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# Use of Mobile Technologies in Personal Learning Environments of Intercultural Contexts: Individual and Group Tasks

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**Abstract:** This paper presents the results of the analysis of the personal learning environments (PLE) used individually and in groups by fifth grade primary education students. The main objective was to determine if the use of mobile technologies in the students' PLEs encouraged their school integration and learning in intercultural communities. For this, a content analysis of the students' responses to an ad hoc interview was carried out, with a content validity index of 0.89. The students represented their answers using 41 concept maps in the individual tasks and 5 in the group tasks, which were analyzed with the Nvivo software in its latest version. The results show the categorization of the students' responses in three dimensions: read, make/reflection and relationship. Among the main conclusions, it was obtained that, in both types of tasks, the strategies and tools that fostered intercultural relationships, intercultural education and communication between the students, and therefore school integration, are mostly linked to the use of mobile technologies applications, such as Wikipedia, the internet, Word, PowerPoint, social networks and YouTube, although it is essential to develop more studies to have more data to understand the phenomenon in depth.

**Keywords:** personal learning environments; mobile technologies; concept maps; intercultural contexts

## 1. Introduction

Current school classrooms represent the cultural, ethnic and religious diversity existing in globalized societies [1,2]. This fact is the main reason that recent educational policies and pedagogical actions aim to improve the educational integration of students in intercultural contexts [3].

Improving the quality of communications between diverse students [4], as well as increasing the interactions that occur between them [5], underlie in the foundations of the recent phenomenon of intercultural education, where concepts such as personal learning environments (PLE) and communities take special relevance.

Accordingly, encouraging students to use learning tools and strategies that enrich their individual PLE [6,7] through group educational reflections or information shared among peers will facilitate the creation of learning spaces common in so-called learning communities [8].

Furthermore, if the current importance that e-learning interactions have in the formation of these communities is taken into account [9,10], the starting hypothesis of this study is emphasized, where the use of mobile technologies in the students' PLEs is presented as a facilitating factor of intercultural educational integration. It is worth considering that these technologies will increase the opportunities

for relationships and thoughtful communication of students [11], as well as provide the access to relevant information related to the improvement of their intercultural competence [12].

In this way and taking into account the social, integrational and cohesive perspectives linked to PLE [13–18], this study attempts to answer two specific objectives:

1. To describe the tools and strategies used in the PLE of an intercultural classroom to carry out individual tasks;
2. To describe the tools and strategies used in the PLE of an intercultural classroom to carry out group assignments.

These objectives will serve to check whether the PLE used promotes intercultural school integration through the use of mobile technologies, more specifically, through the use of smartphones and digital tablets.

## 2. Literature Review

### 2.1. Personal Learning Environments

A personal learning environment (PLE) is generally described as the structure and process that helps students organize the plurality of information, resources and interactions they face daily [19,20]. As mentioned by López et al. [21], a personal environment is built throughout life and can vary over time, depending on the learning sources at that time, so these environments would look like a set of tools, sources of information, connections and activities that each individual regularly uses to learn [22–25]. In addition, PLEs activate the cognitive processes of both formal and non-formal learning [26–28].

When a student develops his or her own PLE, he/she begins to make a series of decisions that will involve choosing the resources and tools necessary to learn, that is, to access, develop and share the information, as well as the people with whom to interact with in learning activities [29]. In this sense, the teacher has a crucial role since he/she will become a mediator between the learning environment and the student, modeling the system and designing the most suitable environment, and taking into account the educational needs and existing resources [30]. According to Nganji [24], the teacher's role will be that of the learning facilitator, assessment test administrator, promoter of educational content and student surveyor.

In addition, when preparing his/her PLE, the student does it in a unique and different way from the rest of their classmates. Although they are in the same educational contexts, even the same person will configure their PLE differently depending on the learning needs and opportunities that characterize the life cycle in which they are in [29], in such a way that will modify the resources or replace it with more new ones as changes in educational needs emerge [27].

### 2.2. Tools and Strategies in PLE

PLEs are understood from two influential approaches: pedagogical and technological [12,31]. The pedagogical approach defines PLE as a change in educational methodology that promotes self-learning through the use of different resources. That is, students have an active role in both learning processes as setting goals, managing activities or the choice of resources to use, among others [32–35]. On the other hand, the technological paradigm conceives the PLE as a kind of platform composed of a content repository with different management and communication tools [36–38]. In this perspective of the PLE, students develop a digital identity and they determine what information to share and when, with whom to share it with and how to do it effectively, and when and whom to merge with to exchange experiences [39,40]. It is precisely in this perspective, where mobile technologies play a fundamental role, although always taking into account the vulnerability of these devices due to cyber-attacks on privacy and data exploitation [41]. Providing students with educational opportunities [42] that do not require temporal and spatial limitations [43–45] will modify the traditional physical relationships between teachers, students and learning [46,47].

More specifically, Churchill [48] establishes six dimensions in which the use of mobile technologies in students' PLEs improves their learning process:

1. Resources: students can use a large number of resources to learn such as web pages, videos and electronic books, among others;
2. Connectivity: students can access learning anywhere and anytime simply by connecting to the internet;
3. Collaboration: facilitates collaborative learning among equals synchronously and asynchronously. Since students can connect with each other to solve educational problems, this improves their understanding and knowledge, as well as negotiates the roles and the administration of educational tasks;
4. Capture: mobile technology is equipped to capture, store and process different forms of data, such as files, videos or photos that will improve access and cooperation of shared educational information;
5. Analytical: mobile technology is useful in analytical and mathematical learning since they have calculators as well as programs and tools designed for it;
6. Figurative: through mobile technologies, students can design conceptual schemes that show metacognitive aspects of their learning.

In addition, when virtual spaces are used in PLEs, the student can alternate learning strategies that include individual learning activities, with activities in small groups and activities with large communities. In the same way, the student will be able to establish the degree of privacy of these spaces, combining totally private spaces with collective spaces accessible only to some members of the community or to the general public [29].

In virtual spaces, the students will choose the tools that best suit their needs and organize them according to their criteria. This way, students will be able to choose applications that allow them to access really simple syndication (RSS) sources of educational content found on the internet or applications related to social networks, which contribute to student learning through interactions with other users [24]. Figure 1 shows some examples of applications that students can choose to use in their PLEs, through mobile technologies.

