



Project-based learning in the classroom: a case study at High school level

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ABSTRACT

This research presents the results of a case study that analyses the Solidarity Atocha project, which was implemented at a school in Madrid, Spain, and in which 114 first-year High school students participated. The main objective of this study is to analyse the experience of students that participated in the Solidarity Atocha project and to understand how they evaluated it and how satisfied they were with it. The method applied in this case study is a mixed one that used both qualitative and quantitative techniques. A semantic differential and a semi-structured interview were used to collect data. In general, the results obtained reveal a very positive evaluation from the students, mainly in terms of teamwork and the use of digital tools. However, they encountered some difficulties with regard to the time spent on the project and to guidance provided as they worked on it. Inferential analyses show significant differences between the team groups.

Keywords: project-based learning, formal education, high school, ICT, design for change.

Aprendizaje basado en proyectos en el aula: un estudio de caso en Bachillerato

RESUMEN

En este trabajo se presentan los resultados de un estudio de caso en el que se analiza el proyecto "Atocha Solidaria", desarrollado en un centro educativo de Madrid, España, en el que han participado 114 estudiantes de primero de Bachillerato. El objetivo principal de este estudio es analizar la experiencia de los estudiantes que han participado en dicho proyecto, comprender cómo lo valoran y su satisfacción en el mismo. Para ello, se ha utilizado una metodología mixta, y se han empleado técnicas cuantitativas y cualitativas. Para recoger la información se ha utilizado un diferencial semántico y una entrevista semiestructurada, ambos instrumentos contruidos y validados por los investigadores. Los resultados obtenidos muestran, en general, una valoración muy positiva por parte de los estudiantes, relacionada principalmente con el trabajo en equipo y el uso de herramientas digitales. Sin embargo, se encuentran algunas dificultades respecto al tiempo invertido y la orientación durante el trabajo. Los análisis inferenciales han puesto de manifiesto diferencias significativas entre los grupos de trabajo.

Palabras clave: aprendizaje basado en proyectos, enseñanza formal, bachillerato, TIC, design for change.

Introduction

Project-based learning (PBL) belongs to a deeply rooted educational tradition of innovation, and so it cannot be mistaken for a passing fad (Pozuelos & Rodríguez, 2008). Over time, the concept has been improved through definitions such as that of Legutke and Thomas (1991), which frames PBL as a task-focused method of teaching and learning and a shared process of negotiation between participants, with its main objective being the achieving of a final product. This method promotes individual and autonomous learning within a work plan defined by objectives and procedures. Students are responsible for their own learning, and during the process they discover preferences and strategies in relation to it. Moreover, they participate in decisions relating to the content and evaluation of the learning undertaken (Thomas, 2000). It is therefore a more flexible way of organizing the process of teaching and learning, and it emphasizes relating the different pieces of curricular content to a central theme that serves to organize and connect the different aspects and disciplines that make up the project.

One of the main aspects of this methodology is the need to integrate school learning with the reality of the students' environment, putting forward research and experimentation activities (Chiang & Lee, 2016; Majó & Baqueró, 2014).

In this regard, project-based learning is an effective method for developing students' competencies, as numerous studies have demonstrated (Mosier, Levin, & Perkins, 2016; Osuna & Rosas, 2017; Wurdinger, 2016). Critical and divergent thinking, finding solutions, dealing with real problems, seeking and managing information, the capacity to synthesize and extract data, social interaction, dialogue and debate, interaction with different people and contexts within school activity, teamwork, self-assessment and presenting results in different formats and languages are some of the competencies and skills that PBL brings into play.

Furthermore, this methodology requires collaboration, meaning that no individual alone can achieve the goal if their peers do not. This type of interaction involves attitudes that facilitate support, and the students are stimulated by both their own classmates and their teachers, which has an impact on motivation and ultimately on academic performance (Johnson & Johnson, 2009).

These abilities and skills are fundamental for students' future success at school and at university, as well as in daily and professional life. When students work on real and authentic projects, they learn to assess their own work by establishing clear objectives and taking into account their peers' expectations. The teacher, meanwhile, determines the project to be undertaken and acts as a facilitator, accompanying students during their process of learning (Caballero, Briones, & Flores, 2014), offering frequent guidance and assessment through reference guidelines for the project and reflection activities (Pozuelos, 2007). PBL is meaningful, according to Vergara (2016), to the extent that the teacher seeks to define education in a non-traditional education framework. It is an educational model that engages with the real learning needs of students, connects the curriculum with their interests, utilizes their way of learning, trains them in higher-order thinking skills and engages them with the context in which they live.

