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PROJECT-BASED LEARNING FOLLOWING B-LEARNING AS A STRATEGY TO STRENGTHEN THE DEVELOPMENT OF SCIENTIFIC COMPETENCIES

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Abstract

The article is part of the master’s thesis on project-based learning (PBL), which utilized B-learning to enhance the scientific skills of sixth-grade students in biology at Rodolfo Castro Castro school in Mariangola, Valledupar, Cesar.

Accordingly, 35 sixth-grade students were involved in the investigation that applied a learning sequence aimed at strengthening scientific competencies (identify, inquire, and explain). The study results demonstrated that combining virtual and face-to-face learning environments through PBL can contribute to the strengthening and development of scientific skills.

The data were qualitatively collected through action research, adopting a pre-experimental design. An observation technique was applied to a group of participants. This project aimed to observe and describe the scientific competencies of the students, including their capacities, abilities, and weaknesses. The aim was to implement a strategy to strengthen competencies where weaknesses were found. Rubrics were used to determine the level of achievement of the students during the development of the PBL methodology.

Keywords: Scientific competencies, B-learning, Project-Based Learning (PBL), and learning environments.

INTRODUCTION

Colombia's Law 115 of 1994 establishes basic scientific training as the primary objective of education (Articles 5, 7, 9, and 13). To achieve such goals, the competencies are adopted by national organizations, such as the Ministry of National Education through the publication of curricular guidelines and competency standards to facilitate the creation of scientific culture. Thus, the development of scientific competencies is regarded as a priority in the natural sciences.

Sanmartí and Marquéz (2017) described scientific competence as a constantly reconstructed concept based on theoretical reflections, practice, and social evolution.

It is, therefore, necessary to note that the concept of scientific competence adopted in this proposal is based on the approaches of the OECD (2006), the ICFES (2007), and Quintanilla (2006), which emphasize the application and use of knowledge in context, specifically to know, to know how, and to know how to be.

This emphasizes the role of education in forming scientific competence in young people and the role of teachers in creating thematic units that, as Ortiz et al. mentioned, must be created with specific guidelines that contribute to the strengthening of scientific competencies.

As scientific competencies for Caña (2012) are not independent and their development is continuous and progressive, it is necessary to start thinking about strategies that, in addition to developing scientific competencies, do not alienate students from science. According to Justi et al. (2011), school science models involving students are crucial, allowing them to more actively participate in class planning and activities. It is related to what Cañal (2007) described, based on the context in which it is found, and what Caamaño (2012) described as the integration of research activities and school inquiry.

This type of activity enables the integration of scientific procedures and creates a link between what is taught in school and what happens outside of it, thereby motivating the student to continue learning (Sanmartí and Márquez, 2017).

Regarding learning environments, Flórez et al. (2012) asserted that they promote essential lifelong learning. In response, Smidt and Velázquez (2021) stated that to achieve success, strategies must be devised relating virtual learning to face-to-face instruction, establishing effective feedback mechanisms, and pairing different strategies.

Based on the above, it is necessary to begin creating environments that enable students to interact both virtually and in person. In these environments, students can take full advantage of both settings. As learning strategies have been completely altered, the role of the teacher as a knowledge holder and the student's role as a receiver of knowledge have been completely re-evaluated.

Project-based learning (PBL) supported by B-learning would be one approach since PBL is a form of student-centered instruction. According to Causil and Rodriguez (2021), the approach has several advantages such as connecting concepts to their context, stimulating emotional intelligence, improving motivation in the classroom, and providing tools for developing interpretation and construction skills. García and Pérez (2018) advocated that students are allowed to build their knowledge through their reality based on their experiences. Sanmartí and Márquez (2017) concluded by stating that students who learn using the PBL are more creative, more responsible, and more aware of their learning, resulting in increased teamwork and motivation.

Furthermore, B-learning should be considered as a strategy. Lopez et al. (2019) referred to B-learning as one of the most outstanding emerging methodologies within virtual teaching models, combining face-to-face teaching with online learning and enhancing the best qualities of each according to the specific needs. Cabero and Marín (2018) further explained this concept by stating that in addition to harmonizing virtual and face-to-face learning, B-learning is a training environment involving different teaching strategies. According to Lopez et al. (2019), the benefits of B-learning are as follows: change in the role of the teacher and the student; the teacher ceases to possess knowledge, and the student becomes the protagonist of their learning; it facilitates the development of digital skills; it adapts to the unique needs of each student and increases participation, collaboration, and communication among students.

