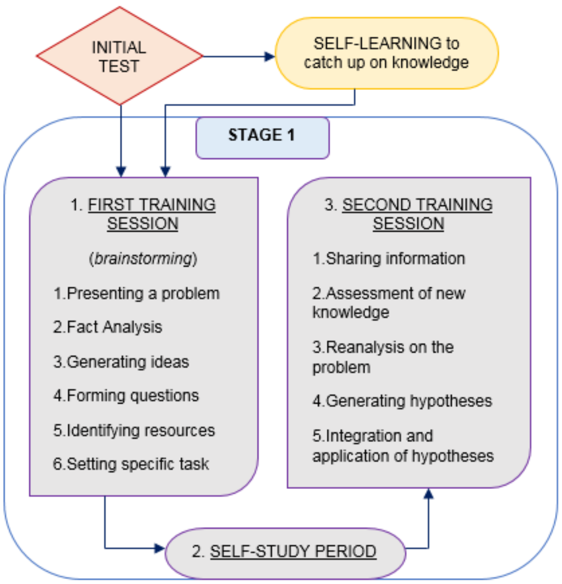


Fig. 2. Structure of the Experimental Model

COMPONENT 3. The structure of the project allows students to interpret it in various activities and formulate individual solutions based on knowledge and information. The start of the project coincides with the period of the last four parasitology exercises of the semester.
Running Time: 6 weeks (between the 8th and the 13th week of the 15-week semester).
Content: Content focuses on a subject and a process provided before or during project development. The Organization provides work in small groups for cooperative activities and cooperation with changing responsibilities in different activities for each stage.
The work environment is formally divided into two spaces. The first is the contact classes with a clear supervision and minimal control by a teacher on the group activity, individual peer discussions to review progress, presentations of interim results and formation of group evaluations. The second is created in Google Drive common space, where: the teacher uploads general information needed for all participants in the project; each participant has an individual folder to upload their finished materials for each activity and in each stage; it is possible to account for and monitor compliance with the specified deadlines. The resources are informational and research and are entirely within the material security of the disciplines in the traditional methods of training in medical and bioengineering majors. The informational attitude achieves a significant enrichment of the fund from materials related to the content, as individual project tasks give directions of searching and processing of a much broader range of scientific information, as well as specific data on the subjects surveyed. In practice, this is reflected in the PBL product, and the presentation of the result is the stage (COMPONENT 4) at which students qualitatively enrich their knowledge on the content of the discipline.
In the created STEM-PBL experimental model, the small groups are meant to encourage student engagement in the learning process and to help learners to develop both understanding of themselves and, in the context of co-learning, to cooperate in their individual intellectual, personal, and professional development. Students share that their teamwork experiences offer new understanding of the benefits of recognition and are another dimension of their life experience. Within the small group, self-confidence, interpersonal communication, and teamwork can be improved, and that is why small groups in the applied PBL design is a critical mechanism for monitoring the development of a set of key skills. The teacher-facilitator draws students' attention to reporting personal skills and encourages them to observe their own learning styles and to adjust those styles to meet the requirements of different tasks. Deeper engagement in the content of the discipline is often cited essential for an in-depth approach to learning. The planned learning outcomes are both the goal our training methods were leading to and motivation for the activity of trainees.

3. Results and Discussions

3.1. Assessment of the Project Work

To assess the effectiveness of PBL in the academic course*,* this study uses: (1) testing method with two distinguished types of tests and 2) a three-part questionnaire: part A “Self-assessment”, part B “PBL performance assessment” and part C “Peer (group) evaluation”. For the implementation of feedback on the quality of teaching and learning and for the investigation of the level of satisfaction of working in PBL learning environment, a quality method is applied – an interview in which the questions are asked in a group and students discuss freely with each other.

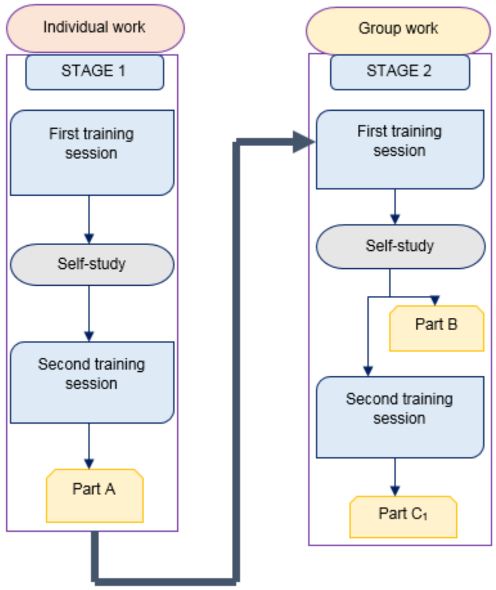


Fig. 3. Location of the Survey Parts in the Structure of COMPONENT 3 of the Experimental Model