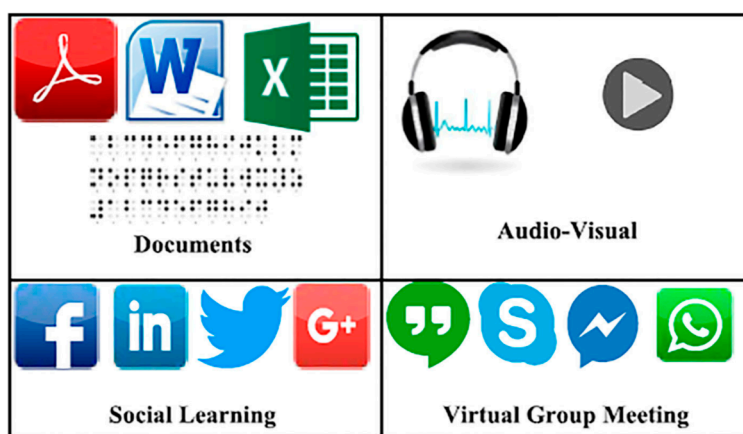


Figure 1. Mobile technology applications [21].

In addition to the aforementioned computer applications, traditional tools such as textbooks, writing books, newspapers, historical novels and the classroom teacher, among others, must be taken into account when accessing, editing and sharing information [49]. Understanding learning strategies as the set of actions to be followed by a student to achieve an educational objective [50] includes that students may have strategies that developed with traditional resources and not only with the most innovative ones. These strategies will be related to motivation (sharing information of interest, accessing specific content through a partner, etc.), the assignment of tasks (breaking the task down

into successive steps, selecting previous knowledge, asking a question, etc.), planning (summarizing, outlining, underlining, etc.) and to cognition (memorizing, superficial reading, etc.) [51].

Finally, it is necessary to emphasize that the realization of this study has been based on the classification of tools and strategies established by Adell and Castañeda [49] and López et al. [21], such as the following tools: tools and strategies related to searching and accessing information (read tools and strategies), tools and strategies related to the creation, editing and publishing of information (make/reflection tools and strategies) and tools and strategies for the establishment of relationships with other people and to share information (relationships tools and strategies).

### 2.3. Learning Communities

A learning community refers to the formations, environments or structures in which students interact, share and/or build knowledge and learning experiences. These can happen in formal learning contexts and in informal contexts [15].

Learning communities are characterized by restructuring spaces, time and curricula into smaller cohort groups, in order to achieve greater coherence in learning and meaningful interaction among their members [52]. Therefore, students actively participate in learning [53]. Spending a large amount of time together [52] and becoming identified as members of the same structure, presents the following aspects: sense of belonging, sense of personal predominance, satisfaction of needs and integration, and emotional ties [54].

In this sense and for several decades, there are numerous investigations that link the belonging of students to learning communities with positive social and educational effects. Related to this, learning communities are linked to the feeling of support and social connection of students in relation to their peers and teachers [55–58]. Furthermore, they positively influence the development of the educational motivation of its members [59] and the promotion of collaborative learning [47–58].

### 2.4. Intercultural Learning Communities

In this study, PLEs are considered as a mediator and generator of intercultural relationships, based on the fact that for this purpose, different strategies and tools interrelate that come from the technological and pedagogical perspective of the construct [6,7].

Therefore, in research, the social approach of the PLE takes special relevance. The social dimension of the PLE alludes to spaces of construction and collective interaction on knowledge, which are developed in a learning community, being understood as a group of people who share motivations and interests for some topic [13–16]. Learning communities also linked to the development and construction of intercultural interactions [60–63].

These intercultural learning communities represent the reality of globalized classrooms, as they are understood as diverse learning communities, and include a multitude of ethnicities, races and religions on equal terms [64,65]. In this way, the use of PLEs in these communities would support the process of peaceful coexistence pursued by the intercultural paradigm, contributing to produce changes in perspectives in students through their own acculturation, which can reduce prejudices, resentments and fears about the diversity presented in the classroom [66,67]. The relationships that occur in intercultural communities offer more than a link between students with ethnic annotations, and are based on culturalism thinking and the homogenization processes of cultural groups [15]. Therefore, the PLEs of these communities are formed by a group of tools and strategies that generate reflection and educational discussion oriented to transmitted knowledge, to the modes of transmission and to the organizational practices of the school institution that reproduce situations of exclusion [68,69].

Finally, and according to Redondo et al. [8], it should be noted that any learning community, including intercultural ones, is based on the principle of community cohesion. This principle is shared with PLEs [13–16], which will help student communication in intercultural learning communities and are carried out progressively from an external participation until reaching the full integration of the users that compose it [17,18].

### 2.5. Characteristics of Virtual Learning Environments

At present, in the communication and subsequent integration of the members of a learning community, the PLE related to technological strategies and tools take special relevance. In fact, the entry into the scene of technologies in the educational world has caused important changes in the way of learning and has created new learning scenarios [70].

Receiving the meaning of virtual learning environments (VLEs), e-learning communities promote the interaction of their members synchronously and asynchronously, allowing the exchange of knowledge between spatially dispersed members [71]. For example, the use of digital media (social networks, blogs, apps, etc.) will allow VLE members to interact autonomously in the communication processes, being decentralized of a physical context [72]. Tools and strategies, which are increasingly being used through mobile technologies in formal learning environments [73–75], have demonstrated their effectiveness to promote communication and peer relationships, as well as to decrease the social isolation of culturally diverse students [11].

Furthermore, VLEs are environments that allow the availability of teaching materials through the internet, thus establishing an unconventional way of facilitating knowledge for students [76]. In this way, through tools such as Google Meet, teachers from all educational stages can expose the contents of their subjects, enhance the online participation of their students, improve communication between them and even carry out evaluations [77,78].

On the other hand, in these environments, the teacher will also have the opportunity to use learning management platforms such as BlackBoard or Moodle [79], which will allow connecting teachers and students from remote places, facilitating teacher monitoring of group work, attendance at conferences or even simulated learning situations [80].

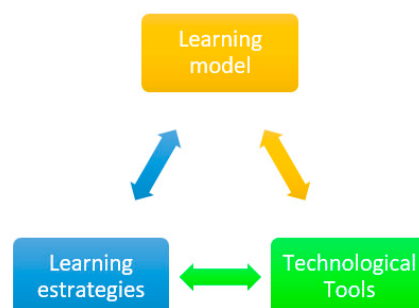
Those educational situations have been evaluated by students in previous research [81–83] with high rates of satisfaction, self-efficacy and ability to achieve.

In summary, according to Cavus [84], VLEs are characterized by presenting the following aspects:

1. A greater need for learning promoted by the constant changes of daily life;
2. Flexible student learning, adapted to the particular conditions of these environments;
3. Learning through different methods and tools;
4. Student-centered learning;
5. The teacher as a mere supervisor of the learning of his/her students.

