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Implementation of Project-Based Learning in Uruguayan Secondary Schools

Implementación del aprendizaje basado en proyectos en centros de educación media uruguayos

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Abstract

Project-Based Learning (PBL) is a well-known student-centered methodology, but it is not commonly used in Uruguayan schools. This study measured students' perceptions of the implementation of PBL and documented the successes and challenges for teachers throughout the process. The data showed that PBL was successfully implemented, but teachers reported a series of difficulties, including the quality of the training, a resistant attitude on the part of some teachers, students' inexperience regarding the PBL methodology, pressure on teachers to cover the content, and issues with infrastructure and internet connectivity.

Keywords: project-based learning, middle school, teaching methodologies, Uruguay, faculty development

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Resumen

El aprendizaje basado en proyectos (ABP) es una metodología centrada en el alumno poco común en los centros educativos de Uruguay. Esta investigación midió la percepción de los estudiantes sobre la implementación de ABP y documentó los éxitos y retos de los profesores durante la misma. Los datos demostraron una implementación exitosa; sin embargo, los docentes enfrentaron retos como la calidad de la capacitación, la actitud de resistencia de algunos docentes, la inexperiencia de los estudiantes con la metodología, la presión del profesor por cubrir contenido, y problemas de infraestructura y conexión a Internet.

Palabras clave: aprendizaje basado en proyectos, educación media básica, metodología de la enseñanza, perfeccionamiento docente, Uruguay

Introduction

According to Guinovart and Troncoso (2010) and the International Bureau of Education (2011), the public education system in Uruguay consists of four main compulsory levels: (a) initial level, 1 year; (b) elementary level, 6 years; (c) secondary level, basic or basic technological levels, 3 years; and (d) upper secondary level (*bachillerato* in Spanish), diversified or technological, 3 years. The upper secondary level was made compulsory in 2009, becoming a challenge for the authorities responsible, because the system was unable to respond to the diversity of students entering the system (Romero et al., 2012).

Uruguay has traditionally been recognized in the Latin American context for its high levels of equity and social integration. However, towards the end of the 1990s, the gaps between social classes became more acute, with the emergence of new forms of social differentiation and socio-territorial fragmentation. One of the consequences of this transformation in the quality and equity of the education system has been the aggravation of two problems: the declining quality of primary and secondary education, and abandonment of the formal education system (Aristimuño, 2009; Instituto Nacional de Evaluación Educativa, 2020; Menese Camargo, 2020; Racioppi, 2018).

Educational quality and the PISA tests

One of the most pressing problems in Uruguay is that segregation by socioeconomic groups and social stratification of educational outcomes has been rising (Administración Nacional de Educación Pública, 2017; Instituto Nacional de Evaluación Educativa, 2017). The 2015 test for the *Programme for International Student Assessment* (Organisation for Economic Co-operation and Development, 2016) shows that, in the case of most of the countries that are members of the organization, the distribution of students across proficiency levels tends to be normal, while in the case of Uruguay there is a marked trend towards lower performances. The test shows a larger gap between students from higher socioeconomic settings who learn more and students from contexts of greater vulnerability, who learn less (Administración Nacional de Educación Pública, 2017, Instituto Nacional de Evaluación Educativa, 2017; Vega & Petrow, 2008).

School abandonment

When the quality of education is insufficient (Instituto Nacional de Evaluación Educativa, 2017), one of the consequences is the high abandonment of secondary education by young people, even compared with the regional context. Since the implementation of the General Education Law, Nº 18,437 of 2008, the six years of secondary education have become compulsory.

Between 2008 and 2019, the coverage of compulsory education for children between 12 and 14 years of age has remained stable, while that of compulsory education between 15 and 17 years of age has increased very little. In 2006, it reached 72% and in 2017 it rose to 83.7%, well below universal coverage (Mirador Educativo, 2019). The proportion of children entering the Uruguayan educational system is increasing, but the access of teenagers to the final level of compulsory education remains low and has not varied significantly in recent years (Instituto Nacional de Evaluación Educativa, 2017).