The self-assessment questionnaire contains two parts that have different subjects of research and are positioned at different times during the course of the project. (Fig. 3) The application of self-assessment and peer-assessment at different times during the course of the project is valuable experience for learners, through which they develop and acquire self-managing learning skills - the main goal of PBL. The cooperative aspect of the proposed experimental design of hybrid learning refers to the self-reflection of students to build the meaning of their own learning, to which the activities organized by the teacher-researcher refer in support of the desired learning outcomes. During the interviews and discussions, the author of the experimental model also received conformation in this direction of the study: "The effort to participate in the project is appropriate. It would be a mistake not to participate in the project." From the data obtained from Part B of the survey, it can be summarized that the dynamics of academic development cannot ensure full consistency between the research contingent of students, as there are many individual differences, but also confirms that students positively appreciate working with others in learning context to achieve their personal learning goals. Students appreciate the benefits of teamwork and the experience they received in this regard allowed a large number of participants at the end of the project to give the researcher the following feedback, presented in summary by one student's statement: "I have improved my ability to work in a team ...I listen more when we need to exchange information."

Two types of test were applied with the testing method: knowledge assessment test and knowledge application test. The Initial Test is essentially a test of knowledge, as it primarily assesses students' knowledge of parasitology facts and the meaning of fundamental parasitology concepts. The exit test is included as a theoretical part of the Colloquium, scheduled in the curriculum for practical exercises in Human Biology to be held in the 14th week of the semester. Essentially, this is a skill assessment test i.e. to what extent the students can apply their knowledge.

The Colloquium is on the section "Parasitology, ontogenesis and general immunology" and consists of a written and practical part. The written part includes a test on parasitology and two open questions – one on ontogenesis and one on general immunology. The practical part involves recognizing three of the permanent microscopic preparations included in the curriculum, the majority of which are parasitological. The results of the conducted Colloquium are an indicator showing the level of knowledge, skills and competencies that students have after the end of the project. In terms of preserving long term knowledge, the student result analysis from the Colloquium and the mandatory for all freshmen Human Biology test shows significant lead in favor of the hybrid curriculum using PBL.

3.2. Data Analysis

We are presenting the results of students who have received traditional training only, marked K_1, and the results of the study group in which the experimental model is applied, marked K_2. Data from the average percentage grade distribution obtained from the initial test, colloquium, final examination and corresponding average success of students with applied PBL by academic year are given in Table 1.

Table 1. Average percentage distribution of grades and GPA of students with applied PBL

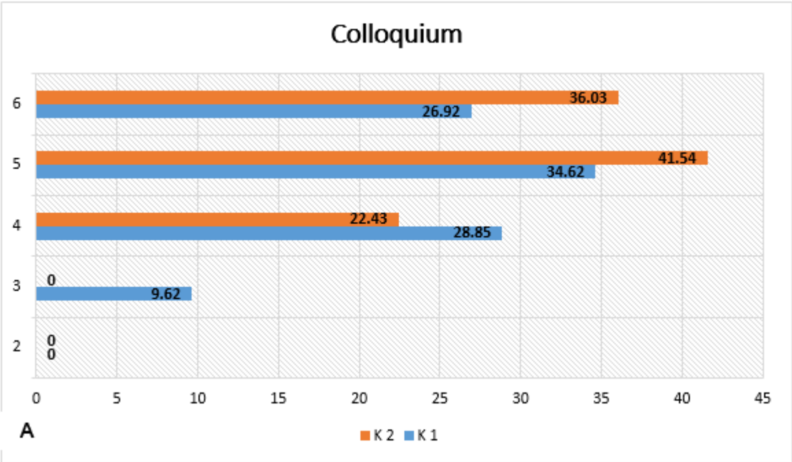
Grade	Initial Test	Colloquium	Final Exam
(2)	12,57%	-	-
(3)	11,74%	-	17,09%
(4)	23,83%	22,43%	36%
(5)	28,63%	41,54%	22,60%
(6)	23,23%	36,03%	12,99%
Average grade	Good (4,05)	Very good (5,13)	Very good (4,66)

This data shows that the provided self-study for catching up and filling the gaps in theoretical knowledge after the initial test gives a positive result not only for successful participation in the STEM project, but also for achieving better results in the scheduled exams. In Table 2. is presented the average success of the two student groups - K_1 and K_2 on the official exams of the discipline. The table shows that among the students who studied additionally through PBL, the achievements of the colloquium, as well as those of the final exam are higher. It should be noted that both exams were conducted by different teachers and the colloquium grade was not included in the formation of the final exam grade