However, Dabbagh [85] establishes that in order to achieve meaningful student learning, in VLEs, it is necessary that the learning models, technological tools and learning strategies used are interconnected.

In this way, the learning models will provide a structure capable of applying educational strategies that require the use of technological tools, and technologies will foster new learning that in turn can influence the improvement or change of the learning strategies used [70] (Figure 2).



**Figure 2.** Necessary elements in meaningful learning in virtual learning environments (VLEs) [70].

## 2.6. Concept Maps as Semantic Organization Tool

A concept map is a semantic organization tool of interrelated concepts [86]. This tool allows to approach a purpose through graphical representations of arrows and boxes [87]. The boxes represent the concepts, which are related to each other through the arrows and the linking words. The relationships between the concepts can be physical (linking) or organizational, where a concept encompasses another [86].

In qualitative research, it is a widely used tool [88], considering it useful and valid to analyze student knowledge [89–93]. This reason, together with the fact that it is an easy compliance tool for primary school students [94–96], and that there are previous studies that have used this technique to understand aspects related to the integration of students [97,98], justify their use in this study.

Furthermore, as has been done in this study, concept maps allow the collection of qualitative and quantitative data on student knowledge [99], previously requiring that students understand in depth the concepts and the links between them [100].

In this way, to describe in this study the type of tools that the students used and the regularity of their use in each of the established dimensions (read, make/reflection, relationship), the number of concepts exposed for the individual and group tasks has been counted separately, a method that agrees with those established as effective by specialists [101,102].

On the other hand, it is important to know the educational strategies used in each of the tasks which have guided the choice of the tools specified in the concept maps. The explanations of the maps (individual and group), given by the students in front of the teacher, have been used, obtaining in this way qualitative data.

## 3. Methods

### 3.1. Participants

A total of 41 students participated in this study, aged between 10 and 12 years old ( $M = 11.72$  years;  $SD = 1.171$ ), of which 29 (70.73%) were female and 12 (29.26%) were male. In addition, 17 (41.46%) were students of religious, ethnic or racial backgrounds other than the majority: 8 (19.51%) of Islamic religion, 4 (9.75%) of gypsy ethnicity, 3 (7.31%) of Latin American origin and 2 (4.84%) of Asian origin.

The students belong to a nursery and primary education center in the city of Granada (Autonomous Community of Andalusia, Spain). This city presents a high number of people from different backgrounds [103], an aspect that is reflected in their classrooms [104].

The educational level in which the study was carried out corresponds to fifth grade of primary education and the area where the explanation was carried out, and subsequently the practical work, was mathematical education, chosen for the ease that the teacher showed for creating working groups in his class dynamics (causal cluster sampling). Table 1 shows the cultural diversity of the working groups.

**Table 1.** Intercultural working group.

Group	Culturally Diverse Number of People
1	2 (Islamic religion) 1 (Latin American origin) 1 (Asian origin) 4 (Majority culture)
2	2 (Islamic religion) 1 (Gypsy ethnicity) 1 (Asian origin) 5 (Majority culture)

Table 1. Cont.

Group	Culturally Diverse Number of People
3	2 (Islamic religion) 1 (Gypsy ethnicity) 5 (Majority culture)
4	1 (Islamic religion) 1 (Gypsy ethnicity) 1 (Latin American origin) 5 (Majority culture)
5	1 (Islamic religion) 1 (Gypsy ethnicity) 1 (Latin American origin) 5 (Majority culture)

In the study, metric parameters were not followed to carry out the affiliation of the members in the different groups, mainly because the distribution started from the knowledge that the mathematics teacher had of his students [105].

The reduced number of participants [106] allowed the teacher to gain an in-depth understanding of the reality of his classroom. He took into account the social attributes [107] related to the cultural origin, and the ethnic and religious affiliation, as well as the convenience of the students in the learning carried out previously [9], to organize the affiliations in the group task carried out in the study.

### 3.2. Instrument

Concept maps were used to analyze the students' responses. Based on Ausubel's [108] assimilation theory, concept maps are considered tools in which knowledge nodes are linked hierarchically [95,109].

These conceptual structures have been used, for several decades, for the qualitative analysis of educational research [88], as it allows to know in an effective way the information requested from students [94].

However, to reach the process of making the concept maps, the students participating in the research were previously asked a series of closed questions. These phases coincide with what was established by Sellmann, Liefländer and Bogner [96], who considered the concept map as a product resulting from a structured and static interview.

The interview used in the study had twelve questions (see Appendix A): six destined to know the first objective and the other six to know the second purpose.

The ad hoc interview was initially based on the PLE classification established by Adell and Castañeda [49] and López et al. [21]. The content validity of this instrument was carried out to verify that the interview measured what was expected. For this, the content validity index (CVI) was analyzed with the participation of 16 experts on the subject [110]. First, the CVI was established for each question (I-CVI), asking the experts to assess the relevance of each item with a Likert-type scale from 1 to 4, where 1 was not relevant, 2 few relevant, 3 relevant and 4 highly relevant. With this index, the percentage of experts who rated the questions with a score equal to or greater than 3 was obtained. Those questions whose I-CVI < 0.78 were eliminated, as established by Polit, Beck and Owen [110]. Furthermore, by analyzing the average of the I-CVI, the CVI of the general interview (S-CVI) was obtained, this being equal to 0.89, revealing an excellent content validity of the instrument in its entirety [111].

### 3.3. Process

#### 3.3.1. Information Collection

After obtaining the permission of the educational authorities, the interview and the construction of concept maps were carried out by the students of the fifth grade of primary education in the academic year 2018–2019. The study was carried out in a classroom within five sessions of 45 minutes each.

In the first session, the concept of PLE and its basic processes were explained, exemplifying to the students the traditional tools and strategies and those that can be used through mobile technologies.

For the explanation, one of the researchers of the study, using the lecture methodology, and leaning on slides exposed through the PowerPoint presentation program, explained types of educational tools, differentiating those used in VLEs and those used in traditional settings. For each of the settings, the researcher differentiated the tools into three main groups: those that serve to search and access information (read), those related to the creation, editing and publication of information (make/reflection) and tools to establish relationships with other people and to share information (relationships).

The first session ended with the explanation of learning strategies. For this, the researcher exemplified real situations, where educational tools (technological and non-technological) were used, to carry out useful strategies in achieving the task. The situations exposed were related to the classification of learning strategies established by Adell and Castañeda [49] and López et al. [21].

In the second session, students were asked to answer the questions of the first part of the interview by making their own concept map. For this, they were suggested to take into account in the responses, the traditional tools and strategies and those they use through smartphones and tablets.

