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Geo-Positioned Activity-Based Collaborative Educational Mobile Platform

Plataforma educativa móvil para actividades geo-posicionadas colaborativas

ABSTRACT

Learning platforms aimed at the traditional content-based pedagogical model are at today settled down (e.g. SCORM (2004)). However, it is still unclear how to best support activity-based learning platforms for informal settings, especially in the case of mobile learning. This report describes the criteria that guided the construction of such a mobile platform for collaborative learning and the difficulties identified during its construction. The first difficulty occurs when the learning path is not predefined, because in this case the users have to find the right content for their learning. The second difficulty occurs when the educational content consists of activities that should be able to adapt to different learning scenarios. Finally, the third difficulty deals with how to geolocate and organize the educational items that users have to visit. These differences allowed us to find original and effective solutions, which are described here.

RESUMEN

Las plataformas de aprendizaje actuales dirigidas al modelo pedagógico tradicional basado en el contenido están a día de hoy bien asentadas (e.g. SCORM (2004)). Sin embargo, todavía no está claro cómo dar soporte a las plataformas de aprendizaje basadas en la actividad en entornos informales, sobre todo en el caso del aprendizaje que utiliza dispositivos móviles. Este informe describe los criterios que guiaron la construcción de una plataforma móvil para el aprendizaje colaborativo y las dificultades identificadas durante su construcción. La primera dificultad se produce cuando la ruta de aprendizaje no está predefinida, ya que en este caso los usuarios tienen que encontrar el contenido adecuado para su aprendizaje. La segunda dificultad se produce cuando el contenido del modelo educativo se compone de actividades que deben ser capaces de adaptarse a diferentes escenarios de aprendizaje. Por último, la tercera dificultad se ocupa de cómo geolocalizar y organizar los elementos educativos que los usuarios tienen que visitar. Estas diferencias nos permitieron encontrar las soluciones originales y eficaces que se describen aquí.

KEYWORDS / PALABRAS CLAVE

Informal learning, Collaborative learning, Mobile learning, Activity-based, Geo-positioned, Content identification, Recommendation.

Aprendizaje informal, Aprendizaje colaborativo, Aprendizaje móvil, Actividad basada, Identificación de contenidos geo-posicionado, Recomendación.

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1. Introduction and State of the art

The new functionalities included in smartphones enable the creation of collaborative learning systems that foster collaboration, outdoor learning, learning by doing, and discovery learning. In particular, handheld devices enhance off-classroom collaboration by promoting electronic interactions among people. The mobile device also engages learners in real-world learning-by-doing tasks, and so ultimately the learner draws on her/his own field experience to discover new knowledge.

Rationale

Authors such as Ainsworth et al. (2010) use the term non-formal learning to refer to non-intentional learning arranged by an institution and informal learning to indicate that this non-intentional learning occurs outside an educational setting. Other authors propose a different classification. For example, Werquin (2010) uses both terms interchangeably to refer to interactions and shared relationships among learners. In this paper, informal learning refers to non-intentional learning that occurs in a variety of activities, regardless of where it is organized by an educational institution. According to this definition, it seems clear that mobile devices have opened the door to new possibilities of informal learning. For instance, learning material can be best transported and customized; outdoor learning can be best exploited with the help of geo-positioning services; and experts may be more willing to share their knowledge when connected through a mobile. However, informal learning also presents some drawbacks, such as the difficulty of content identification. In contrast with formal learning, in informal learning there is often no official selection, planning and sequence for the educational activities. This makes it difficult for the students to find the more suitable content for them, especially when there is a lot of content. This paper surveys how Computer-Support Collaborative Learning (CSCL) can help participants discover fitting content by means of a standard Collaborative Filter (CF) recommender in the domain of mobile and informal learning. In particular, the paper identifies the information that an informal learning platform should collect to ease the automatic identification and recommendation of educational content.

According to Panitz (1997), collaborative learning involves individuals responsible for their own learning whereas cooperative learning is just a division of work among students working together in groups, and in which the teacher maintains a complete control of the class. The system designed in this paper is not only a cooperative learning tool, but a real collaborative learning tool in which learners are pro-active and can contribute with self-generated content from their field experience during the learning activity. Collaborative learning has the inherent difficulty of users and activities management, which is precisely the second difficulty this paper addresses. Thus, the proposed system enables easy management of users, educational activities, points to visit, as well as the assessment of these activities.

