ANEXO III. MEMORIA FINAL DE PROYECTO

TÍTULO: PRE-EVALUACIÓN Y PREGUNTAS DURANTE LAS SESIONES PRÁCTICAS PARA MEJORAR LA COMPRESIÓN DE LOS ESTUDIANTES SOBRE LAS HERRAMIENTAS BIOQUÍMICAS UTILIZADAS

TITLE: PRE-EVALUATION AND THEORETICAL ISSUES DURING PRACTICAL SESSIONS TO ENHANCE STUDENTS' COMPREHENSION ABOUT BIOCHEMICAL TOOLS

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Received: dd/mm/yyyy Accepted: dd/mm/yyyy

Abstract

In subjects where the practical part has a special relevance it has been shown that theoretical concepts are not always correctly assimilated and that the applicability of these concepts to practice is often limited to the specific cases that professor uses as an example. In addition, many times the realization of practices consists in following up the protocol without understanding the real meaning of the different steps that students carry out. Therefore, in the present study, pre-evaluation tools and theoretical issues have been introduced in the practical sessions in order to encourage students' interest in the practice, increase their knowledge and carry out a more efficient interconnection between theory and practice in relation to what is normally done. Our data show that, although the satisfaction of the students did not show significant changes, there was an increase in the knowledge acquired in those practices and groups of students in which the aforementioned tools were applied as demonstrated by the increase in the qualifications obtained.

Keywords: Pre-evaluation, practices, theory, contents interrelation

Resumen

En asignaturas donde la parte práctica tiene una especial relevancia se ha demostrado que no siempre se asimilan correctamente los conceptos teóricos y que la aplicabilidad de dichos conceptos a la práctica muchas veces queda limitada a los casos concretos que el profesor utiliza a modo de ejemplo. Además, en muchas ocasiones la realización de prácticas termina siendo un mero seguimiento de protocolos sin comprender los alumnos el significado real de los diferentes pasos que realizan. Por eso, en el presente estudio se han introducido herramientas de pre-evaluación y cuestiones teóricas en las sesiones prácticas con el fin de incentivar el interés de los alumnos en la práctica realizada, aumentar sus conocimientos y llevar a cabo una interconexión mas eficiente entre teoría y práctica de la que se realiza en la actualidad. Nuestros datos demuestran que, si bien la satisfacción de los alumnos no mostró cambios significativos, si que se observó un aumento de los conocimientos adquiridos en aquellas prácticas y grupos de alumnos en los que se aplicaron las herramientas anteriormente citadas como queda demostrado por el incremento en las calificaciones obtenidas.

Palabras clave: : Pre-evaluación, prácticas, teoría, interrelación de contenidos

1. INTRODUCTION

One of the main objectives of university education is to improve students' conceptual understanding. Many students fail to develop a complete understanding of the fundamental biochemistry concepts and often adquire misconceptions [1], despite the additional preparation they receive in the form of practices. During the last decades, education researchers have analyzed why students incorporate misconceptions during their learning. Thus, many students believe that photosynthesis involves the production of energy for the growth of plants [2, 3], while others believe that leaves breathing is possible in plants due to the special pores for gas exchange. Other misconceptions include ideas such as that amino acids are created by translation [5], that a protein spends its entire cellular life in a native conformation [6], that the enzymes function through a key-lock mechanism (suggested by Emil Fisher in 1894) instead of by an induced adjustment model (described by Dan Koshland in 1958) [7], or that are individuals who evolve instead of populations [8].

The strategies that are usually used to help students to modify these misconceptions are generally based on making them accept scientific evidence even if they disagree with their original ideas, and once this goal is achieved, use this new knowledge to replace the previous one [8]. There are many strategies to help students establish a new correct concept, including the creation of "concept maps" [9], the use of interactive laboratories simulated [10], classroom demonstrations

[11] and computer-aided instruction (CAI) [12]. Although have been demonstrated that recent implementations of computer simulations, as well as the 5E learning cycle (engagement, exploration, explanation, extension, evaluation) [13, 14] have been shown to help some students build new knowledge, many of these misconceptions persist, indicating the need to create new learning strategies and materials that help students build correct models.