Accordingly, the research aimed to implement PBL supported by B-learning in the subject of biology for sixth-grade students at Rodolfo Castro Castro school in Mariangola, Valledupar. The objectives were to strengthen the development of scientific skills (identifying, inquiring, and explaining) through identifying the capacities of the sixth-grade students with a diagnostic activity; designing a learning sequence for a specific topic of biology using the methodological steps of PBL supported by the B-learning; and evaluating the incidence and conducting a satisfaction survey.

METHODOLOGY

This research is based on the action research methodological design and is of a qualitative nature. Hernández and Mendoza (2018) proposed that the first cycle is the detection of the research problem, which includes identifying and diagnosing the problem in the study field; in the second cycle, a strategy or plan is developed to address the problem that was identified; in the third cycle, the strategy or plan will be implemented and the results are evaluated.

Population and sample

This study examined sixth-grade students from the Rodolfo Castro Castro school, located in the Mariangola corregimiento of Valledupar, Cesar municipality. The school encompasses urban and rural communities, and the primary purpose of scientific education is to teach natural sciences (PEI, Rodolfo Castro 2018).

As part of the study, a group of 35 students aged 11 to 15 from sixth grade class - 04 were selected. These students were at the level where formal operations were undertaken. According to Piaget, at this stage, people use their logical reasoning, analyzing and manipulating thought schemes that lead to valid conclusions.

Procedures

After analyzing the results of the diagnostic activity, we proceeded to the stage of implementing the strategy. As part of the preparation for the projects, two groups were formed, each with a maximum of five students and a minimum of three. Group 1 investigated medicinal plants, and Group 2 examined aromatic plants in Mariangola. The unit was “Classification of Living Beings” and was supported by a VLE designed on the Edmodo platform. To use the combined methodology, five stages were considered.

Stage 1 Exploratory. The objective was to optimize the recovery of prior knowledge by taking the students to the slide platform with a question they were to answer based on their experiences and knowledge.

Stage 2 Research and information search. At this stage, the students were allowed to contrast and analyze the information. Because the students were unfamiliar with the process of searching for information, Google, Bing, and Yahoo! were recommended as search engines, along with the table proposed by DePro (2012) to make the search as efficient as possible.

Stage 3 Information analysis, summary, and management. At this stage, the students gathered and structured the information for their respective representations and organizations. Tools used included a concept map, data matrix, timeline, comparative chart, and summaries.

Stage 4 Product development and dissemination. To address the issues they had identified, students presented their final product to the entire educational community, applying what they had learned.

Stage 5 Evaluation and feedback (stage 10). Students reflected on their experience and discussed failures and solutions. They were self-assessed based on a rubric covering objectives, collaborative work, communication with the group, and initiative (product).

Tools

The instruments used to collect information included observation of participants, monitoring and analysis of performance regarding scientific competencies, and two questionnaires. Through the questionnaires, (1) information was collected regarding the students' perception of the teaching methodology of teachers, and (2) an assessment was made of the degree of acceptance concerning the implementation of the strategy.

ANALYSIS AND DISCUSSION OF RESULTS

Assuming that the research objectives have been met, we proceed to analyze and discuss the findings.

The diagnostic activity conducted to determine the capacity and ability of the scientific competencies (inquire, identify, and explain) has yielded the following results.

The students presented several flaws in the three competencies evaluated. With regard to identifying competencies, students had poor reading habits. Throughout the activity, it was necessary to repeatedly remind participants to concentrate on their reading. When extracting the central ideas in a summary, they copied verbatim or they condensed pieces of the reading omitting relevant information. They were able to approach the topic by relating it to current issues; when capturing it, the approach they gave was superficial, and the use of the terminology or language of the natural sciences was poor. Regarding the elaboration of hypotheses, most of them asked questions related to the subject; however, they doubted their knowledge because they constantly asked the teacher for approval.

While students identified a problem or phenomenon to study, they faced difficulties in organizing the information they observed, which resulted in omitting essential characteristics that were necessary for a complete understanding of the subject. They superficially related the concepts to their daily lives since they did not relate the problem in personal and social contexts.

According to Ruiz and Espinosa (2020), strengthening this competency requires linking and understanding disciplinary concepts of natural science, and for this, students must develop skills that allow them to recognize, differentiate, and compare. To develop this type of capacity, the teacher should be adequately involved in the classroom, not only as a close companion but also with activities that stimulate teaching and learning.

With regard to the "inquire" competency, the students' computer skills were poor during the development of the activity. Their understanding of a search engine was limited, and they could not obtain information due to a lack of knowledge of keywords. Furthermore, they did not consider the source for the search, and they were not very clear about what information they needed to collect to answer the questions posed by themselves. Furthermore, they did not compare and classify the information as part of the selection. Consequently, many participants became frustrated and demotivated to comply with the activity. Instead of evaluating the quality and origin of the scientific information, they took the first result that the search engine provided.