Resources management is even more difficult in outdoor learning, where the users and activities might be in different spatial locations. The management of this type of scenarios is facilitated if mobile devices are used to obtain the geographic location of the participants and activities. The third difficulty this paper addresses is geo-positioning the points of interest (hence, POIs) that learners have to visit and helping the activity organizer to monitor the position and routes of the learners. For this purpose, we have implemented a mobile application that takes advantage of the geolocation capabilities of new smartphones. In this paper geo-positioning refers to indicating the geographical position of an element and geolocating refers to finding this element in the map.

To demonstrate the solutions proposed for the above three difficulties, we have implemented an activity-based collaborative educational platform for mobile and informal learning named EduMotion. The core of EduMotion is a repository of users and geo-positioned educational activities to be performed with the support of a smartphone. The project website is at <http://www.edumotion-project.eu/> and the prototype at <http://tel.unir.net/edumotioncms/>

Current content identification methods

Content identification methods are important for the traditional formal Learning Management System (LMS) and also for informal LMS like EduMotion. However, content identification becomes even more useful in the case of informal education. This is because the educational institution does not set up the educational activities, but the student has to choose his/her educational activities.

There are three methods that have been extensively used to identify suitable content:

1. Popularity list. This is an ordered (ranked) list of content that other users have found useful, according to one or more criteria. For instance, James, P. (2003) patented a method to create popularity lists in a peer-to-peer network.

2. Text search. This allows users to go through a large set of documents searching for a list of words and obtain a ranked list with the most relevant content. Page, L. et al. (1999) introduced the well-known PageRank algorithm that serves as the basis of large search engines such as Google. Other authors, (e.g. Laurence A. F. Park, 2007) have reported variations of this algorithm to improve the precision of the search.

3. Recommendation. This is a filtered or inferred piece of information designed to provide unknown and useful information to the user, assuming that the recommender has previously collected features of the user (see, for instance, Jannach et al. 2010). Normally, the user profile is created and updated automatically according to its interaction with the visited content.

Although this paper assesses the above three content identification methods, the remainder of this subsection focuses on describing the methods used by the recommenders. A recommender (or recommendation system) differs from other content identification methods in that it takes the initiative in proposing content without waiting for the user to initiate a content identification process. According to the method used to find pieces of advice, we have the following types of recommenders (see Jannach D. et al. (2010) for a further description of these methods):

1. Collaborative filters draw statistical conclusions from the behavior or preferences of a large set of users in order to cluster users and content according to their similarity. Data can be collected explicitly (e.g. asking people to rate content) or implicitly (e.g. observing the user navigating through the links of a website). Collaborative filters can be roughly divided into two types: similarity-based and prediction-based. Similarity-based filters aim to find similar content or users (i.e. they create clusters). The Similarity score is computed by observing facts such as what they have viewed together. Similar users are those with analogous visits or votes. In contrast, prediction-based-filters use records of users similar to the current user to predict how much a user would like an unseen content or user. EduMotion implements collaborative filters and its implementation is described in "Recommender".

2. Social tagging (or collaborative tagging) systems take advantage of the collaborative annotation of content with freely chosen keywords, named tags. These tags allow users to collaboratively classify and find content using methods that are in some ways similar to the text search methods.

3. Content-based filters recommend content to users based on a description of the content and the profile of the user. Usually, the details of the recommendation method differ depending on the content representation. Pazzani M. et al. (2010) develop this idea.

4. Rule-based recommenders are a kind of expert system that uses rules to infer pieces of advice. Experts in education may predefine these rules, and the system usually allows the instructor to add or customize rules. In contrast to the previous methods, rule-based recommenders are able to generate recommendations different to finding similar content or users. For instance, frequently rule-based recommenders provide students sugges-

tions regarding the activities to undertake to improve their skills or the best training routes they can follow according to their abilities or expectations.

2. Architecture and functionality of EduMotion

This section describes the software applications, architecture, and functionality of EduMotion that support several learning scenarios.

