# APRENDIZAGEM BASEADA EM PROJETOS NO ENSINO DE BIOQUÍMICA METABÓLICA

## *APRENDIZAJE BASADO EN PROYECTOS EN LA ENSEÑANZA DE BIOQUÍMICA METABÓLICA*

## *PROJECT-BASED LEARNING IN THE TEACHING OF METABOLIC BIOCHEMISTRY*

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**RESUMO**: A Bioquímica é um componente curricular que está presente nos cursos de Licenciatura em Química e Biologia e os alunos costumam considerá-lo complexo. A utilização de metodologias ativas de aprendizagem busca tornar o aprendizado desse componente significativo aplicando situações de aprendizagem reais e autênticas e colocando o estudante no centro do processo de ensino-aprendizagem. A Aprendizagem Baseada em Projetos (ABPr) foi escolhida para se trabalhar Bioquímica Metabólica com alunos do 4° ano do curso de Licenciatura em Ciências da Natureza com Habilitação em Química do IFMT – Campus Confresa. O tema "doenças metabólicas" foi definido como ponto de partida para a execução dos projetos e foram abordadas as doenças: diabetes, hipotireoidismo e intolerância à lactose. A ABPr mostrou-se uma estratégia eficiente no ensino de Bioquímica Metabólica, pois foi capaz de unir as três dimensões para o desenvolvimento de competências: a construção do conhecimento (por meio da abordagem do conteúdo), o desenvolvimento de habilidades (trabalho em equipe, comunicação oral e escrita, utilização de ferramentas digitais) e a demonstração de atitudes (por meio da conscientização sobre problemas presentes na sociedade e a utilização da Bioquímica na prevenção ou solução destes problemas).

**PALAVRAS-CHAVE**: Bioquímica metabólica. Doenças metabólicas. Aprendizagem Baseada em Projetos. Metodologias ativas de aprendizagem. Formação inicial do professor.

***RESUMEN:*** *La Bioquímica es un componente curricular que está presente en los cursos de Licenciatura en Química y Biología y los alumnos suelen considerarlo complejo. La utilización de metodologías activas de aprendizaje busca hacer el aprendizaje de ese*

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*componente significativo utilizando situaciones de aprendizaje reales y auténticas y como centro del proceso de enseñanza-aprendizaje el estudiante. El Aprendizaje Basado en Proyectos (ABPr) fue elegido para trabajar Bioquímica Metabólica con alumnos del 4º año del curso de Licenciatura en Ciencias de la Naturaleza con Habilitación en Química del IFMT - Campus Confresa. El tema "enfermedades metabólicas" fue definido como punto de partida para la ejecución de los proyectos y se abordaron las enfermedades: diabetes, hipotiroidismo e intolerancia a la lactosa. La ABPr se mostró una estrategia eficiente en la enseñanza de Bioquímica Metabólica pues fue capaz de unir las tres dimensiones para el desarrollo de competencias: la construcción del conocimiento (a través del abordaje del contenido), el desarrollo de habilidades (trabajo en equipo, comunicación oral y escrita, utilización de herramientas digitales) y la demostración de actitudes (por medio de la concientización sobre problemas presentes en la sociedad y la utilización de la Bioquímica en la prevención o solución de estos problemas).*

***PALABRAS CLAVE:*** *Bioquímica metabólica. Enfermedades metabólicas. Aprendizaje Basado en Proyectos. Metodologías Activas de Aprendizaje.*

***ABSTRACT****: Biochemistry is a curricular component that is present in Chemistry and Biology Teacher Training Courses and students usually consider it complex. The use of active learning methodologies seeks to make the learning process of this component significant using real and authentic learning situations and placing the student at the center of the teaching-learning process. Project-Based Learning (PBL) was chosen to teach Metabolic Biochemistry to 4th-year students of Teacher Training Course in Nature Sciences with Qualification in Chemistry of IFMT - Campus Confresa. The theme "Metabolic diseases" was defined as the starting point for the execution of the projects and the following diseases were addressed: diabetes, hypothyroidism and lactose intolerance. PBL was an efficient strategy in the teaching of Metabolic Biochemistry because it was able to gather the three dimensions for the development of competences: the construction of knowledge (through the content approach), the development of skills (teamwork, oral and written communication skills, the use of digital tools) and demonstration of attitudes (through awareness of current problems in society and the use of Biochemistry in the prevention or solution of these problems).*