Our teaching experience has revealed that there are basic biochemical concepts that students do not fully understand, or that they assimilate erroneously. Practical sessions, although aimed at strengthening knowledge and checking the applicability of it, too often become a mere formality and students only follow the steps of a protocol without fully understanding why and what are they doing. This observation has led us to develop the present study, designed to try to avoid these misconceptions. In this work we propose to use pre-evaluation tools in the practical sessions. The first tool will consist of a questionnaire with two levels of difficulty that will allow us to identify common misconceptions. The first level of the questionnaire usually refers to general knowledge, while the second level involves higher cognitive levels [15]. We also address the common misconceptions of students through a subsequent discussion of the answers provided.

In order to promote critical thinking and improve reasoning ability, we examined whether this new strategy provides a method to improve students understanding of different biochemical issues applied to practice. For this, the students completed a self-assessment rubric that allowed us to determine the acquisition of the basic and specific competences that we have set ourselves. The basis of this study is supported by the most recent literature, which shows that repeated testing could improve long-term learning [16-18]. Our results demonstrate that this method effectively correct misconceptions about basic biochemistry issues applied to practice and improve the acquisition of basic and specific skills.

2. OBJECTIVE

The subjects included in this study (Experimental Biochemistry II and Biotechnology and Food Science from the third course of the Biochemistry degree) share common aspects, as the acquisition of basic knowledge from the Biochemistry field and the practical sessions performed in the laboratory. The primary objective of this study has been to consolidate basic knowledge related to general Biochemistry and to be able to apply this knowledge in a proper and wider maneer under different contexts.

3. MATERIAL AND METHODS

First, the professor makes a brief introduction in which inform the group about the development of the practical session that is performed that day. Likewise, the professor set and justify the practical session in the context of the subject, which in our case are Experimental Biochemistry II and Biotechnology and Food Science, and in relation to Biochemistry degree to which they belong. After that, the students receive a questionnaire with three questions that should be completed during the different waiting times established by the protocol.

The questions included in the questionnaires are three, in each of these questions is assumed the objective to influence different aspect of the knowledge and skills that the student intends to acquire when is working on them. For this purpose, the questions of the questionnaire would focus on:

1.- Theoretical concepts handled in the theory classes of the subject and that are applied during the development of the practical session.

2.- Methodological concepts associated with the development of the practical session.

3.- Application of the protocol developed during the practical session in a completely different context, within the limits set by the program of the subject (i.e. explain a practical case different to that performed in the laboratory in which they need to describe the scientific base and the methodology used to solve it).

Both in the third question, where the objective of the questionnaire is more evident, as in the previous two, there are problems related to the content of the practical session. Thus, its resolution requires assimilation by the student of both what is being done and why it is being done.

The questionnaires are completed jointly by the members of each group. The students per group varied between 2 and 4, depending on the particularities of the protocol applied in each case. Prior to questions resolution the members of each group have discussed the different issues. Furthermore, an exchange of ideas between members of different groups is allowed to be considered very desirable. This exchange introduces new contributions to be discussed later within each group before completing their questionnaire.

At the end of the practical session, each group submit their questionnaire, and it is at this time when the teacher spends between 15 and 20 minutes going deeper in the purpose and theoretical base of the session, instead of at the beginning, as is usual.

The previous work on these ideas, not only with the development of the protocol but also discussing these concepts and techniques during the completion of the questionnaire, transform the students in active agents of this last part. The professor takes the moderator role, directing and / or modulating the knowledge constructed by the students to get all the key concepts exposed during the session.

