Forming groups of mobile learners that promote collaborative learning supported by mobile devices

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Abstract. The educational system of today is marked by advances in information and communication technologies. Initially we attended computer-assisted learning, then mobile technology has in turn been integrated into the education system, hence the Mobile Learning. The technical capabilities of mobile devices associated with wireless technologies make them remote learning tools in their own right. Mobile Learning is a real potential for distance learning because it allows the learner to learn anywhere and at any time to ensure better collaboration between learners of mobile learning, gathered in small groups, hence the new concept of Mobile Computer Supported Collaborative Learning (MCSCL). One of MCSCL's problem is the learner groups' management. This problem is linked to the high mobility of learners (change of position, disconnection of the network, etc.). In our review of the literature we have made a classification of learner group training methods ensuring a better interaction while taking into account the mobility of the learners. In the context of disadvantaged areas, mobile phones can be used for learning.

Keywords: Mobile learning, Mobile Computer Supported Collaborative Learning.

1 Introduction

The socio-constructivist approach encourages learning through an interaction of the learner with his peers and the learner with his teacher. This approach is applied through different methods in the educational system, one of these methods is the collaborative learning method.

Collaborative learning [1] [2] aims to improve the success of learners. It focuses on working in small groups in which learners of different abilities and talents strive to achieve a common goal.

With the proliferation of mobile devices (smart phones, tablets ...) and advances in mobile technology, collaborative online education tends to use mobile devices as a learning medium. This leads us to define a new concept that is collaborative learning supported by mobile devices "Mobile Computer Supported Collaborative Learning (MCSCL)" [3].

One of MCSCL's key issues is to train motivated and diligent groups of learners in their learning activities. In this paper we will focus on the formation of these groups of learners in the MCSCL.

2 Learning group formation in collaborative learning

The various studies carried out on collaborative learning in the classroom [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [18] [19] [20] [21] [22] [23] have a very positive record. Indeed, the learner develops attitudes that ensure better academic performance. Collaborative learning [24] suggests that learners are responsible and endowed with social skills. Indeed learners are responsible for their learning as well as that of the others.Collaborative learning is an approach that gives the learner a lot of freedom. The activities are not very directed and the learners manage the bulk of their group work. For example, the roles of learners are not assigned by the teacher in the case of collaborative learning, but learners negotiate these roles among themselves.

The MCSCL has a definite advantage for learners who are very mobile because of their professional occupation. Indeed, it ensures a strong collaboration and interaction between the learners, a greater autonomy of learning for the learner who has the possibility to come into contact with the other learners as well as the teacher anywhere and at any time.

The training of groups in distance learning platforms is done manually according to the objectives of the trainer. However, what about the number of learners who assiduously use these collaborative tools? Or learners who are not willing to use them? This proves to be a major problem in the implementation of collaborative distance learning if we really want to respond to the principles of collaborative learning, where the interdependence of learners is mandatory.

To promote collaborative distance learning, it will be necessary to:

- Train groups of learners whose numbers are small: to improve and facilitate the positive interdependence of learners. The collaborative approach recommends training small groups, ranging from 2 to 4 or 5 learners per team [7] [25]. Absolutely, a small number of learners promotes meaningful interactions while facilitating coordination and group management;
- Form groups of heterogeneous learners that facilitate positive interdependence, better learning outcomes and real interaction;
- Place a collaborative pedagogical strategy such as collective problem solving :

- Establish a structuring or assistant technological system that aims to direct learners into their activities and learning. (i) Structuring systems provide an interface that guides learners in carrying out their collaborative activities. These systems structure activities and interaction situations. (ii) Assisting systems collect data from the interaction and analyze it to assist learners or trainers (supervisors).

The primary objective of working in a group is to promote the acquisition of social skills by learners, so the establishment of heterogeneous groups is the best approach [26]. Learner-formed groups, which are homogeneous, do not guarantee in the long run an environment conducive to collaborative learning [26] [27] [28] [29].