EduMotion is a repository of learning scenarios, with users, educational activities, itineraries and Points of Interest (POIs) that comprises two applications:

1) The CMS (Content Management System) is a web application to manage users, activities, activity subscriptions, itineraries, Points of Interest (POIs), comments, etc. The CMS also allows for the rating, search, recommendation and assessment of the activities.

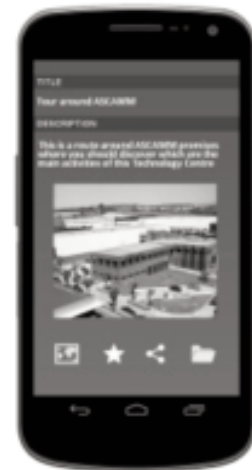
2) The mobile application facilitates information exchange on mobility. The mobile application communicates with the CMS so that users can perform their activity and organizers can track in real time the performance of their users. The mobile's GPS (Global Positioning System) and LBS (Location-Based Service) enable outdoor and indoor users' location tracking.

Figure 1 shows a screenshot of the CMS and the mobile application.

Regarding the user profile, EduMotion defines three roles (authenticated user, organizer and administrator), valid for both the CMS and mobile app, and each of which corresponding to a set of fixed permissions that depend on these roles. Normally, users participate with the authenticated user role. As all registered users receive the authenticated user role, normally they do not need further intervention from the administrator of EduMotion. However, some users need to receive further permission to play additional roles (in particular, the organizer and administrator roles). The users with the organizer role can create activities. The users with the administrator role can grant additional roles to other users and manage information associated with the user's account.



(a) The CMS



(b) The mobile application

Figure 1. Software applications of EduMotion.

The user subscribes to activities using the CMS, and for this purpose they can use a computer or a mobile browser. After that, the user switches to the mobile application to execute the activities because in this way s/he can take advantage of the geolocation capabilities.

EduMotion provides public and private activities. When a user subscribes to a public activity, s/he automatically receives the member activity role. Private activities require the organizer's intervention before the subscribed users receive the member activity role. When a user receives the member activity role s/he can navigate the itinerary (both from the CMS and from the mobile application) and they can post comments (assuming that comments are enabled).

To implement the activity subscription, in addition to the aforementioned roles that the administrator grants or revokes, EduMotion implements activity roles granted by the activity organizer and scoped on the activity itself. In particular, EduMotion provides the non-member, member, and administrator member activity roles.

The users with the organizer role are the ones in charge of creating and publishing activities. In the case of private activities, the organizer is in charge of accepting the subscriptions to his/her activities. The activity must have a title, and as an option may also include a photo, video and a description. There is also an option to indicate whether or not the users can send comments, and a set of POIs that define the itinerary. The start date of the activity is mandatory, and the organizer can also indicate the end date and time.

Open activities

Activity	Date
Visiting Budapest	Wednesday, May 1, 2013 - 10:15
Visit to Ávila	Sunday, May 12, 2013 - 09:00
Visit to the Zoo Aquarium of Madrid	Wednesday, June 5, 2013 - 08:30
Tour around ASCAMM	Wednesday, June 5, 2013 - 09:00

Figure 2. Open activities.

Figure 2 shows the web page that lists the open activities. When the user selects an activity, the activity expands, as Figure 1 (a) shows, to include the title, subscription role, ratings, a photo, the description, the date and the itinerary.

Usually, an activity contains information about the POIs to visit and the order (itinerary) in which to visit these POIs. As Figure 3 shows, the activity management dialog includes a box designated for gathering this information.

Itinerary			Show row weights
Title	Operations		
↕ Hippopotamus	Edit	Remove	
↕ Bears	Edit	Remove	
↕ Dolphins	Edit	Remove	
Add new Point Of Interest			

Figure 3. Management of the itinerary of an activity.



Figure 4. Monitoring an activity.

The cross arrows in the POIs allow the organizer to reorder the POIs in the itinerary. When the organizer presses the «Edit» or «Add new Point Of Interest» button, this POI expands to gather the information related to this POI. The organizer must provide a title for the POI and, as an option, a photo, a video, a description and a geocoded place name (e.g., «Paseo de la Castellana, 163 28020 Madrid»). This geocoded place will be converted to its GPS coordinates using forward geocoding.