Likewise, the capacity of the system to retain students is increasingly inefficient. Only 30.8% of young people graduated from secondary education in a timely manner (ages from 18 to 20) in 2017 and, between 2008 and 2019, the graduation rate rose only slightly to 8.1% (Mirador Educativo, 2019). According to the Educational Achievement Yearbook (Ministerio de Educación y Cultura, 2015), only 45.4% of 17- and 18-year-olds in the lowest income quintile completed the basic level of secondary education. De Melo et al. (2015) reported that the most common causes of dropout mentioned by students were that they found school difficult and expensive, that they had started working, that they were not interested in the content or found it useless, or that they had some health problem.

The alternative of project-based learning (PBL)

In order to answer these questions, many studies have proposed educational innovations. As one of the so-called active methodologies, PBL emerges as a proposal that is better able to engage the interest and motivation of students. When students are faced with a problem, this helps them to seek different strategies to resolve it, participating in small groups in an active and collaborative manner, asking themselves questions, collecting information, and conducting the necessary work to solve the problem (Ananiadou & Claro, 2009; Boss & Krauss, 2018; Bender, 2012; Condliffe et al., 2017; Dole et al., 2016; Holm, 2011; Vergara, 2015), thus creating a commitment to their own learning.

There are sufficient studies that validate PBL as an internationally recognized practice (Casla & Zubiaga, 2012; De la Puente Pacheco et al., 2020; Martínez et al., 2007; Thomas, 2000) that develops different skills that benefit students in terms of their personal and professional improvement (Mioduser & Betzer, 2008; Rodríguez-Sandoval et al., 2010; Willard & Duffrin, 2003; Ye-Lin et al., 2019). Students increase their level of knowledge, their motivation, and develop greater understanding by identifying learning objectives, and participate in self-directed work and discussions (Casla & Zubiaga, 2012; Fajardo Pascagaza & Gil Bohórquez, 2019; Merritt et al., 2017; Newstead et al., 2008).

Similarly, studies such as those by Mergendoller et al. (2006) and Tal et al. (2006) contend that the beneficial academic effects of PBL are more pronounced in students from medium to low social backgrounds. Although there is evidence at the international level, there is no known evidence referring to Uruguay and very little evidence in Latin America as a whole.

Corea and Lewkowicz (2004), Merritt et al. (2017), and Thomas (2000) argue that, for good implementation of PBL, it is important to have good design of problems/projects, small group work, a frequent student-centered inquiry process, communication of findings to the group, resources, technology, and association with the community. Other key elements include teachers having the role of facilitators (Condliffe, et al., 2017; Holm, 2011; Thomas, 2000) and all stakeholders feeling the need for change (Barron et al.,1998; Blumenfeld et al., 1991; Duncan & Tseng, 2010).

By way of summary, we can say that the PBL methodology, being authentic and experiential, will enable students to be better prepared for life. Undoubtedly, in vulnerable socioeconomic settings, this peculiarity takes on greater importance, because students who generally attend schools without motivation will be able to find greater meaning in doing so (Condliffe, et al., 2017; Thomas, 2000). It is therefore novel and relevant to collect evidence of the implementation of the PBL methodology in Uruguay, since it is currently an emerging innovation in the country's classrooms.

Research objective and questions

This research was conducted in three secondary schools, which will be identified as SS1, SS2, and SS3 in order to protect the confidentiality of the participants. They are located in an unfavorable socioeconomic setting, given that it is these types of schools in which Uruguay obtains the worst results in terms of student retention and learning achievement.

One of the objectives of this study was to assess students' perception of PBL during the course of the year. The second aim was to describe teachers' perceptions regarding the process of training, planning, implementation, and assessment of PBL in their respective secondary schools and to identify factors that hindered the practice of PBL and how to minimize their effects in future implementations in these and other schools nationwide.

The following questions guided the research: (a) What is the students' perception of the academic benefits of learning through the PBL methodology before, during, and after its implementation? (b) Are there statistically significant differences in the students' perception of the academic benefits of learning through the PBL methodology before, during, and after its implementation? (c) What was the teachers' perception of the training, planning, implementation, and assessment of PBL?

Prior to the implementation of PBL, the teachers took part in training that was planned and implemented by one of the co-authors, the purpose of which was to instruct the participants in PBL. The workshop, which involves training lasting a total of 30 hours, was completed in three weeks in February 2016 and was divided into (a) initial presentation of PBL, in which a bibliography and resources were provided, (b) modeling of good project designs, and (c) design of projects to be implemented and their preliminary review.