Barrios (2018) indicated a shortcoming in these competencies: the inability to apply methods that make it possible to break down a problem and classify its elements that hinder the ability to identify situations or phenomena.

Pérez and Ramírez (2018) suggested that to strengthen this competency, the "didactic strategy must be based on the generation of contextualized questions or problems to be solved by letting their interests and pre-knowledge be known."

Likewise, the little mastery that the students had in terms of the "explain" competency was evidenced. During the development of the activity, a bit of confusion was observed because the students were not clear about how to capture the information on the board. They had difficulty translating the information into their language and finding words to express what they wanted to explain, reducing it to paragraph snippets. Furthermore, they could not agree with their colleagues on what they had to present, and many even suggested that each member make their presentation.

For the exhibition of the board, the content was divided by fragments for each member, which they only read, without processing the information. With this, very few skills in oral expression were evidenced. That is, it was difficult for them to understand and communicate the results of a study. Barrios (2018) affirmed that it is in the argumentation where the students examine their process and present their reasons to justify a certain position, which requires logical and analytical reasoning (Page 117). Bolaños (2017) suggested "having an adequate setting in the class that stimulates motivation, where the student becomes the center of the class, where space for interaction and socialization is given, thus improving social skills, their speech and their elements, among them, the argumentation."

As a result of a questionnaire administered to the students, it was determined that the contents discussed in the classroom did not correspond to their context when questioning the pedagogical practices used in class. It contradicted the findings of Barrios (2018), who argued that students must work on contextualized classroom problems to develop basic scientific skills. Thus, it avoids having passive students who are simply recipients of information. Instead, it trains more active students capable of applying the reasoning provided by interaction with the outside world and its relation to theory.

During the development of the class, the most used resource was dictation. Very few digital resources were used. Ortiz and García (2019) revealed that one way to arouse interest in students is the use of various digital educational resources, as it improves their curiosity and their abilities in investigative processes. Cortés et al. (2017) affirmed that "although the inclusion of technology is increasing in the field of education (basic, secondary, and higher), the appropriation of teachers is still far from becoming a reality in most of them."

During the development of the class, students never used research. This contradicted what was expressed by Caamaño (2012): integrating research activities or school inquiry is a good technique in teaching science for learning scientific competence because this allows an integration of the scientific procedures.

Accordingly, the methodology used in class lacked strategies for developing scientific skills.

With the design and implementation of the sequence of PBL following B-learning as a strategy to strengthen the development of scientific competencies, it was evidenced that

Regarding the strengthening of the capacities of the "inquire" competency.

In the early stages of the implementation, the students were almost individually accompanied, especially with respect to the planning of searches, selecting keywords, and extracting relevant information.

To learn how to select keywords, one strategy involved group debates where students chose and finalized a list of keywords with the teacher's guidance. Consequently, the students were able to do it on their own in the following sections.

To help them learn how to use search engines, they began by seeking out word meanings on two recommended search engines so that they could later compare their meanings.

For the following sessions, the students used more insurance in the Google search engine. Likewise, with the use of the search planning box, the use of keywords, information gathering, and time management were facilitated. Although it was not an activity they were used to, the students took notes from different sources to classify the information in a data matrix and applied it to their research. This corroborates what was stated by De Pro (2012): To teach the student to search for particular information on the Internet, it is necessary to set some guidelines to plan the search. This will allow the student to do so in a timely manner, become autonomous, and provide the ability to apply what they have learned in other life situations.

Regarding the strengthening of capacities of the “identify” competency.

Regarding the analysis and summary of the information, almost 50% of the students stated that they wanted to carry out the individual activities. They could not organize the notes that each one had to give an answer to the problem raised. To teach them about cooperative work, the strategy used was the assignment of roles where the teacher suggested that they divide the responsibilities. Some were in charge of compiling the information that everyone had, and the others were in charge of making the product to be delivered. For the following sessions, they managed to organize the task and assume roles. This facilitated the use of the information found correctly and improved their motivation to carry out the products. Some students stated the following:

Teacher, doing these activities feels as if one were turned on again and understands what the information consulted is for.

Therefore, it could be said that the students managed to improve their ability to identify, describe, and interpret the information to respond to the problems raised. Furthermore, they strengthened the capacities to describe, interpret, and organize information in different graphic schemes such as conceptual map, line of time, comparative table, and summary. This reaffirms the findings of Cañal (2012): to describe, explain, and predict phenomena, habitual elements for linguistic communication are necessary. Pedrinaci (2012) contemplated codes and forms of representation such as schemes, concept maps, tables, and graphs (p. 148).