***KEYWORDS****: Metabolic biochemistry. Metabolic Diseases. Project-Based Learning. Active Learning Methodologies.*

## Introduction

Biochemistry is an area of knowledge that is found in different undergraduate courses. Within the scope of pre-service teacher undergraduate programs, this class usually is seen in programs such as Biology and Chemistry. Students usually consider it very complex because it is interdisciplinary, brings a very large amount of information and requires prior knowledge of Cell Biology and Organic Chemistry. This complexity of contents is also related to the approach of micro and macromolecular phenomena, a factor

that requires great abstraction ability to understand them (YOKAICHIYA, 2005). In addition, teachers usually adopt traditional teaching methodologies, working in a decontextualized way where students are passive individuals in the construction of knowledge and they need to memorize a series of names, concepts and routes that are not always considered important to them. It is necessary to seek strategies so that the learning of this subject becomes significant and thus students can connect new knowledge with the previous one; therefore, changing students' role in the classroom becomes essential for learning. The promotion of this change can be accomplished through active learning methodologies, which: i) places students at the center of the teaching-learning process; ii) integrates theory and practice, using real and authentic learning situations; iii) promotes greater development of cognitive, interpersonal and intrapersonal skills. Project-Based Learning is an example of such methodologies (MILLS et al, 2003).

When using PBL, students work collaboratively to develop a product and during this development several learning paths emerge and each student becomes responsible for his/her learning, which is constructed in a collective and contextualized way (MORSUND, 1998). Its dynamics is based on the elaboration of questions, debates, work plan, hypotheses test, data collection and its analysis, confirmation or refutation of hypotheses, sharing information about the projects and proposition of new questions. These are continuous and interconnected cycles that lead to the development of the final product. The teacher plays the role of a facilitator and should help students in the definition of projects that are both coherent with the objectives of the curricular component and contextualized with students' daily life. In addition, the teacher should provide ways so the learning process happens and promote frequent assessment and self-assessment opportunities in order to value the process, not just the final product that was developed (BARRON et al, 1998).

The efficiency of PBL for the student learning is widely described in the literature (DRAPER, 2004; HOWARD, O'HARA; SANBORN, 1999; MENEZES; FARIA, 2003; ERGÜL; KARGIN, 2014). Matta and Neto (2015) proposed projects to be implemented in Comprehensive Education by students of pre-service teacher in undergraduate courses. Topics such as biological cycles, transformation of vegetable oils, healthy food, medicinal plants and alcohol were proposed through projects that value both autonomy and collaboration among students. PBL has many advantages over traditional teaching, among them: the greater participation of students in the activities; the development of different

competences; the establishment of connections between learning and everyday life; the possibility of building knowledge in an intercultural way; increased collaboration among teachers; and increased student motivation. Disadvantages include: teachers' resistance to act as facilitators or mediators; the complex organization of the learning process, especially when it is related to assessment methods; and the difficulty in fulfilling the whole course syllabus, especially in a sequential way as in the traditional courses (BLUMENFELD et al, 1991). This work aimed at providing a favorable environment for learning Metabolic Biochemistry, targeting students of the 4th year of a pre-service teacher in an undergraduate program in Nature Sciences with degree in Chemistry Teaching of the Federal Institute of Education, Science and Technology of Mato Grosso (IFMT) - Campus Confresa using PBL.

## Methodology

According to Moreira (2011, p.76), this study is characterized as an experiential report whose main focus is "the interpretation of the meanings attributed by the persons to their actions in a socially constructed reality through participatory observation". During the observation, the researcher collects qualitative data and interprets it using different data collection instruments such as the field notebook, questionnaires, interviews and observations.

The experiment took place between August and December of 2015, during the Biochemistry Metabolic classes. The subject is annual, with a total workload of 80 hours and it is seen in the 4th and last year of the pre-service teacher in an undergraduate program in Nature Sciences with degree in Chemistry Teaching. Twelve students participated in the study and there were 15 weekly meetings of two hours each. Initially the students answered a questionnaire about the curricular component and about teaching methodologies so that we could understand their interests in the subject, what they expected from it and what teaching methods they believed that could favor their learning. From the answers, the subject "metabolic diseases" was determined as the starting point for the execution of the projects.

Then students were organized into three groups with 4 members each, and each group chose a metabolic disease to develop their project which had as expected outcome

the organization of two moments of awareness: one inside the institution on the thirteenth week, and another in a public place on the fourteenth week.

The project was conducted according to the seven-step model by Buck Institute of Education.