Regarding activity monitoring, as Figure 4 (a) shows, the mobile application allows the user to know his/her position as well as the position of the visited and unvisited POIs. If the organizer has enabled this option, the user can add new POIs to the activity and share this information with the users subscribed to this activity.

Finally, as Figure 4 (b) shows, the organizer can check the current position of all the users subscribed to the activities that s/he manages while they are being executed. This functionality is especially useful for schools, allowing teachers to know at all times where their pupils are.

Finally, regarding activity assessment, the organizer can create assessments associated with an activity or POI, and the users can submit comments and attach videos or photos to these assessments. In addition, the organizer can create tests to be completed at the end of the activity.

For scenarios involving formal learning (e.g. schools), the organizer will be able to link to the institutional LMS so that the student will be able to sign in and submit her/his assignments.

3. Content identification

As aforementioned, in "Rationale", the lack of predefined activities in informal learning settings introduces the problem of content identification. This section describes how EduMotion implements the three content identification methods introduced in "Current content identification methods". This section also contributes to the state of the art by highlighting the positive consequences of transforming a piece of advice into another one that is easier for the user to understand.

Common aspects

The methods introduced in "Current content identification methods" for identifying suitable content have the following two aspects in common:

1. Presentation of the results. Typically, in a modern scenario, all these methods produce a list of suggested

items that is presented to the user, and the user can select (click) an item to expand the details.

2. Decision criteria. Two criteria are usually combined: a) relevance, which corresponds to the degree to which content matches the user intentions, and b) popularity, which corresponds to the perceived importance of the content for other users. Text search engines usually consider the relevance first. If the content is not relevant to a query, the engine discards this content. Otherwise, a second group of popularity criteria (such as Google's PageRank) is used to ponder the relevance of each piece of feasible content. When a user searches through a popularity list, s/he implicitly performs the inverse process. The user starts exploring from the top of the popularity list discarding content that does not match what s/he is looking for. Recommenders aim to automate this exploratory process.

Content identification guidance

This subsection introduces our classification for content identification guidance by taking into account two key differences between the above-mentioned methods for identifying suitable content:

1) Personalization level. This indicates the level to which the collected features and preferences of the user (i.e., user profile) are considered during the search for content. While popularity lists tend to ignore the user profile (e.g. the list of best-seller records in an electronic music store is often the same for all the users), recommenders exploit to the utmost the collected profile of the user in order to provide highly customized recommendations. Text search engines are in the middle; that is, they consider some aspects of the user's profile (e.g. country, language), but the most important aspect in making the decision is the list of words that the user provided.

2) Explainability level. This indicates the level to which the user understands the reason why the content has been chosen. Recommenders tend to hide from the user the reason why the content has been designated. Since how these recommendations were determined is not given, users tend to be skeptical of these «out of the blue» recommendations. On the other hand, when the user chooses an item in a popularity list, the user knows perfectly why this content is being recommended. Logically, the position in the list depends on the ranking criterion (e.g. best-seller, funniest, etc.), but this criterion is explicit and perfectly clear. Text search engines are in the middle; the user knows that the suggested content depends on the list of words that he/she provides, but there are other criteria that text search engines normally hide (e.g. PageRank, distance between words, advertisement campaigns, etc.).

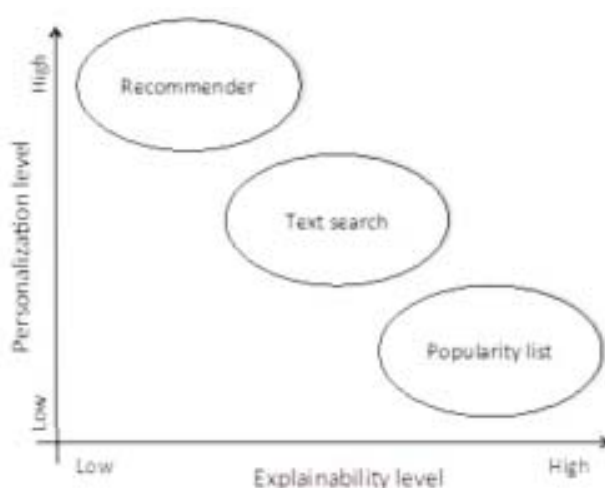


Figure 5. Content guidance tradeoff.