Although the use of information and communication technologies (ICT) in PBL methodology does not affect the educational principles that guide its implementation, it profoundly transforms two aspects of projects: access to and the management of information, and students' communication with the teacher and

with one another (Badía & García, 2006). Technologies can enhance PBL's characteristics, strengthening interactivity, facilitating communication and teamwork, and offering an interdisciplinary approach and an education based on real situations and problems (Molina, Adamuz & Bracho, 2020).

At the present time, in which different projects based on the use of ICT and its integration into educational practice have already been undertaken at schools for years, it is necessary to systematically evaluate these experiences, identifying the strengths and weaknesses of these processes and suggesting guidelines for improvement in order to optimize the efforts undertaken and contribute to the achievement of efficiency and efficacy in schools, an unquestionable indicator of educational quality. Therefore, beyond the description of experiences, it is necessary for there to be research on PBL in schools. The idea is to find evidence, in the context of this type of educational innovation, for both the results obtained and the characteristics of the process, as well as for other variables that should be subjected to analysis: students' satisfaction levels; projects' stages and moments; their relationship or lack thereof with relevant educational principles such as inclusion, collaboration, participation or the promotion of autonomy, to cite just some as examples.

This background is what has led us to put forward this study, which aims to address the monitoring and evaluation of a learning project at the High school level at a school in Madrid, Spain. Through an in-depth analysis of this case, we will delve into its possibilities and limitations, as well as into the factors that promote or hinder this experience, without losing sight of the main objective of all innovation: improving students' learning.

The Solidarity Atocha project

The Solidarity Atocha project aims to give visibility to certain NGOs that carry out support activities with the most marginalized people in their environment. To achieve this goal, the project has been structured in several phases and has followed the method of Design for Change, an international movement that emerged in India in 2009 and that aims to offer children and young people the opportunity to put into practice their own ideas to change the world from their own environment. It is based on the process of design thinking, a profoundly human method of solving challenges that is founded upon creativity, logical thought, collaboration, empathy and learning from mistakes (Kovatcheva, Campos, Del Val Roman, Dimitrov, & Petrova, 2019; Micheli, Wilner, Hussain, Mura, & Beverland, 2019).

In this project, students were organized into teams of 4-5 members, and each student took on a role: guide, spokesperson, community manager, reporter and photographer. Roles were rotated among the members of each team, with the exception of the guide, who was always the same student appointed by the teacher. Each group also had a teacher who served as a mentor and who advised and helped the team throughout the process.

- Guide: this is the student who provided the group with orientation in the design for change process. To this end, the student who assumed this role received two training workshops during the first week of the project, which were delivered by two teachers who were participants in the project.

- Spokesperson: this was the student entrusted with representing the group and speaking on its behalf. Each day this individual was in charge of preparing a short presentation to describe to the others what her group had done.

- Community manager: this was the student responsible for using the group's Twitter account to share everything that the team was doing during the project.

- Reporter: this was the student responsible for making an account of each day and sharing it on the group's blog.

- Photographer: this was the student entrusted with taking pictures during the whole process, as well as with making a short video of interviews with her peers about the activity's progress.

The project was organized into three distinct phases: immersion, implementation and dissemination. In the first phase, which took place over the course of a week, the students undertook a process of immersion at the different NGOs that were participating in the project, in order to gain an in-depth knowledge of the work performed, as well as their social activities. This phase of the project was undertaken by following the stages from the design for change process: feeling, imagining, acting, assessing and sharing.

- Feeling: this is the stage in which students identify possible sources of action from situations in their environment that they would like to be different. In this phase, the students had to select an NGO in a district of Madrid and search for information about it on the Internet. They also thought about a challenge that could improve their chosen NGO's performance— for example, increasing its visibility on social networks, fundraising, and so forth.

- Imagining: this included coming up with and developing ideas to improve the situations that had been analysed at the previous stage and making preparations to put them into practice. In this phase, students put forward ideas to work on the challenge that had been selected in the previous phase— for example, creating an account on Instagram to share the NGO's activities, or making and selling food to raise funds.