Table 2. Average success of the researched and the control group of medical students of the Colloquium and the Final exam

Average grade	Studied group with applied PBL (K_2)	Control group (K_1)
Colloquium	Very good (5,13)	Very good (4,79)
Final Exam	Very good (4,66)	Good (4,07)

Comparison and analysis of the obtained results achieved by the students in the two groups of the final exam (Fig. 4. /A, B**/**) confirms effectiveness of teaching through PBL, because in the studied group with



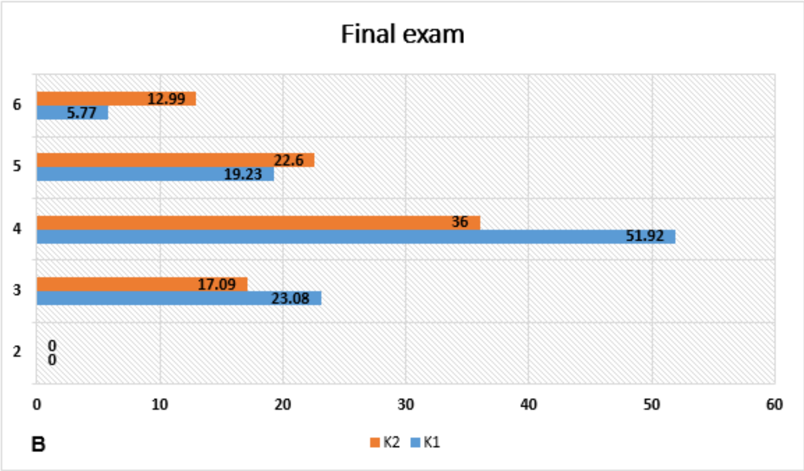


Fig. 4. Comparison of the distribution of colloquium and theoretical exam scores between the control (K_{1}) and the study (K_{2}) student groups

included practical exam, for both, the Final exam and the Colloquium, the indicators for achieved learning goals are higher.

The obtained results and the analysis made subsequently show that, as a motivational incentive for participation in the project, the hybrid method can be defined as an integrated system in which the PBL environment helps students achieve the desired learning outcomes, as well as good results in the context of future academic training and professional realization.

4. Conclusion

In conclusion, students who have completed the training in university courses *hybrid curriculum* are satisfied with the *objectives and requirements set* in the learning process; the learning tasks and activities, the support of students, the assessment in the context of learning in a mixed environment; they are satisfied with the workload within the PBL, but most of all of the acquired skills. Students believe that the training gave them the opportunity to acquire skills for evaluating the information found and for forming a personal point of view. Developed and applied a summarized, theoretically justified, personality-oriented model for STEM-PBL of an academic course applicable in the specialty of medicine and biotechnology engineering, which increases the efficiency of the training process, and hence the quality of the professional training of future doctors and biotechnology engineers.

REFERENCES

[1] Armstrong E G, A hybrid model of problem-based learning. In: Boud D, Feletti GI, eds. The Challenge of Problem-based Learning, 2nd edition. London: Kogan Page, 1997:137–50.

[2] Biggs, J., (1999), Teaching for Quality Learning at University Buckingham UK, SRHE and Open University Press

[3] Helle Laura, Tynjälä Päivi & Olkinuora Erkki (2006). “Project-based learning in post-secondary education – theory, practice and rubber sling shots”. Higher Education, vol.51, n2, p.287-314.

[4] Houghton W., Learning and Teaching TheoryThe Higher Education Academy - Engineerin Subject Centre, 2004

[5] Markham, T. (2011). Project Based Learning. Teacher Librarian, 39(2), 38-42

[6] Palle Qvist, Democratic Elements in Group and Project Organized PBL, in PBL at Aalborguniversitycontributionstothe International PBL ConferenceinLimaJuly 17-24, Kolmos, Anette, Publication date:2006)

[7] Rockland, R., D.S. Bloom, J. Carpinelli, L Burr-Alexander, L.S. Hirsch, and H. Kimmel. (2010) “Advancing the ‘E’ in K-12 STEM Education.” *Journal of Technology Studies*, 36(1), 53-64.

[8] Trujillo, F. (2012). Propuestasparaunaescuelaenelsiglo XXI. [Proposalsfor a schoolinthe XXI century. Madrid: Librosdela Catarata

[9] Wurdinger, S. & Qureshi, M. 2015. Enhancing college students' life skills through project based learning. Innovative Higher Education, 40:279-286. doi: 10.1007/s10755-014-9314-3