Extending CIAM Methodology to Support Mobile Application Design and Evaluation: A Case Study in m-Learning

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Abstract. Traditionally, the development of systems supporting group work has been considered a complex task because multiple aspects have to be considered. As a consequence, it is necessary to apply methodological processes in order to reach successful and usable systems. CIAM is a methodological approach for developing groupware user interfaces by modeling aspects of collaboration and interaction. CIAM addresses the joint modeling of collaboration and human-computer interaction aspects, guiding the engineers through several modeling stages, starting from the analysis of the context of the group work until obtaining an interactive task model. In its initial proposal, CIAM does not deal directly with evaluation mechanisms and processes of the artifacts produced when this methodology is applied. In addition, CIAM is not primarily focused on the mobile computing paradigm. Thus, the objective of this paper is to describe how CIAM is being improved in order to provide more complete support for modeling and evaluation of collaborative applications based on mobile computing and especially the modeling of applications supporting Mobile Learning (or m-Learning).

Keywords: Collaborative mobile systems · Group interaction in mobile systems · Cooperative learning · Mobile usability

1 Introduction

The development of systems supporting group work is a complex task because multiple aspects have to be considered [1]. As a consequence, it is necessary to apply methodological processes in order to reach successful systems. CIAM (*Collaborative Interactive Applications Methodology*) is a methodological approach for developing groupware user interfaces by modeling aspects of collaboration and interaction [2, 3]. CIAM addresses the joint modeling of collaboration and human-computer interaction aspects, guiding the engineers through several modeling stages, starting from the analysis of the context of the group work until obtaining an interactive task model [4, 5]. The final user interface

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is obtained from the interaction model, applying a semi-automatic method supported by the CIAT-GUI tool [6].

In its initial proposal, CIAM does not deal directly with evaluation mechanisms and processes of the artifacts produced when this methodology is applied. Furthermore, the notation used for this methodology is not primarily focused on the mobile computing paradigm.

Therefore, CIAM has been enhanced in order to support the modeling of collaborative applications based on mobile computing and especially the modeling of applications supporting collaborative Mobile Learning (or m-Learning) [7]. For this, we have proposed a framework for design and evaluation of mobile applications [8]. This framework serves as a basis for an evaluation tool that allows for the analysis of m-Learning applications characteristics and representing results into a radar chart. In addition, mechanisms and tools to highlight strengths and weaknesses are incorporated [9].

Thus, the objective of this paper is to describe this framework and how it has been integrated with CIAM in order to provide a more complete support for modeling and developing interactive collaborative systems for mobile computing.

This paper continues by briefly explaining some characteristics of CIAM methodology and highlighting the necessity of extending it in order to design and to evaluate mobile applications. Then, our evaluation framework is described, and panoramic view of how it is used in the CIAM context is given.

2 Previous and Related Work

With the aim of facilitating the development of groupware systems, we have proposed CIAM (Collaborative Interactive Applications Methodology). CIAM is a methodological approach for the modeling and development of groupware applications that takes into account the modeling of work in-group and interaction issues [3]. Thus, the objective of CIAM is to serve as a guide for the engineers when creating a conceptual specification of the main aspects that characterize the groupware systems and lead to the design of the interactions that these systems support. CIAM is technologically supported by the CIAT [10] and CIAT-GUI tools [6]. With these tools, a final graphical user interface is semi-automatically obtained.

CIAM includes a notation called CIAN (Collaborative Interactive Application Notation), which allows for modeling of group and human-computer interaction issues [2]. CIAN can be used for collaborative learning modeling systems, adding higher levels of abstraction in the development of educational applications in specified standards, such as IMS-LD [11, 12]. It has been shown that this language can be used to specify CSCL activities and systems, even in mobile contexts [13].

However, CIAN considers device independence as a fundamental principle. Therefore, it is not primarily focused on this paradigm and the effective utilization of CIAM for development of applications to support m-Learning or collaborative m-Learning activities is difficult, since in these cases it is necessary to consider specific aspects of mobile computing as well as the evaluation of artifacts produced, especially when these artifacts contain pedagogical issues.

There are other authors that have addressed this problem by focusing on different aspects. For example, en [14] a model-based tasks and dialectic is described. In [15] a software engineering and learning tasks based approach is presented. Others [16] use ontologies and its main objective is the modeling of learning context and not so much support collaboration. However, CIAM is and approach focused on interaction and collaboration aspects that are necessary for groupware and collaborative learning.

In the following section, we describe how CIAM has been improved by means of a framework to design and evaluate mobile applications, considering aspects of mobile usability and pedagogic usability.