- Acting: this is where the groups start to take action; it is the moment when their proposals for change are made a reality. In this phase, students began to embrace their challenges on a practical level: they contacted their NGOs, interviewed their personnel and invited them to collaborate.

- Evaluating: this was the moment when they reflected on the experience they had had and envisaged future activities. This phase was undertaken throughout the entire project. Each day, the students in their groups completed a metacognition ladder to assess the activities carried out, and they produced a blog as a record of their work.

- Sharing: this is the period when students put their projects and experiences on show to others, and when they thought about what had worked well and what could be improved. As with the previous phase, this one was undertaken throughout the project. The students shared photos of and comments on the process on social networks.

In the implementation stage, which lasted a month and half, students took practical steps to accomplish the challenges that they had set to improve the selected organizations' activities. Finally, and for two days, they presented their ideas to the NGOs at the MediaLab space of the CaixaForum Madrid (Spain), doing so in close collaboration with students in their school's vocational training programmes, who helped them to develop different posters for the exhibition. In addition, the High school students conducted different workshops with primary-level students to show them the work carried out by their NGOs.

Research methodology

Study objective

The main objective of this study is to analyse the experience of students that participated in the Solidarity Atocha project and to understand how they evaluated it and how satisfied they were

with it. Specifically, the research questions through which we sought to fulfil the objective were: a) what are the notable positive aspects of the project? b) what difficulties and limitations emerged during the process?

We believe that this analysis could be used to guide other professionals who adopt such initiatives to approach the school curriculum with new perspectives, and it will allow the drawing of conclusions that are transferable to other educational contexts in which there is an interest in methodological renewal, as well as to PBL and to students' transversal acquisition of digital competences.

Research design

The investigation takes the approach of a case study along the lines of what Stenhouse (1991) calls an "educational case study" that is, research that aims to improve educational practice and, therefore, the students' condition and the teachers' professionalism (Lacueva, Imberón & Llobera, 2003).

The method applied in this case study is a mixed one that used both qualitative and quantitative techniques. Triangulation was the technique that we deployed in using different sources of information to fulfil the same objective. The sources used are presented in the Instruments section.

In this study, we defined the case as an educational project that involved collaborative work and used ICT tools to implement it. Given its nature, we may describe the case as exemplary, as it is presented as an illustrative example of an innovative educational experience. If we consider the type of event under analysis, we can speak of a synchronous or contemporary case because project analysis took place at the moment when the research was carried out (García-Valcárcel, 2015).

Participants

A total of 114 students from a school in Madrid who were in the first year of the High school participated in the project. They were distributed as follows: 61 boys (53.5%) and 53 girls (46.5%), whose ages ranged between 16 and 18 years. Students were organized into groups according to the subject specialism that they were enrolled in (social sciences, humanities, science, and technology). Table 1 presents the distribution of participants according to the class group that they belonged to. As can be seen, group CD brought together students specializing in sciences and humanities, as few students specialized in humanities.

Table 1.
Participants organized by class group

Class Groups	N	%
Group A: Social Sciences	25	21.9
Group B: Social Sciences	23	20.2
Group CD. Science and Humanities	20	17.5
Group E. Science	19	16.7
Group F. Technology	27	23.7

To carry out the case study, we contacted the management team of the school, which was informed of the study's objectives, its procedure, and the confidential handling of the data. The management team gave their consent and passed on the request for participation to teachers and students.

Instruments

The complementary use of different data-collection techniques is required to compare and enrich information about reality, because each technique used offers a particular perspective of reality.

First, we used a questionnaire aimed at the students who participated in the project. We were interested in collecting information on students' evaluations of the process and learning outcomes. We used a semantic differential format on the basis that it is simpler and more suited to the age of the students. The semantic differential or scale was previously applied to a pilot group of 140 students for the purposes of a psychometric study, through which the initial 31-item scale was reduced to 20 items. The resulting final 20-item scale presented high reliability (Cronbach's $\alpha = 0.908$) (García-Valcárcel & Basilotta, 2013).

We also conducted interviews with each group of students that participated in the project, in order to gain an in-depth understanding of the activities that had been undertaken and their level of involvement and collaboration in the project and the group, as well as to ascertain their assessment and degree of satisfaction. Through doing so, we were able to expand the data collected through the semantic differential format.