In practice, during this 21st century coinciding with the advent of remote learning platforms, many researchers are attempting to offer learner group training solutions in Computer Assisted Collaborative Learning (CSCL). Thus, researchers are using mathematical models [30] [31] [32] [33] [34] [35], algorithms grouping learners [36] [37] [38] [39] [40] [41] [42] [43] [44], implement intelligent systems [45].

What we observe, however, in these works is that they focus more on static learners. This aspect of learner mobility should be taken into account. In terms of mobility, we refer to the apparatus used for learning, namely a mobile device.

Unlike the CSCL, mobile learning is best suited to collaborative learning because of the mobility that enhances the interactivity between the learners. So instead of having static groups, we will focus more on dynamic groups depending on the position of the learner. This brings us to the concept MCSCL.

3 State of the art on the formation of groups of learners in MCSCL

The MCSCL is a particularly dynamic environment. This environment must be able to adapt to changes in the learner's context and this, periodically (position, distance between learners, and availability of learning objects ...).

However, the MCSCL is generally exposed to a number of limitations such as: :

- Technical problems related to mobile technology: limited storage capacity, limited lifetime, frequent disconnection...
- Social problems: individualism, incomprehension...
- Geographical problems: climate change, displacement …

These problems in the MCSCL impact the formation of groups. This means that it will be necessary to form dynamic groups taking into account these different aspects in order to ensure positive interdependence and to maintain the motivation and interaction of the learners.

Teams tend to propose mechanisms for group formation of learners in the MCSCL. Article [46] deals with a review of the literature on the problems of learners' group formation in the MCSCL. Indeed, the authors of this article provide research avenues to the MCSCL community in order to propose learner group training solutions.

We find that some studies propose the formation of heterogeneous groups to promote interaction, others propose the creation of homogeneous groups. On the other hand, Messeguer and others [47] , El-Bishouty and others[48] , Tan, Kinshuk and Huang [49] , Mujkanovic, Lowe and Willey [50] , Muehlenbrock [50] focus on the learning environment to form groups. However, researchers recommend heterogeneous groups that promote collaborative learning through the interactions between learners and their motivation.

We have thus identified three essential criteria for the formation of learners'group, namely :

- The personal characteristics of the learners: This is about data that can help identify learners;
- Learning behavior: It is a matter of collecting data on the learner's behavior during the learning activity. These data can be: social interaction, participation in learning activities …
- Contextual information: relates to real-time data provided from the learner's mobile device.

We find that the majority of the works use mainly the characteristics of the learner, to create groups of learners, these characteristics are: age, level of knowledge, experience ... To enrich the group of learners with the aim of having homogeneous or heterogeneous groups, tools to analyze the learner's behavior can be used, these tools can be digital portfolios, intelligent systems. An interesting aspect of mobile technology is the ability to have real-time information regardless of location and time, which is why the contextual information criterion is used for training groups of learners. In this work the most used information is the location of the learner who can be recovered through Wi-Fi tools, GPS …

However on the twelve articles, only the authors Yin and others [51] combine the three criteria for the formation of groups with the establishment of homogeneous group. We believe that combining these three criteria allows for a generic learner group training system that can be adapted to any learning context.

Another aspect that we have in these articles is the possibility of having groups that can be customized according to the needs of the trainer or the learner, and dynamic groups that change over time due to the mobility of the learners. Two articles Zurita, Nussbaum and Salinas [52], Tan, Kinshuk, Huang [49] propose a method for the dynamic management of learner groups.

4 Proposal for a training system for a learner's group in a Mobile Learning context

The MCSL proves to be a practical learning approach for those who wish to improve their knowledge or carry out continuous training. We want to propose a mobile learning system for professionals who have spatio-temporal constraints to carry out their learning. Distance learning is beneficial only when there is real collaboration between learners. Cooperatively alludes to the establishment of a group of learners. How to train these groups is our main concern. Should it be done manually or automatically by the algorithm implementation? But the manual training

of groups proves to be complex, because many parameters have to be taken into account and the motivation of the learners must be maintained in the learning activities. As seen previously many works, coinciding with advances in mobile technology, propose learner group training approaches in the MCSCL. Through this study of the state of the art, we propose generic learner group formation architecture in the MCSCL (fig. 1).