In the evaluation of the questionnaires, the following aspects have been assessed:

1. Ability to relate and / or correctly apply the concepts and methodologies with others not previously addressed.

2. The originality of the answers.

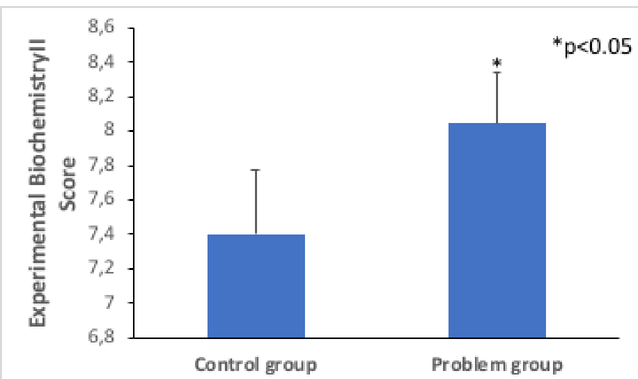
3. Clarity and concreteness in the exposition and development of the answers.

Members from the same group are qualified in the same way being this qualification a 30% of the total score assigned to the practical session.

Finally, to evaluate the efficiency of this type of collaborative learning, at the end of the practical sessions set that integrate the subject in Biochemistry degree, the students complete a rubric in which they self-evaluate the obtaining of basic and specific key competences. This rubric was composed of a total of between 6 to 8 questions with scores comprise from 1 to 4 where 1 means not at all, 2 a little, 3 a lot and 4 exactly.

4. RESULTS AND DISCUSSION

The students including in this study were female (48 %) and male (52 %) in third year of Biochemistry degree. Two different subjects were analysed: Experimental Biochemistry II, taught in English language and Biotechnology and Food Science, taught in Spanish. In both cases the questionnaires used during the practical sessions in the biochemistry laboratory were answered by the students actively and collaboratively. The control groups and/ or practices consisted in a normal Biochemistry practical session in which students needed to apply a protocol and obtain results but without the using of the questionnaire. We observed that problem groups (those in which the questionnaire was used) showed higher interest in the practice and discussed different theoretical concepts and approached to the real cases that they used. An individual knowledge was constructed from the consensus responses obtained between classmates, judging from the answers given in the questionnaire and the subsequent sharing. Thereby, the use of the questionnaire supposed a significant increase of educational potential for the practical sessions. Furthermore, the possibility of contrasts information about an applicability different of that from the practice along with the debate between classmates helped not only to improve the knowledge construction but also to go deeper and to enlarge it. Finally, the sharing led by the teacher involved an assimilation of the contents much greater than that obtained with the normal development of a practical session as demonstrated by the scores obtained by the different groups in the subjects analysed (figure 1).



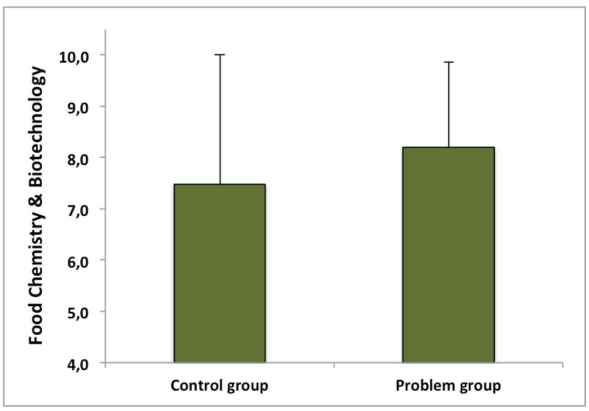


Figure 1. Total score obtained for the two subjects analysed. Comparison of mean scores and standard deviations of groups with (problem group) and without (control group) questionnaire use.

However, no change was observed in the students' perception about the skills and knowledge acquired. As shown by the scores awarded to the rubric complete in this regard (figure 2) and of which an example is shown in table 1.