The interview was based on a previously formulated semi-structured script that directly related to the research questions stated at the beginning of this study. Nevertheless, the script was used as a flexible instrument that, on several occasions, was adapted to the contextual reality in which it was administered. This allowed some nuances that were not collected initially to be explored. We interviewed a total of 23 groups out of the 28 that participated in the project.

Data Analysis

The nature of the study and the characteristics of the information collected with the instruments listed above led us to analyse the information using a quantitative and qualitative approach. Based on the semantic differential format, we conducted descriptive and inferential analysis (with the help of v.21 of the SPSS analysis tool). The interviews were used to undertake content analysis, assisted by the NVivo 11 qualitative analysis tool, which is suitable for working with all text-based information. The process that we undertook is summarized in the analysis that follows. With regard to the quantitative analysis of the semantic differential, we sought the mean of each of the items. We then applied the Kolmogorov-Smirnov test to ascertain if participants' responses followed a normal distribution. Given that there was no normal distribution ($p < .05$), we decided to use non-parametric tests.

On the other hand, and with regard to the qualitative analysis, the content analysis of the interviews focused on students' perceptions of positive and negative aspects during the project, considering that these perceptions were what to a large extent determined whether the project was a success. Accordingly, we extracted the content of the interviews related to these topics and inductively produced a system of categories, which was validated by five experts. We used NVivo 11 for the content analysis of interviews. This allowed us to obtain the frequencies of the categories and compare the different opinions expressed at the different groups through cluster analysis and the Jaccard index (Morgado, López, & Moriña, 2017).

Results

The results presented below are set out according to the following order: a) initial exploration of student responses to the semantic differential; b) comparative analysis of the interviews by groups; and c) a more in-depth examination of what the students said in the interviews.

Initial exploration of students' opinions

The results reveal that the students gave a positive assessment of this learning and teaching methodology. As Table 2 shows, the means for the majority of the questions from the semantic differential are between 4 and 5, on a 1 to 7 scale. The students said that the project was interesting (5.00), that they now found it easier to interact with peers (5.80) and share materials (5.82), that they were comfortable working in team (5.22), and that they managed to do the tasks well (5.36), especially in terms of accomplishing the challenge set.

However, students encountered some problems regarding the organization and also the monitoring of some teachers when it came to implement the activities. For example, the means are lower for the following items: the teacher helped me (4.37); I made good use of time (4.21); and the teacher explained to us clearly what we had to do (4.11).

Table 2.
Students' responses to the semantic differential
(Response scale from 1-negative extreme to 7-positive extreme)

1. 1. It was boring	4.54	It was fun
2. 2. I wasted time	4.21	I made good use of time
3. 3. I learned fewer things than at other times	4.54	I learned more things than at other times
4. 4. I did not read much	4.47	I read a lot
5. 5. It was not interesting	5.00	It was interesting
6. 6. I did not understand what we did	5.72	I understood the activity
7. 7. I was distracted	5.05	I was focused
8. 8. I copied and pasted information	5.09	I created and shared information
9. 9. I am not interested in the topic any more	4.52	I want to learn more about the topic
10. It wasn't useful	4.68	It was useful
11. I did not like this way of working at all	4.70	I loved this way of working
12. The teacher did not help me	4.37	The teacher helped me
13. The teacher did not give us clear instructions	4.11	The teacher clearly explained to us what we had to do
14. We did not share materials between peers	5.82	We shared materials between peers
15. I now find it more difficult to relate to my classmates	5.80	I now find it easier to relate to my classmates
16. We did not manage to do the task well when we worked in a group	5.36	We managed to do the task well when we worked in a group

17. The size of the group was not appropriate (there were either too many or too few of us to do the task)	5.17	The group size was appropriate
18. I was not comfortable with my peers	5.22	I was comfortable with my peers
19. The teacher did not monitor our work	4.86	The teacher indicated to us if we did the tasks well
20. The teacher did not indicate to us the quality of the work presented	4.87	The teacher told us what was good or bad work

We then tested goodness of fit, the result of which would tell us if the scores followed a normal distribution. To test goodness of fit, we applied the Kolmogorov-Smirnov test for each item, verifying that it was not fulfilled in any of the cases ($p < .05$).