3 Supporting Design and Evaluation of Collaborative m-Learning Applications with CIAM

In order to reach our objective, we have developed a framework of design and evaluation of collaborative m-Learning applications. Then, the application of this framework has been included in the process model of CIAM because our aim is to improve CIAM. However, it could be used in an independent way. Therefore, we provide some guidelines on how it could be applied in a methodological process for modeling of interactive and collaborative applications on the mobile computing paradigm.

3.1 Framework for Design and Evaluation

A framework to design and evaluate mobile applications has been developed. It considers aspects of mobile usability and pedagogic usability [9]. Thus, it is divided in the first level into two categories: *Pedagogical Usability* and *User Interface Usability*. Each category is organized into several dimensions and criteria that must be taken into account. For example, *Pedagogical Usability* is organized into *Content*, *Multimedia*, *Activities*, *Social Interaction*, and *Personalization* dimensions; and *User Interface Usability* is organized into *Operability*, *User Error Protection*, *Aesthetics*, *Feedback*, *Accessibility*, and *Motivation* dimensions.

Regarding *Social Interaction*, it is considered that socialization is fundamental for the learning process, and an m-Learning application must promote it among students. For the socialization dimension, five criteria are considered: *Dialogue*, *Collaboration*, *Cooperation*, *Discussion*, and *Sharing*. These criteria are defined according to the conceptual framework in which CIAM is based [6].

Figures 1 and 2 show all dimensions considered in the second level of subdivisions. These dimensions and their criteria (or factors) are described in depth in [9].

This framework serves as basis for an evaluation tool that allows for the analyzation of m-Learning applications characteristics and representing results into several types of charts (especially, radar chart). In addition, mechanisms and tools to highlight strengths and weaknesses are incorporated. Figure 3 shows a partial view of the user interface of this tool. It shows a view of the *Usability Pedagogical* dimension. In the middle there is a questionnaire to gather information about *Content* dimension. The items of the questionnaire are related to the criteria of each dimension. On the bottom side, the results

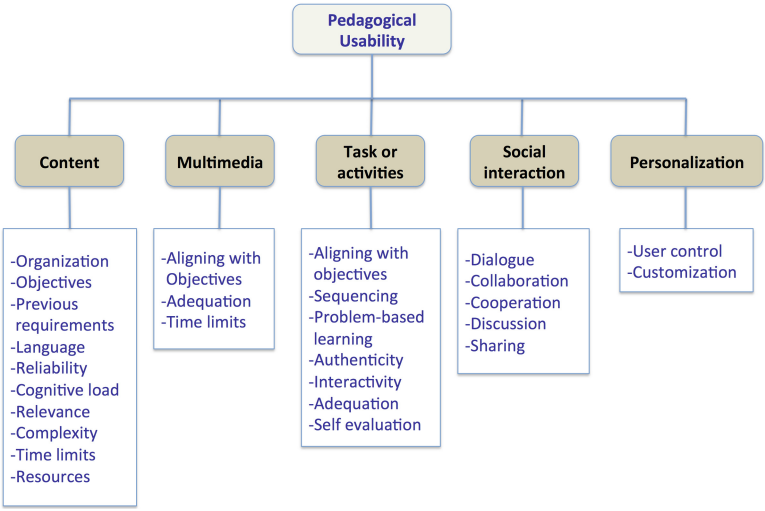

Fig. 1. Factors in Pedagogical Usability

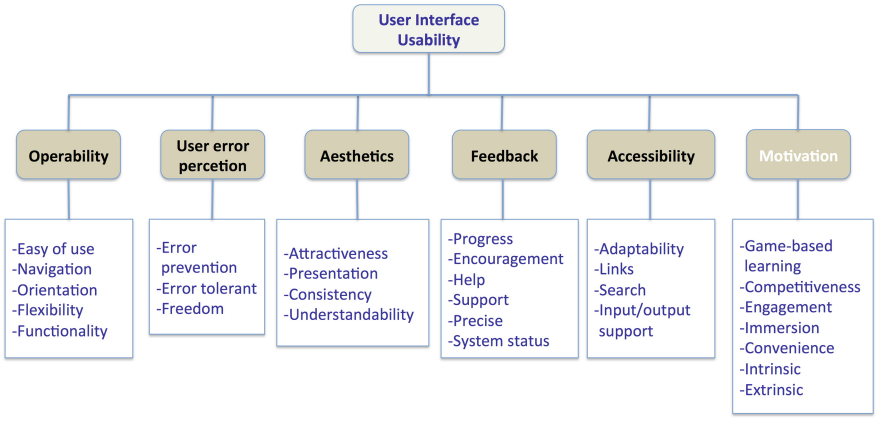

Fig. 2. Factors in User Interface Usability

obtained related to this dimension are shown by mean bar and radar chart. Moreover, some indicators of the reliability of the tests (or measurements) are calculated. For example, in this case it is shown that the *Cronbach's alpha* is calculated (see frame above the questionnaire).