In this session, the researcher posed each of the questions from the first part of the interview aloud to the class group, and waited for all the students to put the answer on their conceptual map to continue with the next question. Students were instructed to only form the maps with the tools they use in individual tasks, and they were asked to put in a different document, with examples of learning strategies in which they use the tools mentioned in the maps.

The results of this activity were discussed in the third session, reflecting on the process of carrying out the individual tasks.

Subsequently, in the fourth session, the students were distributed into five groups formed by students of different ethnicities, races and religion. In this session, the groups were instructed to carry out, with traditional tools and strategies and through the use of mobile technology, one group work related to the teaching of mathematics.

Finally, in the fifth session, the students made the group concept maps. The researcher reminded the students the questions from the second part of the interview, leaving a time interval between questions for the groups to answer. In this session, as it happened in the individual tasks, students were instructed to put on the maps the tools they used in the group task, and in a separate document, the learning strategies that they were pursuing it with.

The session ended with the groups exposing their concept maps in class, and commenting on the learning strategies involved.

Throughout the research process, the ethical recommendations provided in the Declaration of Helsinki and by the Ethical Committee of the University of Granada were followed.

A total of 41 individual and 5 group concept maps were collected and analyzed. These maps represented semantic organizations of the concept of PLE, where the students presented in three tables the tools they used for reading and accessing information, for reflection and editing information and for establishing relationships with other people and sharing information.

In addition, in most of the maps, the students used arrows to relate the term PLE to the tools mentioned above, thus staging the hierarchy of the terms.

Figures 3 and 4 show examples of the individual and group concept maps collected in sessions two and five.



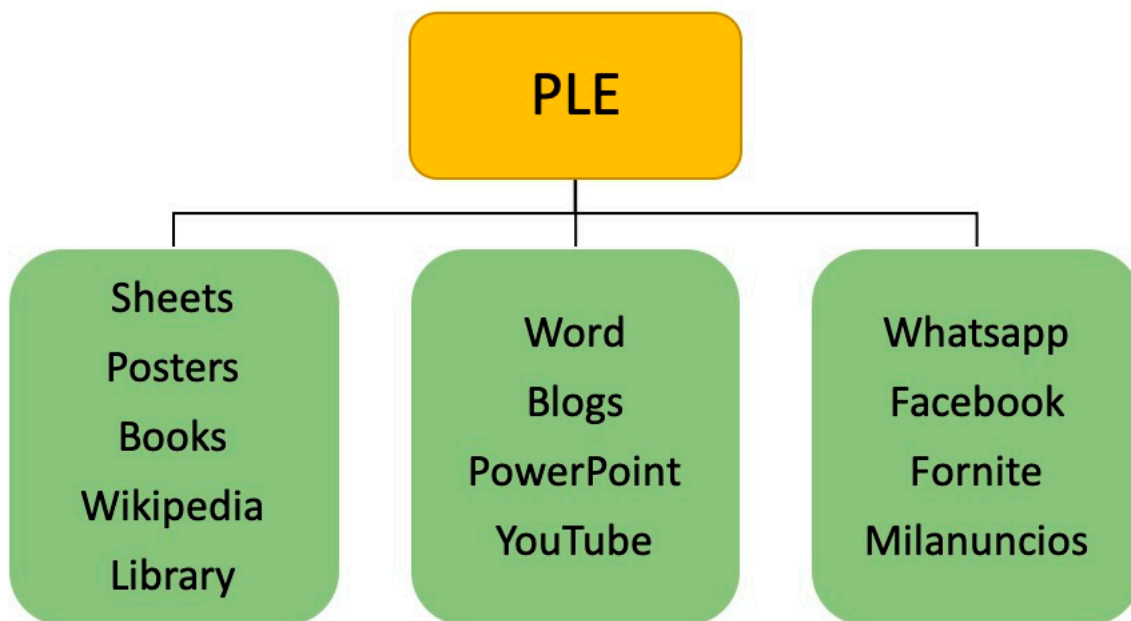


Figure 3. Example of an individual concept map on the personal learning environment (PLE) used (Kevin).

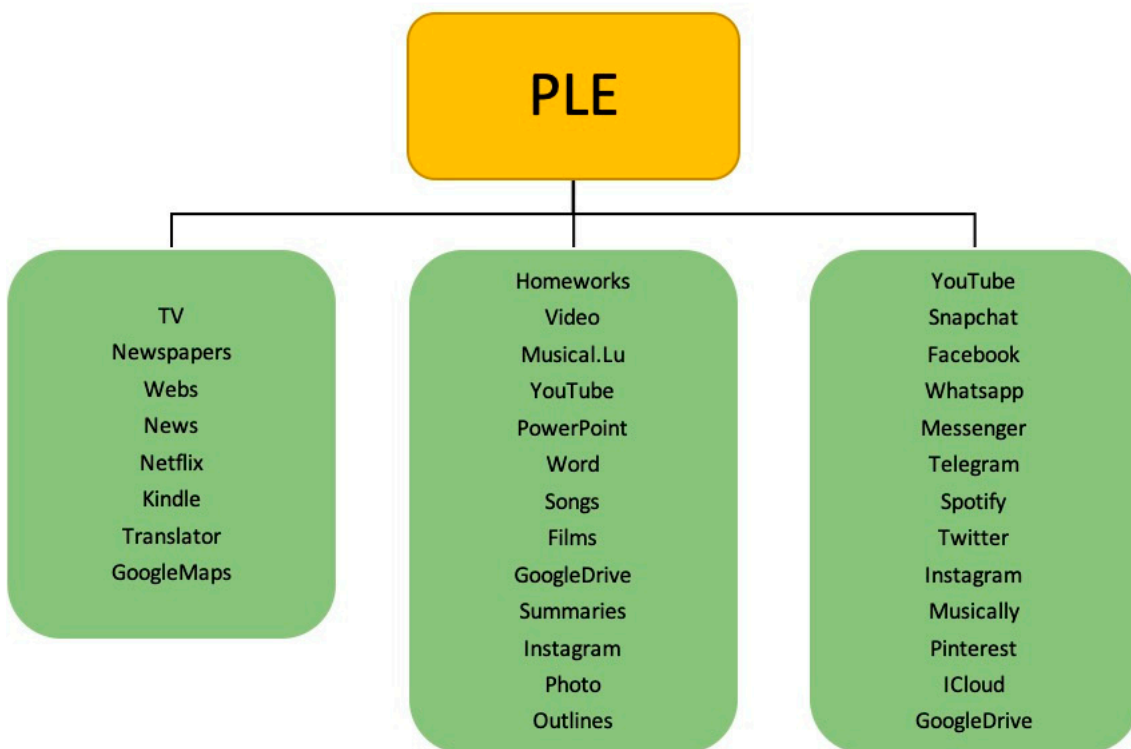


Figure 4. Example of a group concept map about the PLE used (Intercultural group 3).