Because of the lack of normality, in the following analyses we used non-parametric tests: Kruskal Wallis test for k independent samples and the Mann-Whitney U for pairwise mean contrasts, taking each of the items from the questionnaire as dependent variables and considering the personal variables as independent variables.

Accordingly, we first conducted the Mann-Whitney U test, with a significance level of $\alpha = .05$, to determine whether there were significant differences between boys and girls in their assessments of the project through the semantic differential. Analysis of the data indicated that there were no statistically significant differences ($p > .05$).

Second, because we worked with a grouping variable with more than two categories, we applied the Kruskal Wallis test to detect if there were differences according to the class group: A, B, CD, E and F.

Following the completion of the test, with a significance level of $\alpha = .05$ we found significant differences in items 3, 5, 13, 17 and 19.

After detecting these differences, we considered it necessary to delve deeper and carry out some kind of subsequent multiple comparison in order to establish in which pairs of groups the observed differences materialized. We carried out an a posteriori contrast of this sort with the intention of investigating the significant differences detected (Wilkinson, 1999) and facilitating both the subsequent interpretation of the results and the establishment of conclusions.

However, before continuing, as Hernández, Dolores & Amador (2011) state, in

multiple contrasts there is a difficulty known as the multiple comparisons problem that is linked to the significance level. The a priori probability of being mistaken by rejecting a null hypothesis in the contrasts that have just been produced is that established by the value $\alpha = .05$. To maintain the level of significance ($\alpha = .05$) in the post hoc study, it is necessary to recalculate the level of value α for each pair contrast.

To this end, the new value, which we call α' , was calculated using the Bonferroni method. The formula for this calculation is based on $\alpha' = \alpha / T$, where T is the number of comparisons or statistical tests that can be carried out a posteriori (Hernández, Dolores, & Amador 2011; Wilkinson 1999). Therefore, in our case, α' is $.01$ since $.01 = .05 / 5$, with 5 being the number of possible specific comparisons.

Having established our level of significance of $\alpha' = .01$, we proceeded to perform the Mann-Whitney U test for each pair of groups in which the variable "class group" is divided in the

items in which the Kruskal Wallis test previously detected significant differences ($p < .05$). After carrying out this test, we were able to establish the existence of significant differences between class group CD and class groups A, B, E and F. These differences manifested in items 3, 5 and 17 (CD-A), item 19 (CD-B), item 17 (CD-E) and item 13 (CD-F) (see Table 3)

Table 3.
Pairwise differences according to class group.

Groups	Item	Mean	Mann-Whitney U	Sig.	Z
	3	4.15 – 5.24	137.50	.009	-2.624
CD – A	5	4.25 – 5.60	124.50	.003	-2.925
	17	3.95 – 5.64	330.00	.002	-3.026
CD – B	19	4.10 – 5.39	120.50	.006	-2.739
CD – E	17	3.95 – 5.74	87.00	.003	-2.954
CD – F	13	3.35 – 4.96	82.50	.000	-4.137

Observing how the basic descriptive statistics by class group for items 3, 5, 13, 17 and 19 behave, it can be appreciated that the students belonging to group CD had a more negative opinion than did the students belonging to other groups. It is important to recall that group CD was made up of students from two disciplinary areas that were not part of the same class group, meaning that the differences may be explained by a lack of cohesion.

Comparative analysis between student groups

We used cluster analysis as a multivariate technique for classifying our set of interviews in homogeneous groups. This analysis of an exploratory nature was used to measure the similarity (or dissimilarity) in content according to the coding carried out. This similarity was calculated using the Jaccard index, a coefficient that performs comparisons based on data of presence or absence, comparing all interviews on a pairwise basis. Figure 1 shows the coding similarity between the 23 interviews conducted.