However, our aim in this paper is also focused on the description of how this framework is integrated with CIAM, especially with its process model. Therefore, in the next section this approach is described.

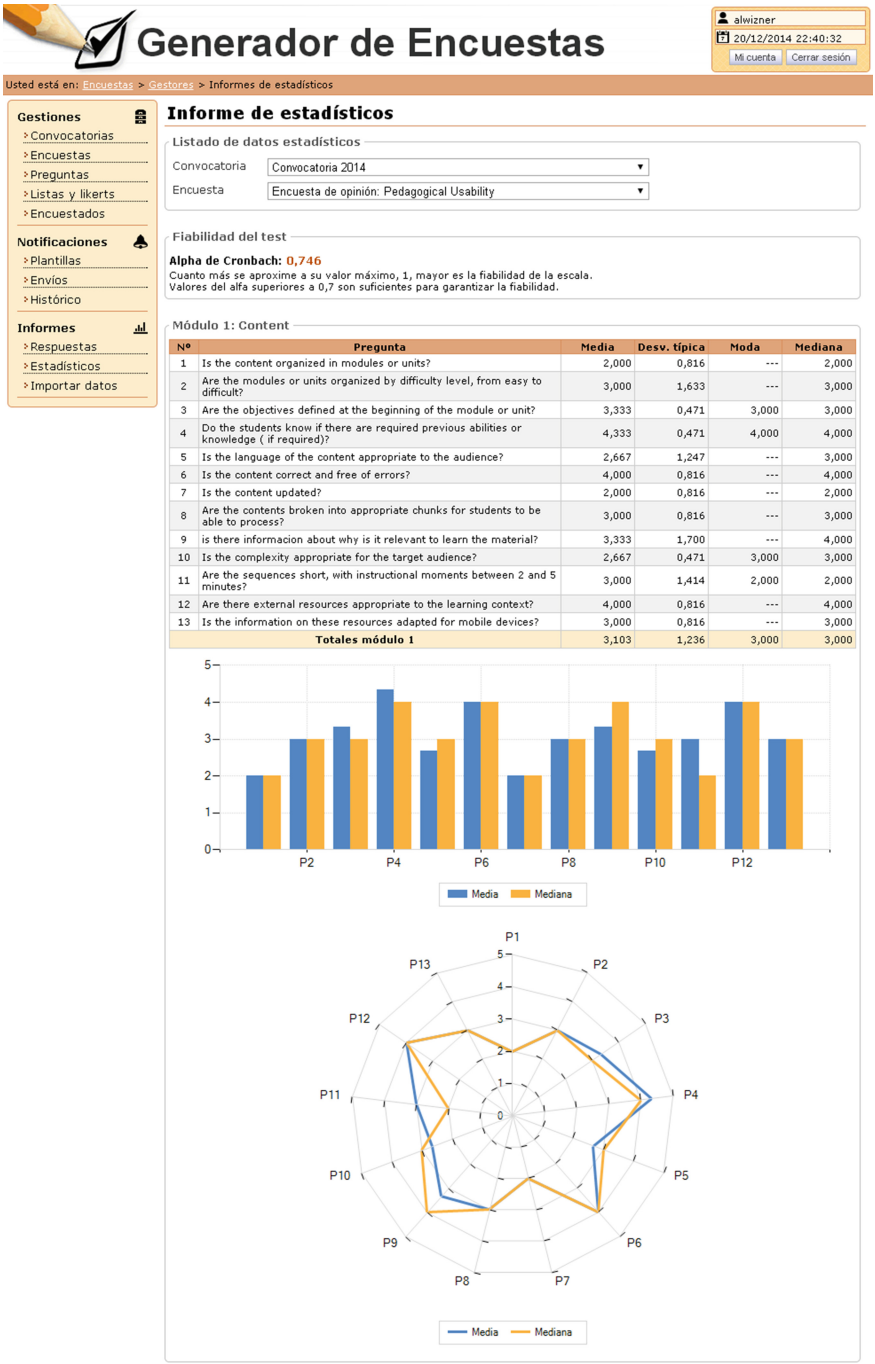

Fig. 3. Partial screenshot of the user interface of the tool for applying the proposed design and evaluation framework (some texts are in Spanish)