Figure 5 shows the tradeoff between the level of personalization and explainability associated with each kind of content guidance. With the popularity list, the user receives high level of explainability and low level of personalization. On the other hand, with the recommender, the user receives a lower level of explainability with a higher level of personalization.

To best demonstrate the consequences of these identification methods in a collaborative educational platform we have implemented them in EduMotion. The following subsections describe these methods.

Recommender

This subsection describes the collaborative filters that EduMotion implements. "Current content identification methods" divided collaborative filters into similarity-based filters and prediction-based filters. Figure 6 (a) shows a similarity-based recommendation that EduMotion provides named «Users like you». This recommendation shows the users who have rated similarly to the currently logged user. The similarity score ranges between +1 (completely similar) and -1 (completely dissimilar). This view only shows up to the 5 most similar users with a similarity score greater than 0.5. The recommendation in this example only shows 3 users, which, for the currently logged user, are the users with a similarity score greater to 0.5.

Figure 6 (b) shows a prediction-based recommendation named «Recommended for you». It recommends nodes that might interest the current user most. This recommendation comes from the fact that other users who vote similar to the current user have rated this content highly.



Figure 6. Recommendation in EduMotion.

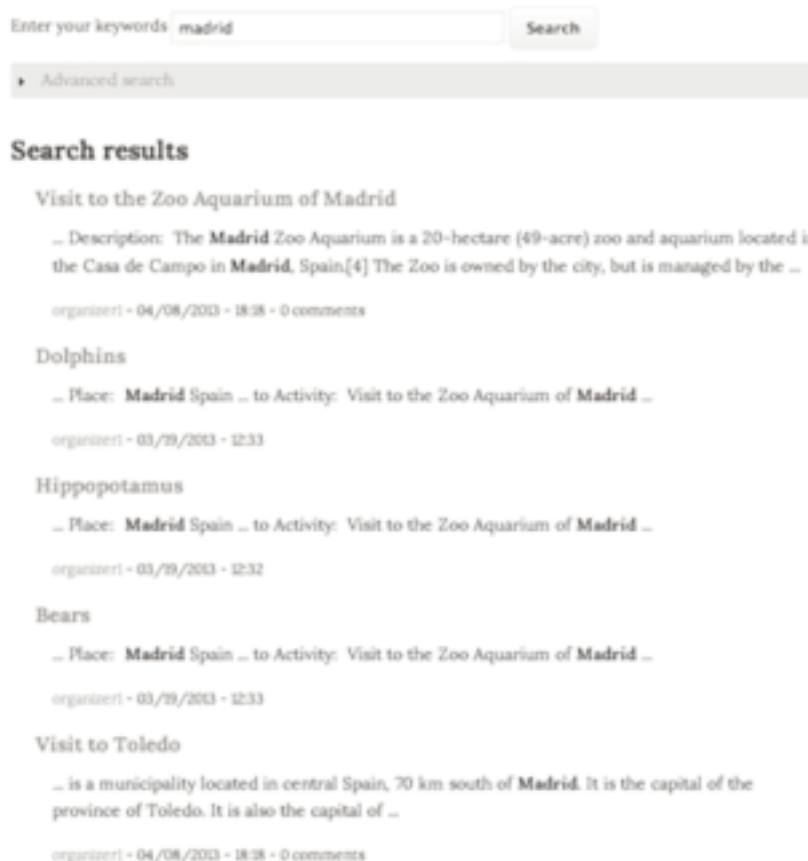


Figure 7. Text search results.

Note that these recommendations, especially the prediction-based recommendation in Figure 6 (b) suffer from a lack of explainability. Users might wonder why they are receiving a recommendation and this would reduce their willingness to pay attention to the suggested items. To make a comparison and best highlight the importance of including explainable guidance, the next subsections describe the other two methods of guidance implemented in EduMotion.