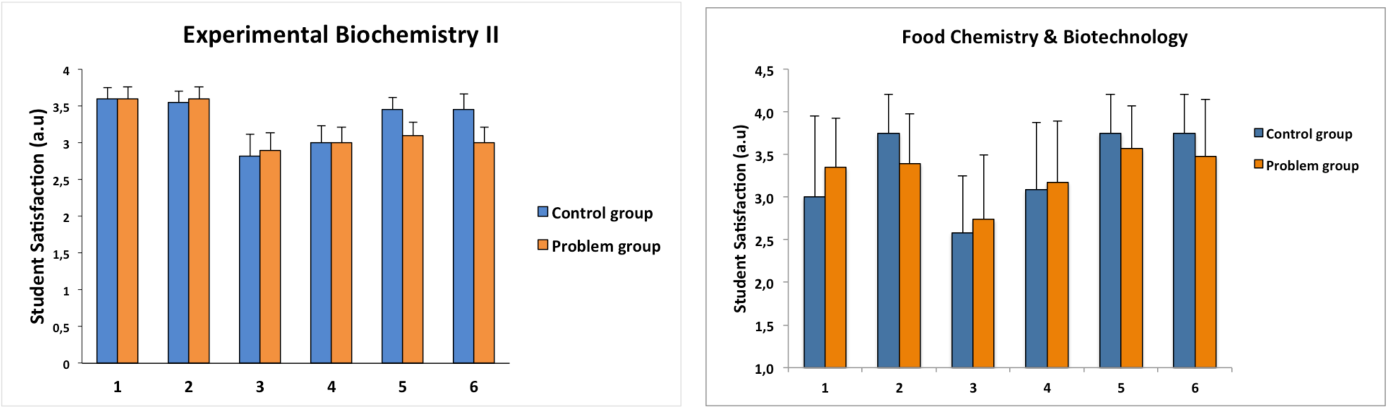


Figure 2. Rubric score in the two subjects analysed. Means and standard deviations comparison between problem (with questionnaire) and control groups (without questionnaire).

Table 1. Example of rubric used in the study.

	Assessment			
Ítems	**1**	**2**	**3**	**4**
1. The practice suppose an adequate extension of the knowledge imparted in theory				
2. The practice is representative of the techniques currently used in research				
3. The student considered himself capable of modifying the proposed protocols to adapt them to similar applications				
4. The student considers having acquired the necessary training to decide which would be the most appropriate protocol in different practical cases				
5. The student consider himself capable of correctly interpreting the results from the practice				
6. The student considers himself capable of writing a practice memory only with what he has learned during the lab sessions				

The pre-evaluation tools applied in this study effectively transformed a traditional Biochemistry practical session into a dynamic and exciting learning environment. Interestingly, most students seemed to appreciate the opportunity for group discussion and collaborative activity afforded by the questionnaire supplied as much as the practice itself. The importance of group discussions has been noted also in other disciplines [19, 20], and is consistent with the social-constructivist's view indicating that knowledge is most effectively constructed via social interaction with others [21]. Giving students the chance to talk to one another during a science class has been shown to be particularly useful as a mechanism for generating ideas, clarifying concepts, and distributing knowledge among peers [22]. In addition, learning and concept fixation may be increased by applying the basic science to real-scientific research as is observed in our case as well as many others [23, 24]. Asking students to propose a real case in which the techniques and knowledge learned in the practices can be applied also increased students´ interest and enthusiasm, this is observed in many practical curses and subjects [23]. However, the greater participation and enthusiasm of the students was not reflected in the scores awarded to the rubrics templates for personal competences self-assessment. This is not surprising since there are some studies indicating that self-assessments are not always accurate because factors as gender or marks obtained by the students influence the results. For example, men rate themselves higher than women and students with higher scores in the final exam are more accurate that students with lower scores [25]. So, at the end is necessary professor opinion to have a realistic picture of this issue [25].

All of the above is supported by the scores obtained by the students. Thus, significant differences were found when comparing the scores of students from pre-evaluated groups with those from control groups. This agrees with the majority of studies conducted to evaluate the potential of collaborative learning, pre-assessment tools and application of theory to real cases [18, 20, 23].

5. CONCLUSIONS

1. The pre-evaluation tools tested in this study would correct misconceptions about basic Biochemistry issues applied to practice.
2. Greater participation and enthusiasm of the students taking part in this study is however not translated into a positive personal competences self-assessment.
3. The tools used not only increase students´ performance but also the knowledge about the subject and the social relationship among them.

ACKNOWLEDGEMENT

The authors would especially like to thank the students which has enthusiastically participated in this study.

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