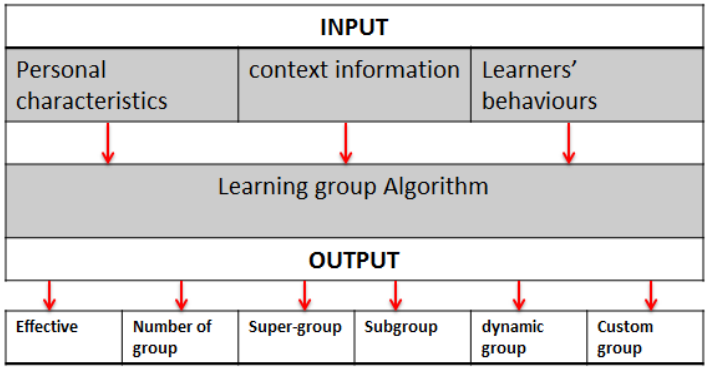

Fig. 1. Generic learner group training architecture.

We intend to propose an algorithm for the formation of heterogeneous groups of learners that receive as parameters:

- Personal traits : gender, title (employed, unemployed), work experience, level of domain knowledge (highest diploma);
- Geographical position: we retrieve the geographical coordinates of learners from their mobile device by activating their GPS;
- Social we analyze the rate of interaction of learners in terms of answers given to the questions of other learners.

In output we have:

- The group size we set at five. A small number of learners promote meaningful interactions while facilitating coordination and group management [7] [25] ;
- We choose a hierarchical organization (super-group and subgroup) of groups to facilitate assignment from the learners to the groups ;
- The groups trained are updated periodically to take into account the high mobility of learners who change positions frequently.

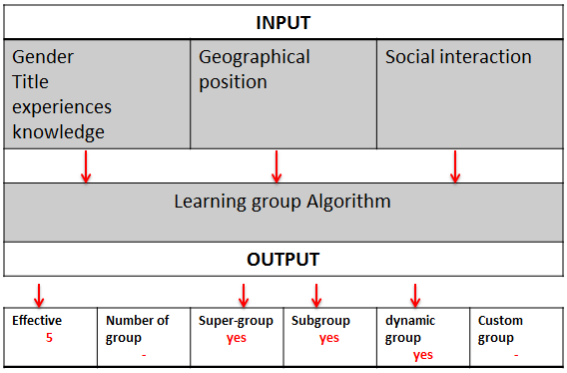

Fig. 2. Algorithm for training groups of learners.

4.1 implementation of the algorithm

We intend to deploy the solution in Senegal for professionals who wish to improve their skills by performing continuous training [53] [54]. We find that these professionals face many spatio-temporal constraints to attend a face-to-face training.

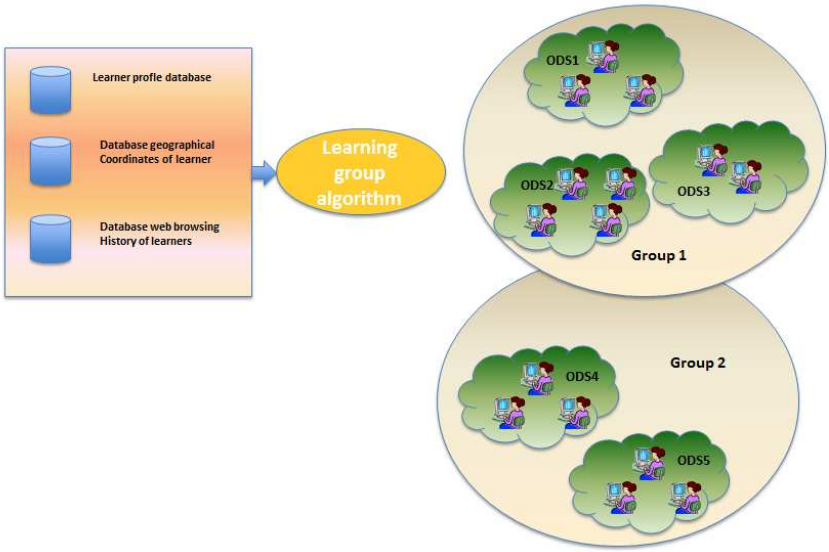

Fig. 3. System of formation of groups of learners.