Text search

Figure 7 shows a result obtained by a user when she searches for «madrid» in EduMotion. Note that although most of the results relate to activities and POIs in Madrid, there appears a non-relevant one such as the activity belonging to Toledo. This is because its description mentions that Toledo is in the south of Madrid.



Figure 8. Rating an activity.

Informative activities			Enjoyable activities		
Title	Average rate	N votes	Activity	Average rate	N votes
Visit to Ávila	85 %	4	Visit to Ávila	80 %	4
Visit to the Zoo Aquarium of Madrid	75 %	4	Visit to Toledo	80 %	4
Visiting Bologna	75 %	4	Visit to Barcelona	70 %	2
Tour around ASCAMM	70 %	4	Visit to the Zoo Aquarium of Madrid	70 %	4
Visiting Budapest	60 %	1	Visiting Bologna	65 %	4
Visit to Toledo	55 %	4	Tour around ASCAMM	35 %	4
Visit to Barcelona	50 %	2	Visiting Budapest	20 %	1

Informative POIs			Enjoyable POIs		
Title	Average rate	N votes	Title	Average rate	N votes
The Two Towers (Visiting Bologna)	93 %	3	The Two Towers (Visiting Bologna)	86.67 %	3
Aerospace Technology Centre (Tour around ASCAMM)	87 %	3	Bears (Visit to the Zoo Aquarium of Madrid)	75.00 %	4
Spanish Federation of Mould and Die Industry Associations (Tour around ASCAMM)	80 %	3	Hippopotamus (Visit to the Zoo Aquarium of Madrid)	75.00 %	4
Bears (Visit to the Zoo Aquarium of Madrid)	75.00 %	4	Dolphins (Visit to the Zoo Aquarium of Madrid)	70.00 %	4

Figure 9. Popularity list.

Popularity list

To predict how useful a POI or activity may be to the user, EduMotion allows users to rate content. Figure 8 shows an example of a rated content. Each user can rate two aspects using two standard five-stars widgets. The user indicates with the first widget whether the content is funny, and with the second widget whether it has been informative. Users are not forced to rate any content because we want the user to rate content only if s/he considers it useful to do so. Otherwise, forcing the user to rate all the content may give rise to a set of ill-considered ratings that do not precisely describe the tastes of the user.

From these ratings, Figure 9 shows an example of a popularity list in EduMotion. The list is divided in four tables. The tables on the left show the activities and POIs that have been rated as most informative, and the table on the right the ones rated as most enjoyable.

Content guidance methods comparison

Table 1 compares the above three methods of identifying content according to the criteria of relevance vs. popularity (see "Common aspects") and explainability vs. personalization (see "Content identification guidance").

Recommenders (such as our collaborative filter) frequently take into account the popularity of the content but do not consider its relevance (e.g. whether it responds or not the user query). As they generate personalized content their level of personalization is high, but as they rarely consider user input, the intelligibility level is low.

	<i>Relevance</i>	<i>Popularity</i>	<i>Explainability</i>	<i>Personalization</i>
<i>Recommender</i>	Low	High	Low	High
<i>Text search</i>	High	Medium	Medium	Medium
<i>Popularity list</i>	Low	High	High	Low

Table 1. Content guidance methods comparison.

Text search is an effective and widely used method, but it has the disadvantage that normally tends to focus on finding relevant content and disregard popularity, and so does not estimate how interested the user is going to be in the activity. The big innovation of the PageRank algorithms (Page, 1999) was that introduced popularity in the ranking. Current large search engines also consider some user preferences.

The popularity lists are very effective in identifying popular content (i.e., the best rated content) but do not allow for finding relevant content (i.e., matching the topic of interest of the user). This is just the opposite of text search in which the topics are easily found, but the popularity (i.e., informative and enjoyable levels) is hidden.

4. Case study: Guiding students on a visit to a zoo

In this section, we focus on demonstrating the flexibility of the activity-based pedagogical model and how it adapts to real-world situations that were not considered during the initial design.