**Table 1:** Seven stages of the project development.

| Stage | Description |
|---|---|
| 1 | Proposal of a contextualized and open work, allowing students to obtain different results by means of varied paths. |
| 2 | Proposition of small activities related to the project so that students demonstrate their development of skills and competences. |
| 3 | Theoretical background using collaborative methodologies for the construction of the final product. |
| 4 | Demonstration of knowledge built through the debate on metabolic diseases. Also considered the mid-term assessment. |
| 5 | Integration of knowledge that was built in order to create a flyer. |
| 6 | Preparation of flyers, with visual identity and organization of the presentation for the community. |
| 7 | Achievement of the moments of awareness and group final assessment. |

Source: authors

The assessment was carried out in a procedural, formative and summative way. Students were assessed by the teacher and their peers during the process and by the visitors during the final assessment.

## Results and Discussion

In the initial questionnaire, when students were asked what they would like to learn related to Biochemistry, 9 out of the 12 students answered that it would be contextualized topics to better understand diseases, test results and nutrition. This result was used as motivator to choose the theme of the projects because besides being in line with the course syllabus it would bring the possibility of contextualization within the society, valuing students' previous knowledge. A small explanation was made about metabolic diseases and then some examples were pointed out. The groups chose the three diseases that they would study: diabetes, hypothyroidism and lactose intolerance. When asked about the reasons that led them to choose those diseases, the students always brought personal motivations since some family member had the disease.

Concerning the project development, students were always encouraged to ask themselves so that they could construct knowledge in an investigative way and at no time ready answers were given to them. However, at the beginning of the activities, students faced many difficulties to work autonomously because, according to them, they have not had opportunities to work in such a way during their formal education. That could be perceived in their answers in the initial survey, since 11 students said they would like teachers to use different methodologies; however, only 3 said they liked to ask questions and do collective activities either inside or outside the classroom.

At the end of each class, 10 to 15 minutes were given to the group discussion and self-assessment. The groups talked a little about the work done up to that time, the difficulties they found and ways to overcome them. These moments were becoming richer each week, showing that collaborative attitudes that demand student's autonomy can be developed if the teacher promotes appropriate environments for that to happen.

In the fourth phase, the students had the opportunity to discuss outside their work groups through a debate on metabolic diseases. This stage was of great importance for the process since the projects could be evaluated by their peers, who provided feedback and feedforward for each group. During the discussion, students demonstrated some understanding on metabolic processes related to the selected diseases such as glycolysis, Krebs cycle (citric acid cycle), fatty acid oxidation, integration and hormonal regulation of mammalian metabolism and oxidative phosphorylation. Photosynthesis and biosynthesis of amino acids and lipids were subjects that were not previously studied by the groups during the project development; therefore, there was a need of advancing discussions on these subjects. Some of the questions raised during the discussion were not answered efficiently by the groups, what made them to turn to the teacher to provide the answers. This is an intrinsic characteristic of the traditional educational system, but these questions were used as a reference to guide the rest of each group's work.

The fifth phase happened both inside and outside the classroom. Students began to determine what would be important for the informative flyer. One of the strategies used to facilitate this process was the OPERA teaching strategy (Own, Pair, Explanation, Ranking, and Arranging) where they could list the possible information to be placed in the flyers and define which were the most important and deserved more attention. The time of presentation and the role of each group member were also defined.

Since the flyer information was defined (the diseases, their symptoms, prevention, treatment and brief biochemical explanation of the causes of diseases) in the sixth stage, the students began to construct the visual identity of it in the computer science laboratory. The software used to do the flyer could be freely chosen in order to value students' autonomy and creativity.

In the final presentation that took place in two moments - at school and in a public square - each group prepared a stand, decorated and organized in order to facilitate the awareness of visitors about the three metabolic diseases. In addition to the flyers, the groups prepared a series of activities during the presentation, such as blood pressure and blood glucose measurement, food and drug samples that are used to control some diseases, lactose-free food recipes and symptom checklist for pre-diagnosis of hypothyroidism. The students also showed how to interpret some laboratory tests such as hemogram and lipidogram and made a small game about the amount of sugar present in food, making the awareness moment even more dynamic.

## Final considerations

PBL was an efficient strategy in the teaching of Biochemistry for students of a pre-service teacher in an undergraduate program in Nature Sciences with degree in Chemistry Teaching because these future teachers will have a great social function in the classroom and by raising awareness about metabolic diseases, among other subjects, they can play this role.

The proposed strategy gathered the three dimensions for the development of competences: knowledge, skills and attitudes, because in addition to promoting the construction of knowledge regarding the contents, the strategy made possible the development of teamwork, oral and written communication skills, as well as the use of digital tools for teaching and the awareness awakening regarding problems present in society using Biochemistry in the prevention or solution of these problems.

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