Method

Participants

The population of interest is students and teachers at secondary schools in Uruguay. From this population, a convenience sample was obtained consisting of 135 students, including three groups from SS1, one group from SS2, and two groups from SS3, and their respective teachers. These students received the same questionnaire on three occasions: in the first week of the school year, during the process to implement PBL, and at the end of the school year. Eight teachers were also interviewed, three from SS1, three from SS2, and two from SS3.

Instrument

The questionnaire used a five-point Likert scale (strongly disagree, disagree, not sure, agree, and strongly agree) for students to rate 36 statements described in similar publications or questionnaires as being associated with the benefits of PBL (Goodnough & Cushion, 2006; Sockalingam et al., 2011; Usmani, et al., 2011). The internal reliability index of the questionnaire was obtained using Cronbach's alpha, which produced a value of 0.961.

The responses to the questionnaire were analyzed using overall and center descriptive statistics, and inferential statistics to compare changes in student perceptions over the course of the school year. Given the categorical nature of the Likert scale and the data obtained for the same students on three different occasions, nonparametric analyses such as the Kruskal-Wallis H and Mann-Whitney U tests were used. As the research is exploratory in nature, it was decided to use a $p < 0.05$ significance level in order to attempt to maintain a balance between the possibility of type I and II errors.

Interviews with teachers

To gather information on teachers' perceptions on the training, planning, implementation, and assessment of PBL, they answered several guiding questions using the semi-structured interview technique. Specifically, they were asked to give details of which projects they had implemented (Table 1), their perception of PBL prior to the training workshop, how students responded to the PBL methodology, and which aspects of PBL they felt were the most successful or required improvement.

Table 1
Projects implemented through PBL

Project and brief description	Teacher
• **Food, games and art in ancient Egypt**. The students cooked typical dishes, and designed and built models of games, jewelry, and pottery from ancient Egypt.	Alba
• **Local news report**. The students researched, wrote, filmed, and edited news stories in areas of interest such as sports, national and international news, culture, and politics, among others. • Debate about community problems. The students investigated different social, economic, or emotional issues in their neighborhood and proposed and advocated solutions to these problems.	Alejandra
• **Programming of videogames**. The students decided on the type of videogame they were going to create and how to divide the tasks between different groups in the computer science and robotics courses.	Balbino
• **Origin of life**. The students carried out bilingual research on aspects of the origin of the universe, paleontology, the Big Bang, evolution, and the formation of continents, among other things. • Journey to the interior of the cell. The students conducted research on different types of cells and made models of the immune system, including bilingual presentations. • Life in an ecosystem. The students conducted research and created bilingual posters of an ecological subsystem, a native animal, or a region of Uruguay.	Andrea
• **Internet sciences**. The students created a scientific blog-type internet page, in which they shared their knowledge of physical sciences in an audiovisual way.	Benjamín
• **Solar car**. The students researched, designed, and built scale models of a solar car.	Bernardo
• **Cultural identity of the neighborhood**. The students researched historical, geographical, and interdisciplinary aspects of their neighborhood, and published an article in a local newspaper.	Braulio
• **Architectural models of the school**. The students obtained the measurements, proportions, and dimensions of the school and produced 3D printable models using the software program Sketchup.	Bruno

Source: prepared by the authors.

The interviews were transcribed and organized by teacher and school so that the unique stories and settings of each SS could be portrayed. To analyze the statements in the semi-structured interviews, and code and identify emerging themes, the researchers followed an iterative process of thematic analysis, as described by Braun and Clarke (2008) and Nowell et al. (2017). The write-up of the qualitative findings provides a rich and detailed description of the experience of implementing PBL from the teachers' perspective (Creswell & Poth, 2018; Merriam, 2016; Rubin & Rubin, 2012).

Results

Students' perception of the benefits of PBL

The overall perception of the benefits of PBL for the three SS started with an average value of 4.21 + 0.21, but dropped slightly to 4.11 + 0.20 at the midpoint, albeit a difference that is not statistically significant (n=36, U=488.5, p=0.073). The mean value of the score after implementation was 4.06 + 0.13. Although this value is not significantly different from the previous one (n=36, U=505.5, p=0.110), it is statistically different from the first one according to the Mann Whitney U test (n=36, U=360.5, p=0.0012).

Table 2
Average responses of the students of the three SS to the questionnaire Learning with Projects before the implementation of PBL (Pre-PBL), midway through the semester during the implementation (PBL), and at the end of the semester, after the implementation (Post-PBL). The results of the Kruskal-Wallis H test are also included.