This selected case study describes how EduMotion applies to a school that wants to complement biology classes with a visit to the Zoo Aquarium of Madrid. In this case, the school (and not the students) subscribes the users to the activity and therefore the content identification is used from an organizational level. Also, the individual students may require deciding the next exhibit (i.e. POI) to visit and they will use the recommender features of EduMotion. The students will also collaborate by cross-posting comments regarding the different POIs.

At first sight, the requirements of the school seem to fit with the activity-based functionality that EduMotion implements. The school wants to reinforce the skills being studied in class through fieldwork activities. The school already has government funds to buy a mobile for each student so they only need to acquire a license to use EduMotion in order to carry out these out-of-class activities. The POIs seem to be the ideal way to indicate the animals that student are going to get to know, while the students use the provided content identification methods to build their own visit plan. The teachers are pleased with the possibility that EduMotion offers of monitoring at all times the position of students, because in this way they can reduce the changes of losing a student. The comment posting system facilitates collaborative learning. This is a local government requirement they need to comply with to get the out-of-class activities funded. However, when we moved forward in preparation for the activity two problems were identified:

(1) Grouping. EduMotion does not provide the option to create groups, and teachers want to bring students into groups of no more than 20 students. We preferred not providing this ability to create groups in order to reduce the difficulty of using EduMotion. We think that this feature would be used only in a few cases like this, and will merely clutter the system, making its usability harder for the target audience (mainly preteens and poorly trained workers).

(2) Itineraries. Teachers do not want students to have to visit the POIs in a particular order, but prefer students to visit all points in the order that they prefer.

After reflecting on the first problem we realized that an activity subscription is already a form of grouping users. The proposed solution was to take advantage of the fact that EduMotion allows for cloning an activity. Since all groups were to perform the same activity on different days, it was possible to create an activity that would serve as a template and clone it as many times as groups. Once an activity is cloned, the title has to be changed to add the group name (e.g. «Visit to the Zoo de Madrid (Group B)»). The starting day of the activity would also need to be adapted accordingly.

The solution to the second problem was just to allow students to visit the POIs in the order they prefer. In fact, EduMotion does not designate a path for the user, but simply marks on the map the user's position, the positions of the visited POIs, and those that are pending for visit. To ensure that the student visits all POIs, the teacher asks the students to take a picture of the POI with the phone and send it as a comment associated with the POI.

The teachers thought that the way we proposed to create groups by duplicating activities was comfortable, since the main duty for them was to create the description of activities and places to visit during the activity. The second solution was also accepted as a valid way to ensure that students visit every POI.

This case study shows that EduMotion is able to adapt to different informal learning activities intended to be executed out of class.

5. Discussion, conclusions and future work

This report described how the problems of content identification, activity management, and the outdoor execution of the activities can be addressed in a collaborative environment for informal learning. To do so, we have designed and implemented a learning platform for informal scenarios called EduMotion. Among other interesting features, such as, i.e. activity monitoring and itinerary management, EduMotion provides a solution for content identification in informal learning situations. The solution is based on a combined use of recommenders, text based search and popularity lists, offering a balanced functionality with different levels of personalization and explainability, to best suit the end user. EduMotion offers enough flexibility to be adapted to different off-classroom and activity-based learning scenarios. The presented case study (a visit to the zoo) discusses how EduMotion fits the needs of both teachers and students and foster collaboration, including when the participants are in different spatial locations.

Regarding content-identification, this paper has proposed that explainable guidance tends to be more reliable for the user than highly customized guidance, and so it should not be disregarded. This is because it is easier for the user to accept advice when they understand how it was generated. Furthermore, this paper highlights the positive consequences including pieces of advice easily understandable by the user. To demonstrate this approach, we have implemented an activity-based collaborative educational platform that incorporates personalized and explainable guidance.

The unstructured nature of informal learning requires different ways of collaboration. EduMotion fosters collaboration by using mobile devices to facilitate the management of activities and enabling information

exchange among peers. As a result, the students are motivated to interact and active participants in their own education.

As a future work, our next step will be to use the EduMotion platform to conduct experimental tests in order to determine the level of accordance and confidence of each kind of guidance, as well as the achievable benefits when combining them.

Notes

(1) In this paper geo-positioning refers to indicating the geographical position of an element and geolocating refers to finding this element in the map.

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