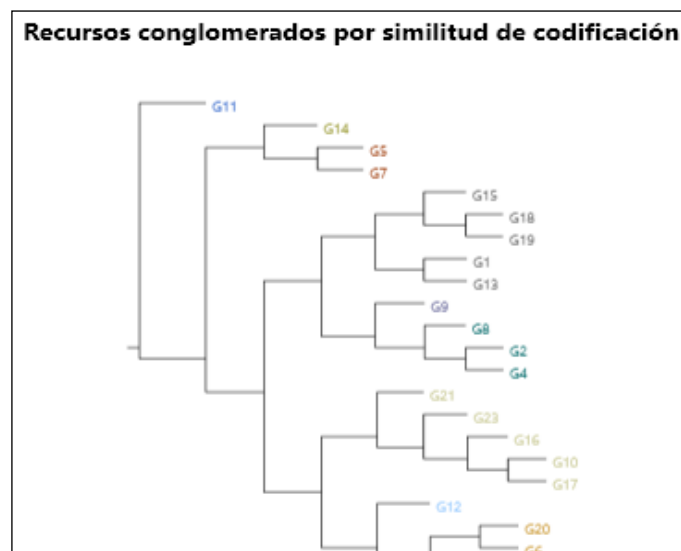


Figure 1. Clustered according to coding similarity

We observed a strong similarity in some cases, such as interviews 18 and 19, which both belong to Group F, or between 4 and 2, which belong to group A. This indicates that these groups may share the same opinions. Moreover, there is coincidence with the

teams that were subjected to greater monitoring by the teacher/mentor. In any case, we did not observe any interview that was a significant distance from the others, which allows us to confirm the cohesion of the opinions expressed by different groups of students.

An in-depth examination of what the students said in the interviews

An initial appraisal carried out through a general computation of textual units that relate to the positive aspects of the project and the problems encountered during it reveals that the students interviewed identified more positive aspects than negative ones. Specifically, there were 371 textual references that refer to positive aspects against 213 that alluded to difficulties, that is, 63.52% positive against 36.47% negative.

- *Positive aspects of the project highlighted by the students*

We first obtained a word cloud using NVivo 11 with the goal of exploring what words appear frequently in the participants' discourse. As Figure 2 shows, the words that appear most frequently are: people (72 references), children (63 references), liked (49 references), groups (44 references), project (36 references), work (34 references) and Medialab (29 references).



Figure 2. Word cloud of the positive aspects. Compiled by the authors.

A review of the students' stories made us sure that the experience provided substantial satisfaction to all those involved. We found no exceptions, though this certainly does not mean that everything came together effortlessly. Table 4 contains the textual references obtained in the different categories of analysis related to the positive aspects that the students identified.

Table 4.
Positive aspects of the project. System of categories

Categories	Textual references	%
Positive aspects of the project	371	100
1. Acquisition of key competencies	181	48.78
1.1. Learning to learn competency	7	1.88
1.2. Linguistic communicative competency	7	1.88
1.3. Cultural expression and awareness competency	6	1.61
1.3.1. Creativity	6	1.61
1.4. Sense of initiative and enterprising spirit competency	16	4.31
1.4.1. Autonomy	8	2.15
1.4.2. Responsibility	4	1.07
1.5. Digital competence	22	5.92
1.6. Mathematical competency and basic competencies in science and technology	2	0.53
1.7. Social and civic competencies	121	32.61
1.7.1. Affective and emotional development	28	7.54
1.7.2. Civic education	15	4.04
1.7.3. Interaction and collaboration	64	17.25
1.7.4. Problem solving	12	3.23
2. Learning applied to real life	16	4.31
3. Involvement and participation	78	21.02
3.1. Of external actors	24	6.46
3.2. Of family	27	7.27
3.3. Of students	14	3.77
3.4. Of school	3	0.80
3.5. Of teachers	8	2.15
4. Integration of the project into the curriculum	5	1.34
5. Motivation	57	15.36
6. Personal satisfaction	34	9.16

As we can see, the reference that the students rated most positively has to do with the degree of collaboration that took place between the participants in the project:

“Mainly the group work, because we all spent a week together working, and that is something that we had never done (...) I’ve learned to work with all people, and not getting used to always working with your group of friends” (Interview group 21).

“The whole school got involved, everyone was aware of what was going on, we helped each other, and so we made new friends” (Interview group 1).

We can see here how without excluding individual work, PBL encourages collaboration among students. These situations provided real interaction between the students, making mutual assistance possible and improving their social relationships. These ideas are reflected in the word cloud (Figure 3).

In addition, students had the perception that they developed different affective and emotional capacities related to personal growth, patience and empathy: “The ability to cope with being overwhelmed, to say wow, I’m really overwhelmed but I have to get on with it, whatever it takes” (Interview group 15).