I think that learning through projects will help me to …	Average score			H	p
	Pre-PBL	PBL	Post-PBL		
Clarify my doubts with my teammates	3.99	3.95	3.84	0.704	0.703
Achieve my targets in class	4.38	4.17	4.18	3.666	0.160
Apply the vocabulary I learn	4.17	4.00	3.94	3.925	0.141
Apply what I learn in a different situation	3.95	4.00	3.98	0.550	0.760
Learn more rapidly and efficiently	4.22	4.03	3.99	2.130	0.345
Learn from my teammates	4.15	3.85	3.97	3.793	0.150
Learn in a more active way (less passively)	3.97	3.81	3.89	1.727	0.422
Learn in a way that more closely resembles the real world	3.87	3.88	3.82	0.249	0.883
Learn in a more interesting way	4.40	4.34	4.07	5.726	0.057
Learn in a more varied way (less monotonous)	3.99	4.12	3.96	6.839	**0.033**
Learn better	4.50	4.26	4.21	4.568	0.102
Learn by myself	3.80	3.58	3.74	1.531	0.465
Increase my interest in the classes	4.29	4.15	4.06	4.379	0.112
Connect what I think, what I do, and what I learn	4.02	4.05	4.03	0.750	0.687
Consider different points of view when solving a problem	4.09	4.12	4.06	0.052	0.974
Control the rate of my learning better	4.17	4.16	4.12	0.157	0.925

Create a good atmosphere in the class	4.28	4.25	4.01	4.554	0.103
Make me aware of the importance of what I learn	4.34	4.20	4.11	4.341	0.114
Divide a difficult subject into easier-to-learn parts	4.09	4.07	4.18	1.328	0.515
Find information in the library or on the internet	4.40	4.16	4.13	3.317	0.190
Understand the process of researching new information better	4.15	4.02	4.06	0.810	0.667
Understand what the teacher expects from me better	4.31	4.17	4.08	2.811	0.245
Make me responsible for my own learning	4.35	4.32	4.14	2.082	0.353
Identify the main idea of a reading	4.07	3.91	4.02	3.225	0.199
Reach agreements in my team	4.35	4.20	4.13	3.298	0.192
Improve my skills as a leader	3.77	3.84	3.80	0.318	0.853
Improve my communication skills	4.33	4.19	4.19	2.233	0.327
Obtain better grades	4.65	4.42	4.30	10.96	**0.004**
Organize my time better	4.15	4.13	4.17	0.363	0.834
Think in more creative ways	4.29	4.30	4.24	0.06	0.970
Think better	4.32	4.31	4.16	3.175	0.204
Remember better what I learn in high school in the long term	4.24	4.13	4.12	1.938	0.380
Hand out tasks based on what each classmate prefers	4.01	3.81	3.97	2.59	0.274
Respect the opinions and ideas of my teammates	4.52	4.27	4.10	9.058	**0.011**
Work better in a team	4.53	4.47	4.09	11.86	**0.003**
Use what I have learned in another subject	4.36	4.41	4.27	2.005	0.367
Totals	**4.21**	**4.11**	**4.06**		

Source: prepared by the authors.

A separate analysis of each of the 36 statements from the three SS using the Kruskal Wallis H test indicates that 32 (88.8%) of the paired scores for the statements remained statistically similar. Given that the averages stayed within in a range between 4.2 and 4.0 or "agree", it is possible to conclude that the students' perception of the academic benefits of learning through the PBL methodology was generally positive. However, the significant difference between the perception before and after implementation suggests that not all of the students' expectations had been met.

Students' perceptions: results by SS

The results of the questionnaire for the students in the three groups at SS1 are summarized in Table 3. For SS-1A, 31 (86.1%) of the statements showed similar scores and five (13.9%) displayed significantly decreases. In SS-1B, even more significant decreases in the scores were observed (10 in total, or 27.7%). In the SS-1C group all comparisons resulted in similar scores.

Table 3

Average responses of the students of SS1 to the questionnaire Learning with Projects before the implementation of PBL (Pre-PBL), midway through the semester (PBL), and at the end of the semester (Post-PBL). Only statements with statistically significant differences, according to the Kruskal-Wallis H test, are included.