Regarding the strengthening of capacities of the “explain” competency.

At this stage, it was possible to observe that most of the groups could construct and represent their results by carrying out a pre-report. In this, the construction of some arguments in a logical order was evidenced. This was done through their experience and application of knowledge in their writing and their respective socialization through the socialization of their results. They gave satisfactory answers to the questions: How are Mariangola’s living beings classified? They also conducted guided research with the PBL, Taxonomic Classification of Medicinal and Aromatic Plants of Mariangola.

In response, Barrios (2018) stated that the development of this competency is essential as it is necessary to function in their day-to-day lives, transmit their thoughts, and defend their ideas.

The Edmodo platform was evidently very practical and easy to use when used in conjunction with the B-learning methodology to support the PBL. Through this approach, students were introduced to platform management and had the opportunity to explore a diverse range of digital educational resources, which aligns with the findings of Cabero Y Marín (2018). Additionally, they claimed that B-learning is a training environment in which multiple teaching strategies are coupled. This reaffirmed the assertion made by Smidt and Velázquez (2021) that strategies linking virtuality with face-to-face interactions should be established, providing effective feedback mechanisms.

Furthermore, the didactic unit was designed with the PBL approach, which included a stage for recovering previous knowledge. During the first few sections of this stage, it was observed that the students were hesitant to contribute and often asked for clarification: teacher, what do I write here? And is it wrong? A strategy used by the teacher to remove their fear was to tell them that there were no wrong answers and that, over time, they confirmed how right or wrong their response was. As a result of the PBL approach, the students' confidence improved, and in the subsequent sections, more active students were observed who were not afraid to answer questions based on their existing knowledge without fearing being wrong. This increased the number of answers and participation from students. This reaffirmed what Causil and Rodríguez (2021) stated: PBL has the advantage of connecting students' concepts with their context, stimulating their emotional intelligence, improving motivation in the classroom, and providing tools to develop skills such as interpretation and construction.

The incidence and acceptance of the strategy by students

As a result of the questionnaire, participants indicated that the theme was relevant to the context of the classes, which increased their interest and liking for them. As Cañal (2007) indicated, the use of didactic strategies based on context-related situations creates a connection between what is taught at school and what occurs outside of it. This makes learning meaningful and motivating for the student.

The degree of satisfaction with the PBL methodology supported by B-learning was very high. According to Vargas et al. (2019) and Romero et al. (2018), PBL methodology, when combined with ICT, is an excellent strategy for acquiring knowledge. This approach enables students to take charge of their learning, improves their motivation, and enriches their understanding through real-life situations and experiences. This allows them to be protagonists of their learning. As a final statement, they stated that they would like to continue developing their biology classes in accordance with the proposal that has been implemented. According to Rodriguez (2014), a student's learning environment may influence the different ways in which they learn. A learning environment is adequate when all participants feel comfortable, when creativity is developed, and participation in problems found in the student environment is evident.

CONCLUSIONS

Concerning the implementation of PBL supported by B-learning in the biology subject to enhance sixth grade students' development of scientific competencies, the following conclusions can be drawn:

Regarding objective 1. It was evidenced that the students exhibited deficiencies in most of the capacities related to the three competencies. These competencies are essential for basic scientific training and are essential to function adequately in the social and natural world, directly impacting their learning and motivation.

Many of the shortcomings of scientific abilities were primarily caused by the use of strategies such as workshops, dictations, and activities, which focused on providing students with a vast amount of content but little opportunity to investigate and experiment. This approach contradicts the institutional PEI, which emphasizes scientific education as a primary objective.

Regarding objective 2. It can be concluded that the implementation of the didactic unit, with the PBL stages and supported by B-learning, is an excellent pedagogical strategy for the development of scientific competencies since it focuses on the student. It is focused on research to solve a problem related to its environment, which contributes to meaningful learning; the development of skills and abilities such as self-learning; collaborative work; and identification, description, and search for information. Likewise, B-learning contributes to the harmonization of learning environments, enabling the management of digital platforms and the self-exploration of computer resources and tools from different points with specific objectives.

Assessing objective 3. Students are left with a positive impression of the implemented methodology. In their opinion, this method has enabled them to improve their motivation and learning. They have been the protagonists in their process, utilizing their experience and context, with which they have also used a wide range of interactive digital resources. Through these resources, they have demonstrated a greater level of enthusiasm, participation, autonomy, collaborative work, commitment, and responsibility in the classroom.

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