### 3.3.2. Data Analysis

Concept maps represent students’ responses to the interview questions. For the study of these maps, content analysis was used [112,113]. With this analysis, the responses were discovered inductively [114] through the following process:

In the first phase, the initial codes were established. In this way, the “Read” code from the analysis of the data related to questions 1 and 2, the “Make/Reflection” code of questions 3 and 4, and the “Relationship” code of the analysis of questions 5 and 6 of the two parts of the interview were obtained.

In the second phase, answers with similar contents were put together. First it was done with the individual concept maps and later with the group maps.

Finally, in the third phase, the established codes were redefined (read; make/reflection; relationship). This process was carried out by two researchers, an article’s authors and an external expert to the study, where, through the latest version of the qualitative program Nvivo, the reliability of the analyses carried out was obtained.

To know the reliability, the concordance of the codes was obtained. Code concordance among investigators ranged from  $K \geq 86$  to  $K \geq 95$ . In addition, the expert carried out the analysis of the concept maps, showing a level of concordance of  $K \geq 95$ .

The interview and concept maps were analyzed in Spanish, although they were translated into English to illustrate the results in this paper.

In this study, the word clouds obtained in the Nvivo program have been used to graphically present the results of the count of educational tools shown in the individual and group concept maps.

In this way, the program represents the concepts (educational tools) in different sizes depending on the number of times they have been repeated in all the concept maps, the largest concepts being those that have been named a greater number of times in the concept maps.

Figures 5 and 6 show how this methodology has been applied, for the data of the individual tasks and for those obtained from the group tasks.

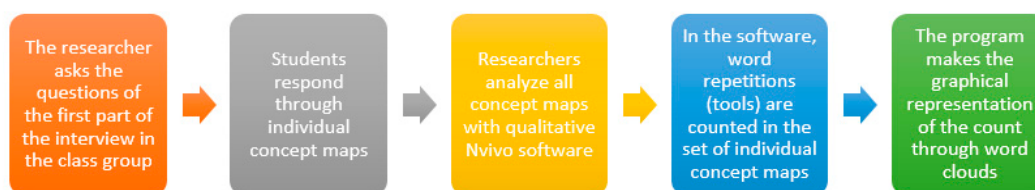


Figure 5. Data collection process and methodology used for individual concept maps.

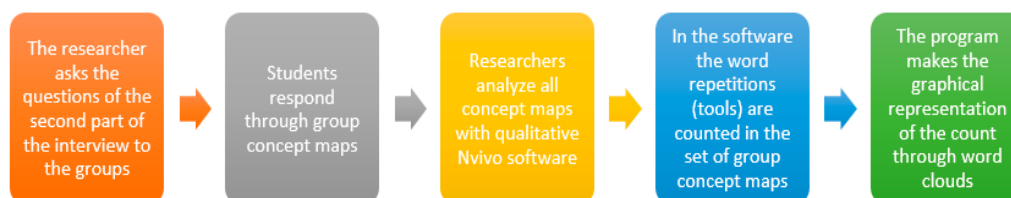


Figure 6. Data collection process and methodology used for group concept maps.

Although the sum of the word clouds obtained is necessary to clearly differentiate the size of the concepts, in this section, as an example, the word clouds of culturally diverse students are shown, after content analysis of the individual (Figures 7–12) and group (Figures 13–15) concept maps.



Figure 7. Word cloud of read strategies and tools (Mohamed).



Figure 8. Word cloud of make/reflection strategies and tools (Mohamed).



Figure 9. Word cloud of relationship strategies and tools (Mohamed).



Figure 10. Word cloud of read strategies and tools (Cristina).



Figure 11. Word cloud of make/reflection strategies and tools (Cristina).



Figure 12. Word cloud of relationship strategies and tools (Cristina).

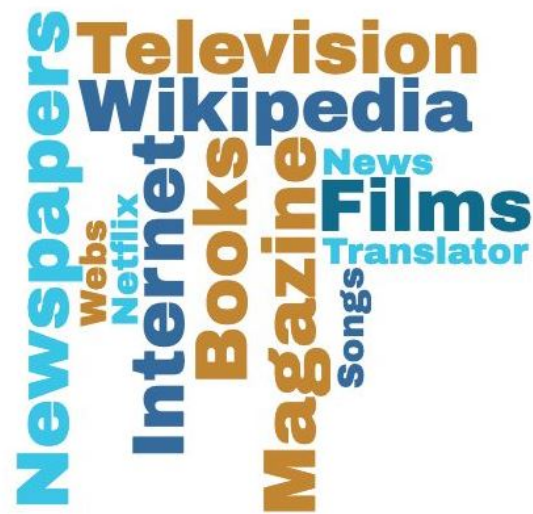


Figure 13. Word cloud of read strategies and tools (Intercultural group 2).

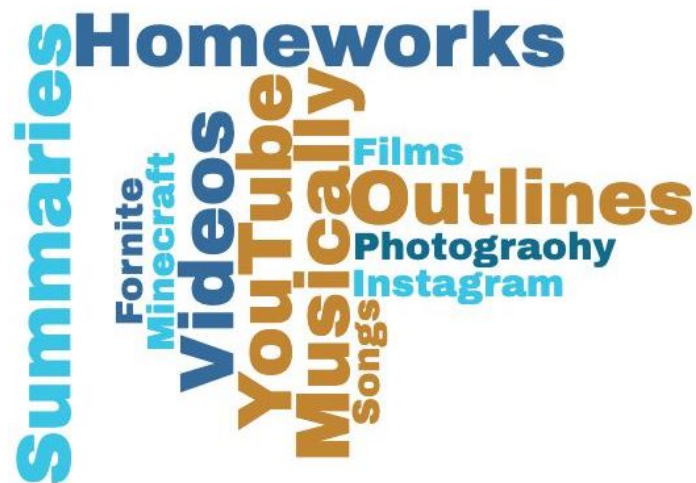


Figure 14. Word cloud of make/reflection strategies and tools (Intercultural group 2).



Figure 15. Word cloud of relationship strategies and tools (Intercultural group 2).

## 4. Results

### 4.1. Individual Concept Maps Results

One of the most relevant aspects to highlight, from the data obtained with the evaluation of individual concept maps, is the difference in the number of tools used by students during their learning process. The minimum number was 6 (student # 2) and the maximum number was 35 (student # 23), with a total average of 15 tools used.