I think that learning through projects will help me to …	Average score			H	p
	Pre-PBL	PBL	Post-PBL		
SS-1A					
Learn more rapidly and efficiently	4.31	3.54	3.74	7.330	0.026
Learn by myself	4.04	3.21	3.54	7.449	0.024
Increase my interest in the classes	4.50	3.79	3.79	6.950	0.031
Remember better what I learn in high school in the long term	4.71	3.96	3.63	15.46	0.0004
Work better in a team	4.38	4.25	3.46	6.82	0.033
SS-1B					
Learn in a more varied way (less monotonous)	3.88	4.77	3.91	17.36	0.0002
Create a good atmosphere in the class	4.54	4.32	3.83	7.805	0.020
Find information in the library or on the internet	4.60	4.59	4.00	7.529	0.023
Understand the process of researching new information better	4.32	4.18	3.82	6.319	0.042
Make me responsible for my own learning	4.40	4.55	3.74	14.03	0.001
Obtain better grades	4.72	4.82	4.09	12.36	0.002
Think in more creative ways	4.67	4.55	4.05	6.763	0.034
Think better	4.56	4.50	4.00	8.704	0.013
Work better in a team	4.72	4.59	3.74	11.92	0.003
Use what I have learned in another subject	4.72	4.59	4.26	7.032	0.030
SS-1C					
None					

Source: prepared by the authors.

In SS2, only one group participated in the study. Of the 36 statements, all comparisons turned out to be statistically similar, with the exception of "improve my skills as a leader," which scored highest, at 4.38 points, during the implementation of PBL, compared with 3.52 and 4.24 points before and after implementation, respectively (n=24, H=8.610, *p*=0.014).

In SS3, the two groups that took part in the study were identified as SS-3A and SS-3B. The analysis showed that almost all the scores for both groups (33 out of 35, or 91.7%) remained stable before, during, and after the implementation of PBL. In the case of the students in SS-3A, all three statements with a significant difference showed improved scores, as did two of the three statements answered by students in the SS-3B group.

Table 4

Average responses of the students of SS3 to the questionnaire Learning with Projects before the implementation of PBL (Pre-PBL), midway through the semester (PBL), and at the end of the semester (Post-PBL). Only statements with statistically significant differences, according to the Kruskal-Wallis H test, are included.

I think that learning through projects will help me to …	Average score			H	p
	Pre-PBL	PBL	Post-PBL		
SS-3A					
Connect what I think, what I do, and what I learn	3.58	4.11	4.32	7.353	0.025
Organize my time better	3.50	4.32	4.32	7.437	0.024
Remember better what I learn in high school in the long term	3.33	3.79	4.32	7.845	0.020
SS-3B					
Clarify my doubts with my teammates	3.67	4.31	4.00	6.882	0.032
Apply the vocabulary I learn	4.39	4.06	3.71	6.779	0.034
Create a good atmosphere in the class	3.33	4.50	3.88	9.664	0.008

Source: prepared by the authors.

When comparing the three SS, it is clear that the significant difference between the overall perception of the benefits of PBL before and after its implementation is almost entirely due to the effect of only two of the six groups of students, SS-1A and SS-1B. It is important to underline that, even in the group whose questionnaire scores dropped the most, the majority of their statements did not show significant decreases. With respect to the statements with some significant difference, almost none were repeated, indicating that the type of project and teacher mentoring may have created unique educational experiences in each group exposed to PBL. Hence the importance of the qualitative data, shown below, to describe and rate the teachers' experiences and their level of success in the implementation of projects.

Perception of PBL training, implementation, and assessment

Alba – SS1. Alba considered that the PBL training process was positive, because she was able to learn about the methodology and break down preconceived notions about PBL. She said that the most useful part of the training was that she was able to put together a project, understand the necessary steps, and differentiate what types of activities and topics would be best suited to PBL.

The students initially had a hard time getting organized and she had to guide the more responsible students to understand that they did not have to do the work for the whole team. Halfway through the process, her students had taken on their tasks responsibly, but some had difficulty connecting the relevance of the project to their lives. Some students also had problems understanding the new role of the teacher and did not readily accept that it was not the teacher who would provide them with the information and materials for the project.

As a final activity, in addition to a written report, the projects were presented at a fair, which was attended by all members of the school. In conclusion, Alba felt that the overall response from the students was positive, as all teams were able to complete each project successfully.