Digital competence is another reference made in most of the interviews. The students described how through the project they used different Web 2.0 applications and tools: “The challenge was to make a Youtube channel and upload videos to raise awareness in people, our idea was to make lots of videos” (Interview group 13).

“We did a lot of computer activities, apps, blogs, we also did a video” (Interview group 20). “We worked with Garageband for the iPad, which costs money, what happened was they left Charo’s iPad with the class, and Sara and I were in the radio workshop, and we quite liked the idea, and we learnt through this app” (Interview group 17).

Furthermore, the students positively perceived family involvement in the activity. The project and its relevance in linking the different contexts in which the students live encouraged and facilitated strong participation from parents: “My mum came to see the exhibition, I told her to come and see us, and she said of course, once you have done it I’ll go and see it” (Interview group 15).

“My dad took part in the concert, because he plays guitar with me, I have two groups, one with my dad and one with my friends from here, so I asked him if he wanted to come and he said yes” (Interview group 18).

We also established that the participation of external agents within the group largely generated that feeling of security attributable to external collaborators: “They came from the NGOs and associations to give us talks so that you’re aware of what’s happening and is right around you but that you don’t see, and someone needs to get you to see it” (Interview group 5).

When the initiative is a collective one, it unites people and catches on, so what starts as something for a small group eventually creates connections with other members of the school.

- Problems and difficulties encountered by students in undertaking the project

Although the students were satisfied with the outcome, some limitations can be highlighted. First, and as was the case in the section on positive aspects, we produced a word cloud in order to find out which terms appeared most often when the students talked about difficulties. As Figure 3 shows, the words that appear most frequently are: time (53 references), week (47 references), things (39 references), information (32 references), people (27 references), project (27 references) and challenge (25 references).



Figure 3. Word cloud of the problems and difficulties. Compiled by the authors.

Table 5 shows the textual references obtained in the different categories related to the problems and difficulties that students encountered during the project.

Table 5.
Problems and difficulties encountered System of categories

Categories	Textual references	%
Problems and difficulties encountered in undertaking the project	213	100
1. In relation to students	147	69.01
0.1. Dedication, effort and time	46	21.59
1.1.1. Exhaustion, strain, stress	15	7.04
0.2. Lack of orientation	28	13.14
0.3. Lack of teamwork	46	21.59
1.3.1. Different levels of involvement.	12	5.63
1.3.2. Division of work	11	5.16
1.3.3. Lack of affinity among students	3	1.40
1.3.4. Lack of responsibility or commitment	9	4.22
1.3.5. Communication problems	11	5.16
0.4. Problems in accomplishing the challenge	13	6.10
0.5. Use of ICT tools	14	6.57
2. In relation to teachers	21	9.85
2.1. Lack of organization or coordination	21	9.85

Categories	Textual references	%
3. In relation to family	5	2.34
3.1. Family pressure	5	2.34
4. In relation to the school	6	2.81
4.1. Lack of dissemination	4	1.87
4.2. Lack of means or resources	2	0.93
5. In relation to the curriculum	20	9.38
5.1. Lack of integration of the project in the implementation of the official curriculum	9	4.22
5.2. Pressure regarding the official curriculum	9	4.22
5.3. Problems with evaluation	2	0.93
6. In relation to the Solidarity Atocha project	14	6.57
6.1. Breadth of the project	5	2.34
6.2. Moment of carrying out the project	9	4.22

As can be seen, the most repeatedly described obstacle relates to increased work, which demanded effort and meant that significant periods of students' time became occupied. These ideas fit in with the terms in the word cloud (Figure 4). Here we highlight some of the textual references about this area: "You have to use up more time, because you have to reach agreement with your classmates and that takes more time" (Interview group 15). "It took us time, and we had to do the project and study for exams" (Interview group 16). "It took a lot of work and effort" (Interview group 17).

Another aspect of note is teamwork, which was mentioned as a significant limitation. Several students thought that many of their peers were not equally involved in group activities: "I had to find out about the project, and when I told them about it, it was a bit more difficult because one person was here, another was there, one day someone was missing, I had to go looking for him and it was a mess" (Interview group 1). "The problem was, apart from the fact that there were four of us, the only one in my class, one person did no work at all and complained lots when you asked him to do something because you didn't have time, another person didn't have much initiative but would do things, and the bulk of the work was done by two of us" (Interview group 22).