The learners are grouped in open digital spaces (ODS) according to their geographical position [55], their profile, as well as the browsing history of the web pages. These data are stored in databases and analyzed and exploited to form groups of learners. The principle of the algorithm is to associate the learner with the nearest

ENO after locating it. For this, our algorithm is based on the Dijkstra algorithm [56] which serves to solve the problem in the shortest path.

4.2 Principle of group formation

Method 1

In this first method, our algorithm is characterized by:

- Groups that are identified by a fixed value and are named ODS ;
- ODSs are organized in ascending order ;
- The search for a current ODs: the dijkstra algorithm is applied to determine the ODS closest to the learner (mobile node) who wants to connect;
- The ODS is uniquely identified by the couple (Latitude, Longitude)

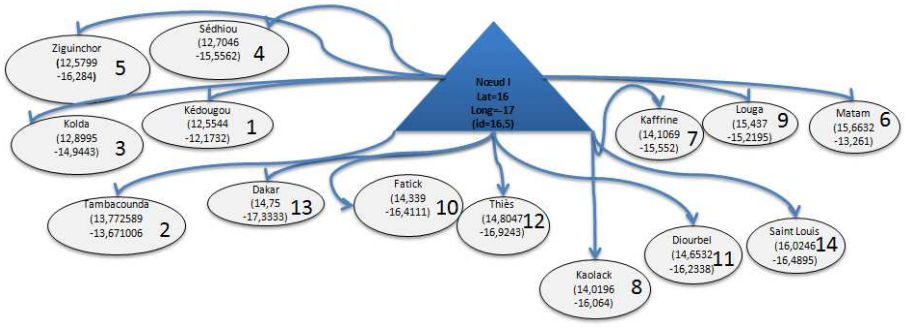

Fig. 4. Search algorithm with method 1.

By applying the principle of djisktra, to search the current ODS of node I, we will browse the nodes step by step starting with the node that has the identifier. Thus our search begins with the node Kédougou and ends with the node Saint Louis which will be the current ODS of the node I.

Doing an analysis of the algorithm, the parameter of complexity is related to the number n corresponding to the number of ODS. To improve the algorithm it will be necessary to reduce the number of ODSs to be traveled to find a current ODS.

Method 2

In this second method we try to improve the algorithm of the first method, so our second proposed algorithm is characterized by:

- Associate a group number for each ODS;
- Associate with each mobile node (learner) a group number that corresponds to its original group ;
- Regroup the ODSs by group ;

- Find the current ODS starting from the originating group of the mobile node;
- Each group covers an identifier interval ;
- The maximum number of ODSs in a group is limited to five.
- The groups are as follows :
    - Group 0: identifier is between 11 and 11.9
    - Group 1: identifier is between 12 and 12.9
    - Group 2: identifier is between 13 and 13.9
    - Group 3 : identifier is between 14 and 14.9
    - Group 4 : identifier is between 15 and 15.9
    - Group 5 : identifier is between 16 anf 16.9