In addition, the PLEs were confirmed by a number of very different strategies and tools in each of the categories analyzed (read, make/reflection, relationship).

Information regarding the strategies was obtained from the comments made by the students in class about the examples of learning strategies in which they use the tools mentioned in the maps.

#### 4.1.1. Read

Regarding the tools related to reading and searching for information, the analysis revealed that, of the 190 elements obtained for this category, almost half (44. 21%) referred to the use of tools used through mobile technologies.

In the individual concept maps, the most repeated elements were “books”, with a count of 40 times which corresponds to 21.05%, followed by “Wikipedia”, with a repetition of 24 times with a percentage of 12.63%, and the “Internet”, with a repetition of 13 times, equal to 6.84%.

Some examples of learning strategies where students used these tools were the following:

*“I use books when I need to memorize for an exam”.* (Samantha)

*“I search Wikipedia to remember information that does not come in the book, before I start writing about it in the activities that the teacher sends”.* (Karim)

*“I always search the internet for the words I don’t understand”.* (Antonio)

In addition, of these majority tools, in the individual tasks, the concept maps showed, among others, the following tools: “Magazine”, 12 times mentioned with a percentage of 6.31%; “Google” and “Sheets”, repeated 11 times with a frequency of 5.78%; “Newspapers”, with a repetition of 9 times and 4.74%; “Comic”, 7 times repeated with a percentage of 3.68%; “Television” and “New Posters”, 6 times mentioned with 3.26%, “Films”, repeated 5 times and 2.63%; “Webs”, mentioned 4 times with a 2.11% frequency of appearance; “Netflix”, “EBooks”, “PlayStation”, “Google Maps” and “YouTube”, 3 times repeated for each term with a frequency of 1.58%; “Electronic Newspapers”, “Google Translator”, “Notebooks” and “YouTube Page”, mentioned twice for each concept with a percentage of 1.05%; and “Boys”, “Library” and “Dictionaries”, once mentioned for each term with a frequency of appearance in the concept maps of 0.53%.

Figure 16 shows the word cloud that was obtained as a result of the sum of the terms indicated in the individual concept maps for this category.



**Figure 16.** Word cloud of the read category of individual concept maps.

#### 4.1.2. Make/Reflection

The elements obtained related to reflection tools and information editing, used in the individual concept maps, were a total of 215 terms. In this case, most of them were linked to the use of mobile technology to learn (77.53%).

The words that appear most frequently were “YouTube”, 22 times with a percentage of 10.23%, followed by “Power Point” and “Word”, with a count of 18 times or 8.37%. Further, as an element not related to the use of mobile technologies appears the term “Homework”, with a repetition of 16 times and a percentage of 7.44%.

Examples of learning strategies where students used these tools included the following:

*“I like to watch videos on YouTube to delve into content that the teacher shows in class”. (Amelia)*

*“I use Word to write, modify and save class activities”. (Ming)*

*“I usually reflect when the teacher asks me to do so at school”. (Yousef)*

In addition to the more assiduous tools already mentioned, students use some other tools such as the following: “Videos”, “Pictures” and “Musically”, 13 times mentioned with a frequency of appearance in the concept maps of 6.04%; “Summaries” and “Songs”, repeated 10 times with a percentage of 4.65%; “Videogames” and “Photography”, mentioned 9 times with 4.18%; “Twitter”, “PlayStation”, and “Blogs”, 6 times repeated with a percentage of 2.75%; “Instagram”, “Google”, “Snapchat”, “Spotify”, “Fortnite”, repeated 4 times for each term with a frequency of 1.86%; “Video star” and “Internet”, 3 times mentioned with a percentage of 1.40%.

Figure 17 shows the word cloud resulting from the sum of the terms related to this category, exposed in the individual concept maps.



**Figure 17.** Word cloud of the make/reflection category of individual concept maps.

#### 4.1.3. Relationship

Regarding the tools used in the individual concept maps related to the relationship category, the elements obtained were a total of 201 terms. Most of them linked to the use of mobile technologies (88.56%).

Figure 18 shows the word cloud resulting from the sum of the terms displayed by the students in the individual concept maps of this category, which reflect the network of connections that students used to share information and knowledge. The most used terms were “WhatsApp”, 33 times repeated with 16.41%, followed by “Instagram” and “Snapchat”, with 12.44% and a 25-fold count, and “Facebook”, 22 times mentioned and a percentage of 10.95%.



**Figure 18.** Word cloud of the relationship category of individual concept maps.

Examples of learning strategies where students used these tools included the following:

*“When I have a question, I ask my classmates for messages through WhatsApp”.* (María)

*“I send photos about activities done in class to my classmates through Snapchat”.* (Daniela)

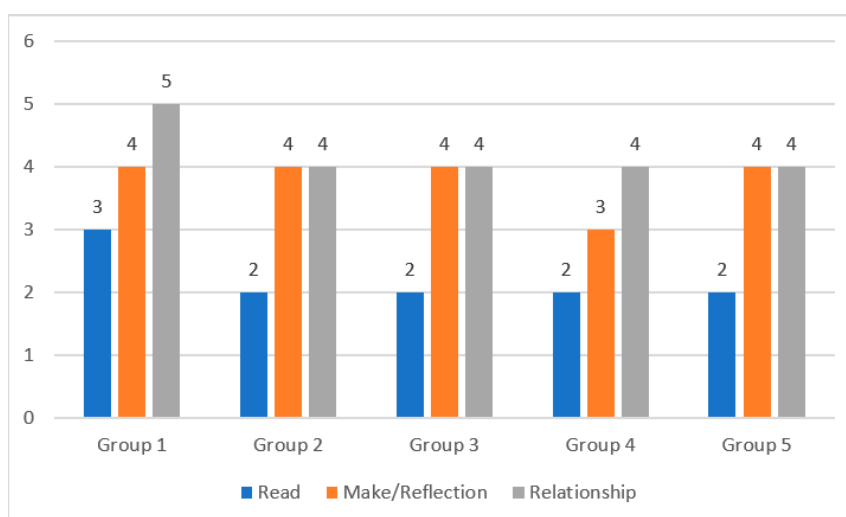
*“On Facebook, the class delegate informs about the delivery dates of important activities”.* (Farah)

In addition to the strategies and tools mentioned, the students showed in the individual concept maps the use of various tools to share information and relate to. Among others were the following: “YouTube”, 17 times mentioned with a percentage of 8.45%; “Musically” and “Messenger”, with a repetition of 12 times and a frequency of 5.97%; “PlayStation” and “Telegram”, 8 times repeated with 3.98%; “Video star”, “Internet” and “Tuenti”, 5 times mentioned with 2.49%; and “Fortnite”, “Online games” and “Google”, with 4 repetitions per term and an appearance frequency of 1.99% in the individual concept maps.