Some students even felt lost when faced with the newness of the project, and they required further guidance from the teachers: "We were a bit lost, because they didn't tell us what we had to do next, we finished one thing and had to go and ask what we had to do next because we didn't know, they hadn't told us what we had to do next" (Interview group 9).

It is possible that, as a High school-level experience, the academic load was greater, and the pressure of the educational curriculum more substantial: "It all goes well for you during that week, but then you have to catch up and go back to writing up what you didn't do during that week" (Interview group 12). "For me, it went well in maths, but, for example, in biology I didn't see the link with making an infographic, it had nothing to do with it, they put it in biology but may as well have put it in

philosophy, or language, it would be the same" (Interview group 17). "It should count toward our grades, because we said okay, we're doing this but really it's not going to count for anything at school" (Interview group 23).

However, we believe that the limitations are a fundamental aspect since they assist in understanding the case and in seeking solutions and measures to prevent them. In other words, they improved the project for future applications of it.

Discussion and conclusions

The results in general show a very positive evaluation from students in relation to the PBL methodology, and in particular to the Design for change strategy that was adopted. There were no significant differences according to sex. However, there were differences in the assessment of the project based on the class group to which the students belonged. In particular, group CD (science and humanities) gave lower values to the items related to the monitoring and instructions provided by the teachers during the activities carried out, as well as to the suitability of the group's size of four members in most cases. We also found in the cluster analysis that the most associated interviews belong to groups A (social sciences) and F (technology), the groups that noted the most positive aspects during the experience.

Specifically, this research leads to the conclusion that the students were satisfied with the results achieved. The project's methodology presented knowledge related to situations that were specific and recognizable for the students. Learning was not exhausted through classroom activities, and instead it responded to the demands and interests of the students and thus was applicable in everyday reality and other contexts, which contributed to the generalization and transfer of the knowledge covered at school (Pozuelos, 2007).

The approach to working was another aspect that students evaluated positively. They highlighted having learned and having developed different skills and abilities, especially teamwork and the use of digital tools.

Technologies supported the process and were an integral part of the learning environment, since they provided a convenient means to interact and communicate ideas, which is a central component of the PBL approach. In this project, they used web 2.0 tools and applications for mobile phones and tablets to manage information in different formats (for example, video, audio, presentations and text) and facilitate the learning process. Throughout their work, students therefore developed a good command of technologies that will be very useful in their present and future (Gámiz, 2017).

The involvement of families and external actors was also essential for the implementation of the project, and it produced motivation and an atmosphere of full confidence. The students were aware that it would have been impossible for them to undertake the experience individually, and they were very satisfied with the levels of collaboration (Deslandes, 2019; Lam, Wing, & Choy, 2010).

But despite the numerous positive aspects, the students found some difficulties. These mainly related to the time that they spent on the project. The most repeatedly expressed obstacle related to the more intense level of work that comes with an initiative that demands effort and obligations that can occupy significant periods of students' time.

Given that in PBL it is not possible to transfer information quickly, as it is when conventional methods are used, there are greater time requirements placed on students as they accomplish

their learning, and sometimes the projects require more time than what is allotted for them.

The students pointed out that they may have needed more help and information from the teachers to carry out the activities, as at times they did not know what they had to do. This demonstrates that PBL needs to be well structured and monitored by the teacher (Gros, García, & Lara 2009), who should offer feedback to students on the quality of the product put together by the group (Basilotta, Pinto, García-Valcárcel, & García, 2018). They also noted the need for the project to be better integrated into the official curriculum, because it took them time that on occasions did not seem to them to be reflected in their final grades. In this regard, we consider it necessary that experiences of this type have a greater weight in final evaluations so that students view the project as an integrated part of the educational curriculum and not as an isolated activity that has been undertaken at a particular moment and has involved a lot of time and effort.

Finally, we believe that these findings make it possible to expand and systematize theoretical considerations and practical guidelines that will allow a more effective implementation of this important strategy in schools. By using semantic differentials, teachers may obtain an overview of students' opinions in other experiences that use PBL. We would also like to point out the usefulness of analysing students' perceptions through interviews to obtain an in-depth understanding from the students' perspective. Our comprehensive analysis of the information provided by the students prevents us at this time from presenting teachers' points of view, though these would undoubtedly offer useful a complementary framework for obtaining a complete overview of the agents participating in the project.

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