Alejandra - SS1. Alejandra said that the training process was unfamiliar, as she had previously used PBL successfully. She gave a positive evaluation of the training, because it provided examples of other tools and enabled her to refresh her knowledge and contrast PBL in Uruguay and her home country.

During the implementation process, Alejandra stated that her "dynamic" personality helped her students understand that they had to work at a certain pace, that "they weren't going to be sitting down all the time." Alejandra noticed that the students were interested in the topics and demonstrated a lot of creativity and participation.

Midway through the process, she observed that the students found it difficult to process the large amount of information gathered in the time available. Part of the problem may have been that her students were only in the first year of secondary school, so understanding the vocabulary and identifying the meaning of the information was difficult for them. In the case of the second project, which was more closely related to their personal experience, the students had already improved in that aspect and managed to conduct very relevant discussions.

At the conclusion of the projects, she was very satisfied with the overall process. The students responded very well, considering that they were quite restless and disorderly groups. Some even asked if they could continue working on the same project next year, showing that they were proud of their process.

Alejandra ended the project by assessing PBL with the students, who responded positively and expressed appreciation for the flexibility of the PBL methodology. She said it was the following year that she was better able to see the results of what had been worked on the previous year, as the students demonstrated better teamwork and problem solving and were even motivated to participate in an external project of the Municipality of Montevideo.

Balbino - SS 1. Balbino considered that the training seemed "quite brief" and "it was so rapid that I couldn't implement it exactly like the methodology we had seen." Even so, he managed to "pick up what was useful to me … things that I felt sure enough to implement."

Balbino felt overwhelmed during the process of planning his projects, partly due to non-academic factors, such as activities at the secondary school during the inauguration. He also noticed that "there was a lot of difference between the students" and it took a few weeks to "sound them out" and get to know them to better understand the extent to which they could adapt to PBL.

Midway through the project, the students became comfortable with the proposal and understood what they had to do in the project. Balbino used a checklist to let the students know what they had to complete as he guided them. Even though some of the computers were not working and SS1 faced infrastructure and internet connection problems, he was surprised by the creativity of his students: "As I didn't provide anything, a whole lot of products emerged that hadn't even occurred to me."

At the conclusion of the PBL implementation, the groups presented their game, the game documentation, and a tutorial on how to play it. Reflecting on the students' performance and how he managed to cover the academic content, Balbino stated that "being able to create something and learning while doing something, that was the most positive thing I saw."

Andrea – SS2. As Andrea learned about PBL in the training, she understood the potential of the methodology to motivate students to learn, particularly if the teacher selected an engaging project and prepared in advance. Andrea rated the structure and schedule of the training as "very good", and it motivated her to continue learning about PBL, so she completed an online course on the subject.

During the planning, it was suggested to Andrea that she collaborate in PBL with the English teacher, something that "worked great" and allowed her to develop projects with a lot of flexibility and adaptability, and that "came out of the IPA box." In Uruguay, IPA refers to Instituto de Profesores Artigas, a teacher training institution for secondary schools.

For a project on the origin of life, Andrea explained how she framed the project in the context of a "letter" from a researcher at the Faculty of Science asking for their help in answer the great dilemma: "Which came first, the chicken or the egg?" Likewise, the project on ecosystems was presented as a friend needing educational resources for tourists to learn about Uruguay.

One of the positive aspects of the implementation was that, while the students were working as a team and meeting the project goals, they had space to say how they felt about it and how they experienced it. Andrea understood that learning is a highly emotional process and "if I connect with the idea, that's when I learn and when I remember."

Andrea commented that one of the difficulties in implementing PBL is that the teacher has to be involved in everything at the same time and at all times, since there are several groups. "Everyone has their topic, or their project, or their stage, or their interactions. So … you don't sit down for a second." She understood that PBL would be better with two teachers per class. As a reflection, Andrea described the PBL experience as "wonderful", although she regretted that there were topics she had to leave out because there was not enough time.

Bernardo – SS2. Bernardo said that he had previous experience with projects, although in the context of his career as an architect, but not in the educational setting. He described the PBL training as "introductory."

During the planning process, Bernardo created a Gantt chart with weekly requirements for a solar car, as well as rubrics for assessment. Bernardo said that the organization of the teams was not done randomly, but based on the characteristics of each student.

He initially tried to get students to understand the PBL methodology, as their previous school experiences were passive or traditional. Bernardo criticized teachers who try to implement PBL but skip this first step, as it could contribute to the methodology not being successful.