#### 4.2. Group Concept Maps Results

At the time of performing a group task, the minimum number of tools used by the groups was 9 (group 4) and the maximum number 12 (group 1). The description of the elements used in each of the categories (read, make/reflection, relationship), as well as where the examples of the learning strategies, were used as described below.

In addition, Figure 19 shows the distribution of the tools used in each of the intercultural groups of fifth grade primary education. The data reveal that the most used elements are linked to the relationship category.



**Figure 19.** Tools shown in the group concepts maps of fifth grade primary education.

##### 4.2.1. Read

In the analysis of the concept maps related to the reading category and information search, made by the intercultural groups, a total of 27 terms was obtained. These elements correspond to the following tools: “books”, with a count of 9 times and a percentage of 33.33%, followed by the term “Wikipedia”, repeated 7 times with a percentage of 25.93%; term “sheets”, with 14.81% and a count of 4 times; term “Webs”, 3 times mentioned with a frequency of 11.11%; the concept “Internet”, 2 times repeated and a percentage of 10%; and the words “Magazine” and “Newspapers”, mentioned only once with 5%.

In addition, it is necessary to highlight, as learning strategies used in the group task of mathematics, where the most common tools were reflected, in which the following examples were found:

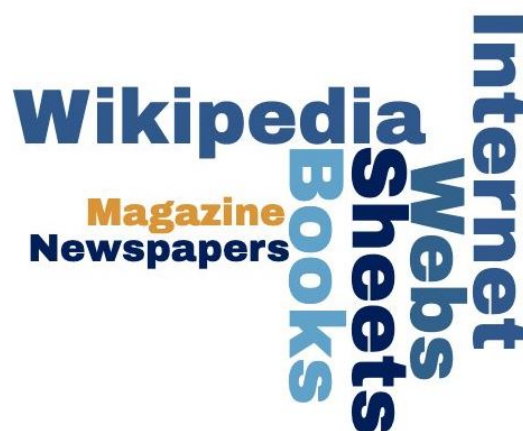
*“In order to focus the task, we looked in the book for similar activities that were solved”.* (Group 1)

*“We decided to complement the information that the teacher of the task gave us by searching Wikipedia”.* (Group 5)

*“Before solving the activity, we looked for similar activities in our sheets”.* (Group 4)



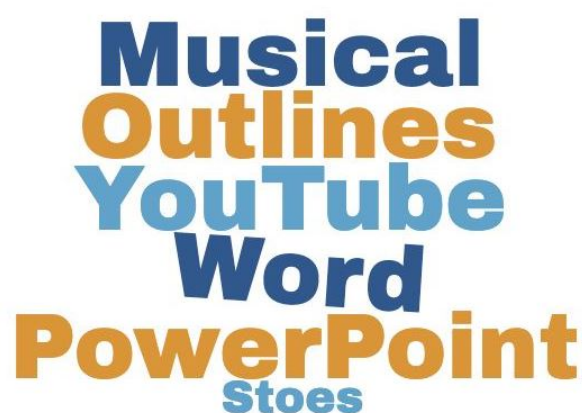
Figure 20 shows the word cloud of the sum of the terms obtained in the group concept maps for the read category.



**Figure 20.** Word cloud of the read category of group concepts maps.

#### 4.2.2. Make/Reflection

Figure 21 shows the word cloud obtained from the sum of the elements exposed by the students in the group concept maps, related to the tools of reflection and editing of the information. In this case, of the 35 terms obtained in the analysis of this category, most of them, 71.42%, are linked to multimedia resources that the students used through mobile technologies to carry out the established group task.



**Figure 21.** Word cloud of the make/reflection category of group concepts maps.

The most repeated terms related to the use of this technology were the following: “Word” repeated 9 times with 25.71%; “PowerPoint”, with a count of 7 times and a percentage of 20%; and “YouTube”, with a percentage of appearance of 17.14% and 6 times mentioned.

The learning strategies, in which these tools were used, which the groups used to carry out the task are shown:

*“To carry out the activity and erase the errors that arose, we used Word”.* (Group 3)

*“We used PowerPoint to clearly separate the steps that we had to follow in the task”.* (Group 2)

*“We watched different videos on YouTube to answer the teacher’s question about how the homework answer could be applied in real life”.* (Group 4)

In addition to the tools and strategies mentioned above, the group concept maps showed the following make/reflection tools: “Outlines”, 5 times repeated with an occurrence frequency of 14.28%; “Musical”, 4 times mentioned with a percentage of the 11.43%; “YouTube”, 3 times repeated with 8.57%; and “Stoes”, only mentioned once with an appearance percentage in the group concept maps of 2.86%.

#### 4.2.3. Relationship

When analyzing the concept maps of the tools of relationships used by the intercultural groups, it was observed that all the resources are closely linked to the use of mobile technologies to share information and interact in the process of carrying out the group task.

Of the 39 terms obtained in the analysis, the most repeated elements were the following: “Facebook”, with a count of 10 times and a percentage of 25.64%, followed by “WhatsApp”, with a frequency of 8 and 20.51%; and “YouTube” and “Instagram”, with a percentage of 17.95% and 7 mentions in each term.

In this sense, the groups mentioned some examples of learning strategies where they had used the previous tools:

*“We asked ourselves questions about the doubts that arose when completing the task through Facebook and WhatsApp”. (Group 5)*

*“We share photos found on the Instagram of other colleagues related to the task”. (Group 4)*

*“We used YouTube to upload and share videos where you could see the steps to follow to complete the task”. (Group 1)*

In addition to the most usual tools specified above, the groups used the following resources to share information and interact when performing the group task: “Snapchat”, 4 times mentioned with an appearance rate of 10.25%; “Twitter”, 2 times repeated with 5.12%; and “Messenger”, only once mentioned, with an appearance percentage in the group concept maps of 2.56%.

Figure 22 shows the word cloud from the sum of the terminologies obtained in the group concept maps of this category.



**Figure 22.** Word cloud of the relationship category of group concepts maps.

## 5. Discussion

The purpose of this study was to know the use of mobile technologies in the PLEs of an intercultural classroom for individual and group tasks, in order to analyze if the school facilitates integration.

Subsequent to the analysis carried out through concept maps, the results show that in both individual and group tasks, in the processes of reading and searching for information, intercultural

students opt for strategies and tools that facilitate individual concentration. This preference may be due, as pointed out by Levine et al. [115], because it improves the anguish that students suffer when they have to face a new learning task, so that in the concept maps analyzed, the terms “book”, “Wikipedia”, “Internet” and “sheets” prevail.