3.2 Extending the Process Model of CIAM

Figure 4 shows a diagram of the process model and stages of CIAM methodology. In this diagram there are six types of elements:

1. Processes (elliptical shapes), such as *Process Modeling* and *Responsibilities Modeling*.
2. Artifacts (rounded square shapes) that are produced by the processes (i.e. *Participation Table*).
3. External processes, such as the GUI Design stage, that represents a *model-based user interface design process* (MBUID), like the one supported by the CIAT-GUI tool [6].
4. Arrows connecting processes and artifacts.
5. Gateways that represent joint and synchronization points.
6. Sheets for evaluation of Pedagogical Usability requirements (B) and User Interface Usability requirements (A). These elements are part of our new proposal of extension of CIAM.

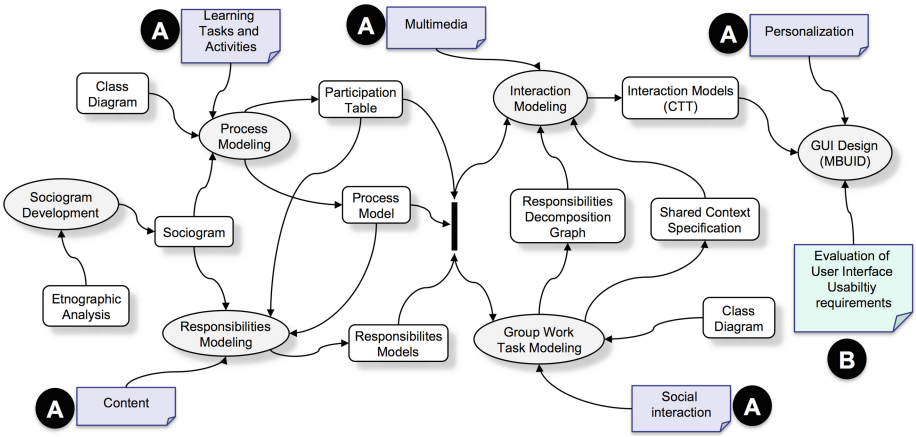

Fig. 4. Process model of CIAM including elements of the design and evaluation framework for m-Learning

CIAM is organized into several stages. In each of them several collaborative and interactive systems issues are specified. The *Sociogram Development* stage allows for the specification of the social context in which the work in-group will be developed (roles, actors, work teams, etc.). The following two stages allow for the specification of the tasks of greater level of abstraction to be performed by the group (*Responsibilities Modeling*) and the temporal and data dependencies that exist among them (*Process Modeling*). In the *Group Work Task Modeling* stage the collaborative and cooperative tasks identified in previous stages are specified in a differentiated way and with a greater level of detail. The collaborative tasks specification is based on the *shared context* definition [17]. In the *Interaction Modeling* stage the interactive tasks to be supported

by the application user interface to develop are specified. For this, the CTT [18] notation is used. An interactive task tree will be created for each individual task or individual responsibility and for each work in-group task. In the case of collaborative tasks the interaction model is obtained from the shared context definition.

Regarding the framework of design of evaluation of m-Learning, the dimensions of *Pedagogical Usability* are spread across the most of stages of CIAM. However, the dimensions of *User Interface Usability* are focused on the *GUI Design* stage because it is applied to the artifacts managed by the process of model-based user interface design (MBUID) that is developed in this stage.

We think the main improvement obtained by integrating our proposed framework within CIAM is that pedagogical aspects can be considered during the modeling process. This feature is not taken into account by other proposals for collaborative systems design, especially in m-Learning contexts.

4 Concluding Remarks and Future Work

In this paper, we address the problem of improving CIAM methodology in order to support design, modeling and evaluation of interactive and collaborative mobile applications, especially for m-Learning.

The applying of a framework for design and evaluation of m-Learning applications with has been proposed with special attention to collaborative activities. As a consequence, the dimensions and criteria of this framework that can be incorporated into the process model of CIAM have been described.

Currently, there are tools that support the CIAM processes and the final semi-automatic obtaining of the user interface of a modeled application. Furthermore, there is a tool to apply the design and evaluation framework for assessing of *Pedagogical Usability* and *User Interface Usability* dimensions in m-Learning applications. In future work, we plan to integrate these tools in a single platform supporting the whole of the extended version of CIAM.

Finally, we plan to apply our approach to previous designs of m-Learning applications developed with the initial version of CIAM. Thus, the advantages that this approach provides will be highlighted.

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