As the implementation continued, Bernardo confirmed that once the students noticed the "chain of events" they found the process easier. Bernardo's strategy was to let the students work quietly for two days and on the third day "drop in to see what they were up to."

Bernardo described the performance of his students' as "impressive" considering their socioeconomic context. He attributed the fact that the students learned much more than the first-year of the basic level curriculum to the PBL methodology: "[The students] had already done everything that was in the program, but they require much more knowledge, a lot more things." However, he regretted that the solar car project did not have more interdisciplinary aspects, which he attributed to the "rigid" and "traditional" pedagogical preparation of his colleagues at the school.

Benjamín – SS2. Before the training, the impression that Benjamin had of PBL was that the teachers "let the kids do whatever they want" in the classroom. The training left him with a lot more questions than answers, especially regarding how to reconcile the regulations to pass the grade and the logic of PBL. Despite the training, he felt that not all the teachers were prepared to implement "pure PBL."

Benjamín mentioned that the first year was quite irregular, as both the students and teachers were "the first generation and they were just learning how to implement PBL." At the start of the implementation, he emphasized that to his students, as some of them "arrive with bad habits" and "they don't know the rules of behavior."

In the first few weeks, he noticed that students responded quite well "to the mixture between PBL and traditional learning." Midway through the implementation of PBL, he observed that the students' interest increased. Since "the kids really like to do presentations," at the conclusion of the project, Benjamin required his students to give an oral presentation about their website. "Using the projector takes away some of their fear of standing up to speak, of the public, and it's good, you see them advance with that."

Benjamin expressed the view that the success of the implementation was due to its mixed traditional/PBL approach, which was implemented in parallel "for them to write and retain things in their heads." Another factor that helped this success was the support of the director and Universidad del Trabajo de Uruguay.

Braulio – SS3. Prior to the training, Braulio knew about project work, but was not very familiar with the details of PBL. In his opinion, the training was "very theoretical," as well as "a first attempt, which we have continued to work on perfecting."

In planning his project, he included an ambitious interdisciplinary agenda containing aspects of history, geography, photojournalism, writing, and research "that were strong and had a bibliographic weight." He also made sure that students could do the project in the classroom rather than at home.

The start did not go as expected. "The first big shock we had with the project … was that we had very extensive expectations, which we then had to scale back," as the students showed that they needed instruction in certain areas before fully undertaking the project.

During implementation, he continued to note a positive response, although the students' work did not reach the expected levels of quality, as he sometimes saw "cutting and pasting" used commonly or a lack of ability to select items. He was also able to see that "there are groups that go faster and others that are slower."

Despite the multiple challenges and the length of time required, Braulio concluded that the students "did learn … enriched by the interrelation between different subjects" and that the PBL objective was achieved "because the projects were presented and, in some way, they had the objectives that we had planned."

Bruno – SS3. Bruno is an architect, so the notion of working on projects was not new to him. The project he planned, a 3D survey of the high school, drew heavily on his experience in architecture and computer science.

Prior to implementation, Bruno thought carefully about how to form the teams, knowing that "[the students] react in one way when you allow them to form the teams freely and react another way when the teacher guides them." The assignment of roles also required care, since "there are some who carry the team on their shoulders or those who don't want to take the baton."

At the start of the implementation, Bruno had to modify the project as he went along and "not get out of phase, since time was short and we had to move forward." He noted that the concepts of measurement, proportion, and space generated the most impacts. In the first few weeks, the students had already learned a lexicon of structural elements and the architecture and design programs, and reacted with surprise at the things they could do.

Around the midway point of the implementation, Bruno noticed that there was certain discomfort in some of the groups because their grades were affected if there were students who were not participating to the same degree. Bruno made it clear "that there was a project grade, but also an individual grade [to be fair]; [I] saw who, so to speak, was 'treading water' and who wasn't."

He considered that the conclusion of PBL was "very gratifying", because the students did not imagine that they would be able to make a virtual model. Bruno reflected that, although the project may be fantastic, the factor of the "student population" is always outside the teacher's control.

Discussion

The information from the student questionnaire on their perception of PBL indicates that, regardless of the SS, the students noted many positive aspects of the methodology before, during, and after its implementation, which is consistent with previous research (Casla & Zubiaga, 2012; Merritt et al., 2017; Mioduser & Betzer, 2008; Rodriguez-Sandoval et al., 2010). Their responses were more positive prior to beginning PBL, suggesting that students were receptive to working with innovative teaching strategies.