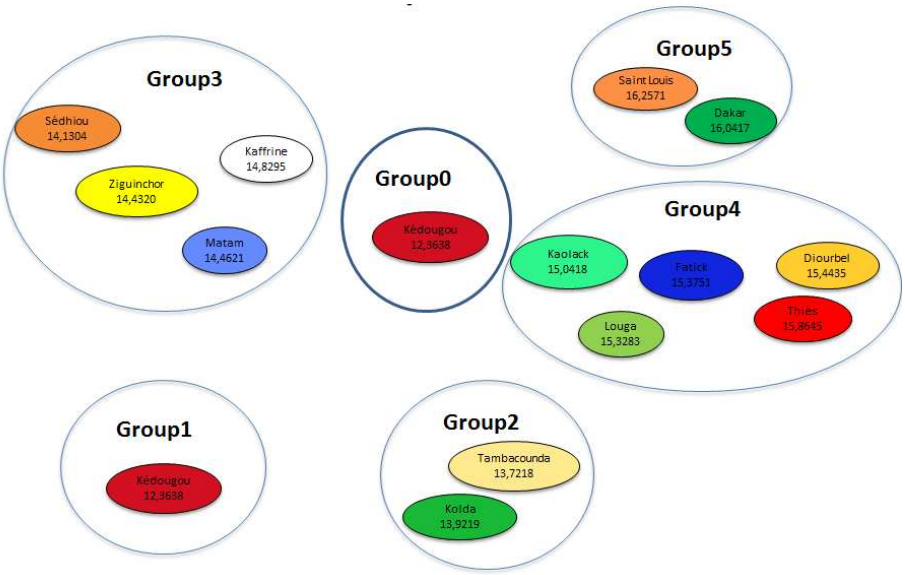

Fig. 5. Grouping of ODSs by group.

By always analyzing this algorithm in relation to the previous one, the complexity is less. Decidedly, the number of ODSs to be covered is reduced since the ODSs are organized in groups. FIG. 6 shows the time taken during the localization of ODS using the two methods presented above:

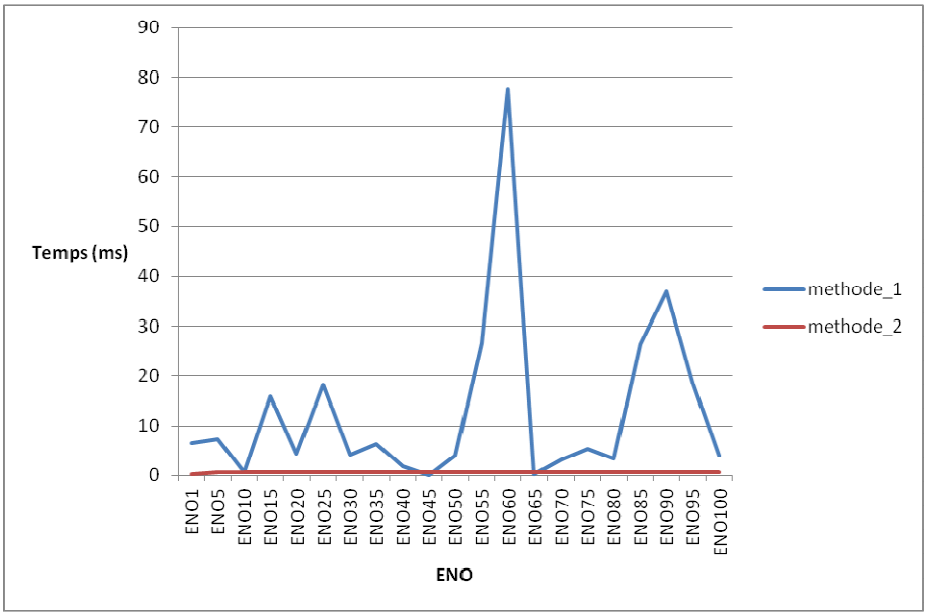

Fig. 6. Comparison of the two methods.

The second method (red curve) with constant complexity is the best approach to implement because we find a real reduction in the search time of the closest ODS according to the parameters defined previously. Indeed, the maximum time observed in the second method is 0.6s contrary to method 1 where the maximum observed time reaches 80s.

5 Conclusion and Perspectives

This paper is part of our doctoral research work. The objective of our work is to propose a mobile learning solution to Senegalese professionals who face spatio-temporal constraints to continue their learning by attending classes. Thus we have established a detailed state of the art on the practices of Mobile Learning. One of the major issues in Mobile Learning is to be able to form groups of learners that are sustainable over time while ensuring real collaboration between these learners. This has prompted us to focus our research on the formation of learner groups in Mobile Computer Supported Collaborative Learning (MCSCL). In summary, what we can retain is that to form groups of learners assuring a positive interdependence, the following criteria must be taken into account: Personal traits; Geographic position; Social interactions.

The algorithm that we have proposed can be adapted to any mobile learning situation. As a perspective, we plan to deploy the solution and then evaluate its impact in the learning process of Senegalese professionals.

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