In the case of books and sheets, there are several investigations [116–118] that highlight the preference of students for printed material to read and access relevant information in their learning. In the investigations, as in this study, the use of electronic resources to access information is done to a lesser extent and specially to expand the content shown in traditional texts of the books.

However, it should be noted that the use of tools such as Wikipedia and the internet are considered effective for student motivation and learning, especially when there is good postural hygiene and a calm study environment [119].

In the obtained results, it is striking that students do not use closeness with peers and teachers as the main strategy to access information, making little use of peer learning [120,121].

On the other hand, in the concept maps related to the use of make/reflection strategies and tools, the terms YouTube, PowerPoint and Word predominated, terms that required the use of mobile technologies to perform the tasks.

The fact that the analyzed students use YouTube to reflect on their learning can be considered an advantage in promoting intercultural education.

YouTube is an application that encourages students to reflect on different learning, including those related to intercultural aspects [122]. The application, through the videos, shows different cultural realities that students can observe from a critical perspective [123–125]. The reflection of intercultural content can lead to students modifying racial or ethnic prejudices and changing their vision towards certain classmates, avoiding, in the worst case, discriminatory attitudes towards minority students [126,127].

Regarding the use of the software Word and PowerPoint, the analyzed students use these mobile applications to edit and create information in the learning processes, mobile applications whose use is widespread in the majority of students on a daily basis and which has led to changes in traditional teaching methodologies [46,128].

Next, the analysis of the concept maps shows that, in terms of relational strategies and tools, both in individual and group tasks, intercultural students use the best-known social networks housed in mobile technologies to create learning communities [60–62]. In this way, Facebook, Instagram, WhatsApp and Snapchat were the most used in the learning networks. These are influential applications in the feelings display [129] and in the development of intercultural skills and competences [130] that will facilitate the school integration of culturally diverse students [131–133], if used appropriately.

As with the strategies and reflection tools, the multimedia resources to mobile technologies in the relationship processes prevail, an important aspect to take into account in the training of future digital citizens, due to the rise of globalized, multicultural, digital and smart cities [63,134]. This leads one to consider that the role of the teacher to ensure the proper use of these resources will be fundamental [135], since, for example, tools like social networks can improve the intercultural relations of the students, but it can also be a means of segregation between them [66,136,137].

Finally, regarding the affiliation of the students in the group task that was carried out in the study, it should be noted that it was made intentionally, based on the selection made by their teacher [105,138], due to his knowledge of the students derived from observations of the characteristics of the classroom, as well as from the teaching–learning processes that occur in class, since it is a small number of students [106,139].

For the formation of groups, the mathematics teacher took into account social attributes such as the ethnic-religious affiliation and the cultural origin of the students, which are part of a group training approach focused on the profile of the students [107]. This approach has been used in previous research [140–142] and as stated by Xie, Zou, Lee, Wong, Rao and Ho Wang [143], it is important since it can affect the effectiveness or efficiency of the group members' learning. Cultural and religious

equity have been taken into account in this study, and the same representativeness was sought in the intentional groupings, so the results of the use of mobile technologies in a group activity would be conditioned in the same way as in the established groups.

In addition, the teacher took into account the convenience of the students, based on the confidence and interactions that the subjects had shown in previous group activities [9]. In relation to this, it is necessary to mention that, the greater the trust between the members of a group, the greater interest they will show to interact [144–146]. This is an important aspect in the study, since group interaction is essential to be able to evaluate the use or not of mobile technology in collaborative learning. It is for this reason that the teacher, taking into account the conditions of equity mentioned in the previous grouping approach, grouped the intercultural students based on the trust they observed among themselves in group activities carried out previously, which has conditioned the socialization of the subjects shown in the results.

However, although in this research, social relationships in group work were facilitated by the convenience factor in affiliation, the use of mobile technologies to establish such relationships in learning has ratified the idea established in other studies [10,147,148], in which the use of electronic resources is positively linked with the creation of e-learning communities.

## 6. Conclusions

After completing the analysis of the concept maps of the PLEs represented by the students, the conclusions of this study focus on two important aspects: the response of the students and what the researchers discovered.

When analyzing the opinions of the students, it is observed that there is a clear tendency to use, mostly, the same reading, make/reflection and relational tools in individual and group tasks. These were the following:

- Books and Wikipedia to access to the information or read;
- YouTube, PowerPoint and Word to reflect on the information and edit it;
- Facebook, Instagram and WhatsApp to share information and be connected.

The students only differed in the use of the internet and sheets for the read category, and of YouTube and Snapchat for the relationship category.

These tools, except books and sheets, are used by students through smartphone and/or tablets.

Furthermore, the concept maps of the students have shown a greater use of tools of relationship, when they develop group tasks, a fact that involves the use of a greater number of learning strategies related to situations where students share information and relate, an aspect that generates greater opportunities for interaction and communication not only in the traditional context but also in the virtual environment.

This, together with the fact that in the individual tasks, the students also use relationship tools and strategies to communicate in intercultural contexts, justify the idea that the PLEs used through mobile technologies promote the school integration of these students in the learning communities created.

On the other hand, with respect to what the researchers discovered, it stands out as the main conclusion that the closed interview used is valid to measure the opinions of students about their PLE in individual and group tasks.

The qualitative results obtained demonstrate the effectiveness of the instrument and the validity of concept maps to answer the established questions.

Furthermore, the choice of the category system can be considered adequate and reliable. Obtaining a valuable category system to order and group the different answers given by the students in the concept maps.

Finally, it should be noted that the results obtained must be considered cautiously, as well as avoiding their generalization, since the selected sample is relatively small and only focuses on a classroom in the province of Granada (Spain).

Despite this, the study has increased previous research on PLEs used in individual and group tasks through the use of mobile technologies in students from intercultural contexts. Further, it shows a first approach to the knowledge that relates the use of smartphones and tablets and school integration in intercultural learning communities.

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## Appendix A

Interview for the analysis of the PLEs used in individual and group tasks.

Individual task:

1. What tools and strategies do you use to read?
2. What are the sources of information that you use the most?
3. What tools and strategies do you use to reflect on the information?
4. What tools and strategies do you use to edit information?
5. What tools and strategies do you use when you want to share information?
6. What tools and strategies do you use when you want interactive with another person?

Group task:

1. What tools and strategies have you used to read?
2. What sources of information have you used to carry out the task?
3. What tools and strategies have you used to reflect on the information?
4. What tools and strategies have you used to edit information?
5. What tools have you used to share information in your work group?
6. What tools and strategies have you used to interact between you?

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