Of all the statements in the questionnaire, the initial perceptions of five out of six groups were high and they remained so for 90% or more of the students. The interviews with the teachers support the quantitative data, as they described the success of the implementation, the positive feedback from the vast majority of students, and the quality of their projects, an essential factor for successful implementation of PBL (Corea & Lewkowicz, 2004; Merritt et al., 2017; Thomas, 2000).

The interviews also revealed that the majority of the teachers did a good job of "shielding" students from external situations that could have affected the PBL and the quality of the products prepared by the students. The external factors that teachers mentioned having to struggle with during the implementation of PBL included some colleagues' resistant attitude to the methodology, inexperience in implementing PBL, planning projects that were appropriate for the age and ability of the students, students' inexperience in learning with PBL, teacher pressure to cover content, infrastructure and internet connection problems, and the excessive amount of work for teachers. Some of these factors have been identified as essential for successful PBL implementation (Corea & Lewkowicz, 2004; Merritt et al., 2017; Thomas, 2000), so it is possible that, if not addressed as soon as possible, PBL will not remain a permanent component of these SS teaching methodologies.

It is important to acknowledge that each SS had unique circumstances that affected the implementation of the PBL methodology, both positively and negatively. SS1, where the most notable drop in students' perception of their learning with PBL was observed, opened its doors for the first time that year with three first-year groups, totaling 72 students from a highly vulnerable socioeconomic setting. The director and teachers spent much of their time handling coexistence conflicts between the students and pedagogical issues (including the implementation of PBL) became difficult. This establishment is a full-time, free school in the west of Montevideo, which is privately managed and has a somewhat bureaucratic style of management.

SS2 also opened for the first time that year, with 22 students from a highly vulnerable socioeconomic setting from elementary schools in the area. Unlike SS1, the director of SS2 focused on supporting teachers in the implementation of the projects, maintaining a clearly pedagogical leadership that was close to both teachers and students. It should be noted that SS2 is a technological basic-level school that depends on the Technical-Vocational Education Council (CETP), which allows greater flexibility in the curriculum than the other two schools, which depend on the Secondary Education Council (CES). It is also a full-time, free, privately-managed center, located in the north of Montevideo[1].

On the other hand, SS3 already had elementary and secondary levels, and served students in the area from a lower-middle socioeconomic background. It is a full-time private school, located in the north of Montevideo and which charges very low fees. It has two first-year groups, totaling 37 students. The administration of the school changed in 2016, so the decision to implement PBL was imposed by a higher level of administration. In fact, two years later, SS3 requested new training in PBL that was more extensive and included classroom support, in order to carry out the methodological change.

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1. The north and western parts of Montevideo have neighborhoods with vulnerable socioeconomic settings.

Despite various obstacles, the data are clear that, from the students' perspective, the implementation of PBL was positive, it achieved learning, and it developed essential skills and attitudes, such as creativity, autonomy, problem solving, teamwork, and interdisciplinary thinking. It is unquestionable that the PBL methodology is an authentic and motivating educational practice that is internationally recognized and validated by dozens of research studies. However, implementation of PBL is imperfect due to a range of national, regional, and local factors.

Conclusion

In the context of this study in Uruguay, and based on the research questions, we reached the following conclusions: First, most students' perception of the academic benefits of learning through the PBL methodology is high before implementation, but tends to decline during and after implementation. The degree of that decrease depended on the specific context of the SS, the group in which PBL was implemented, and the teachers responsible for the design, planning, implementation, and assessment of the projects.

Second, teachers' perceptions of the PBL training, planning, implementation, and assessment were generally positive from the perspective of their interactions with students, but mixed from the perspective of teachers' interactions with the training, curricular requirements, administration, and school infrastructure. Teachers offered highly relevant suggestions that, if heeded, would certainly improve future implementation of PBL.

The findings of this study should be taken into account in the context of its limitations. Given its exploratory nature, it is impossible to generalize the conclusions based on three secondary schools, six groups, and eight teachers. Also, the information received about the teachers is self-reported. However, the study does provide a detailed description and analysis of the experiences of a specific group of teachers and students in implementing PBL, which could be useful for replicating and extending this methodology for the benefit of other schools in the area and the country.

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