PACO - A Framework for Planning Learning Activities Supported by Computers

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Abstract. *Many computer tools have been developed to be used in learning activities. However, the effective use of these resources depends on the teachers' decisions, therefore, it is necessary to assist teachers in the planning of learning activities. This paper presents PACO - a framework for Planning learning Activities supported by COmputers. The essence of PACO is that the design of activities and the choice of computer tools should be addressed by Pedagogical aspects and characteristics of the target-students.*

1. Introduction

For an efficient process of e-learning supported by computers it is necessary to develop computer tools as forums, chats, whiteboards, collaborative editors etc. to promote communication and collaboration, among teacher, students and communities, and to be used in different devices as desktops, cell phones and also low-cost laptops. The effective use of these resources depends on decisions that teachers should make while planning a learning activity. However, the learning activity planning process is not trivial. Even teachers that are motivated to execute a learning activity face the question "where should I start?", and many times they give up and do not execute a learning activity supported by computers. Thus, it is necessary to help teachers to plan learning activities.

Although some models to help teachers in the use of computers in learning activities have been specified in literature, they limit teachers' participation considering a specific view of the learning process [Edelson, 2000], being dependent of technological solutions [Bianco *et al.*, 2002], or even do not consider a structural support [Chang *et al.*, 2003]. It is necessary to guide teachers in the process of planning learning activities supported by computers, but giving them liberty for taking decisions, being a flexible framework that is independent of a specific pedagogical model and technological support.

This paper presents PACO - a framework[1] for **P**lanning learning **A**ctivities supported by **CO**mputers. The essence of PACO is that the choice of what activities will be done and which computer tools to use should be addressed by Pedagogical

[1] Framework is defined in Cambridge Dictionary as: 1 -a supporting structure around which something can be built; 2-a system of rules, ideas or beliefs that is used to plan or decide something. In Computer Science, a framework is understood as a supporting structure where a software project can be organized and developed. PACO is a supporting structure around which learning activities can be built and also it is a system of rules or beliefs that guides teachers during the learning activities planning.

aspects and characteristics of the target-students. PACO were already used by teachers in different areas as computer science, nursing and occupational therapy, without previous knowledge in learning activities supported by computers. This paper is divided as follows: section 2 presents PACO, its 7 steps and examples; section 3 discusses the results obtained in case studies, section 4 presents a prototype tool to support the planning of learning activities based on PACO and in section 5 some conclusions and future works are presented.

2. PACO Framework-Planning learning Activities supported by COmputers

PACO is a seven-step framework that guides teachers during the planning of learning activities supported by computers. The essence of PACO is that the design of activities and the choice of computer tools should be addressed by pedagogical aspects and target-students characteristics. The planning process starts by clarifying the theme that will be taught, the target-students and the main goals. Then, teachers should organize the theme and choose the pedagogical support - which are considered very important steps. Guiding in the development of learning material and tests are also supplied. The seven steps are presented following and the artifacts obtained from a learning activity, planned and done with nursing students, are shown as example.

Step 1 – Choose the theme, target public and general goal

To start planning a learning activity, it is really important to know the profile of the target public and what are the students' expectations about the course. If the theme is developed in a way that meets the students' expectations, in general, better results are obtained in the teaching and learning process. Even when the theme is already decided, it is possible to adjust the way it will be worked, considering such profile.

After this reflection about the public and the theme, it is time to define the general goal of the activity. The general goal is also important, because during the planning, teachers will have to take decisions and so, if the general goal is clear it will be easier to see which option is better. Figure 1 illustrates an example.

Theme: Environmental Comfort in the Elderly Personal Space

Target Public: Senior nursing students. No previous experience with e-learning activities.

General Goal: Complement the nursing students' basic knowledge, presenting some notions about environmental comfort adjusted for elderly, so these students will be able to better orient people that take care of old people about simple and cheap solutions that propitiate comfort at home.

Figure 1. Example of an artifact resulting from step 1

Step 2 – Theme Organization

Step 2 is about the activity summary. Teachers should define the topics and in what order they will be worked and in what detail degree (there are some cases where the summary is already defined by an external agent like university or school; but even though, many times it is possible to reorganize the topics).

Teachers can use some techniques that help to choose topics and to establish relations between them. One of these techniques is Conceptual Maps [Ausubel, 1968; Novak, 1977]. According to Ausubel, better results appear in learning process when a

person consciously and explicitly establishes links between the new knowledge and the relevant concepts that s/he already knows. Ausubel says that significant learning occurs when a series of changes is produced in a person's mind cognitive structure, modifying the existing concepts and forming new links. Based on the concept of significant learning, Novak (1977) made a representation for the conceptual maps, using a structure that goes from the more generic to the more specific concepts. This representation is used to help the ordering and hierarchical sequencing of the learning contents, aiming to offer adequate stimulus to students. Summarily, the steps to divide the learning content to form a conceptual map are: (1) Identify the main themes; (2) Identify the general concepts, intermediate and the specific ones; (3) Make the links between the concepts and (4) Label the links [Almeida *et al.*, 2005].

Figure 2 illustrates part of the Conceptual Map done for the Environmental Comfort in the Elderly Personal Space learning activity. Using Conceptual Maps, the course was divided in four modules. It can be noticed in Figure 2 the concepts organized hierarchically, having the abstracts concepts in the top and the specific ones subordinate to them in the hierarchy lower levels. Moreover, the concepts are linked to each other and the links are labeled with specific descriptions ("present and discuss", "consider" and "student should") as it is proposed by Novak (1977).

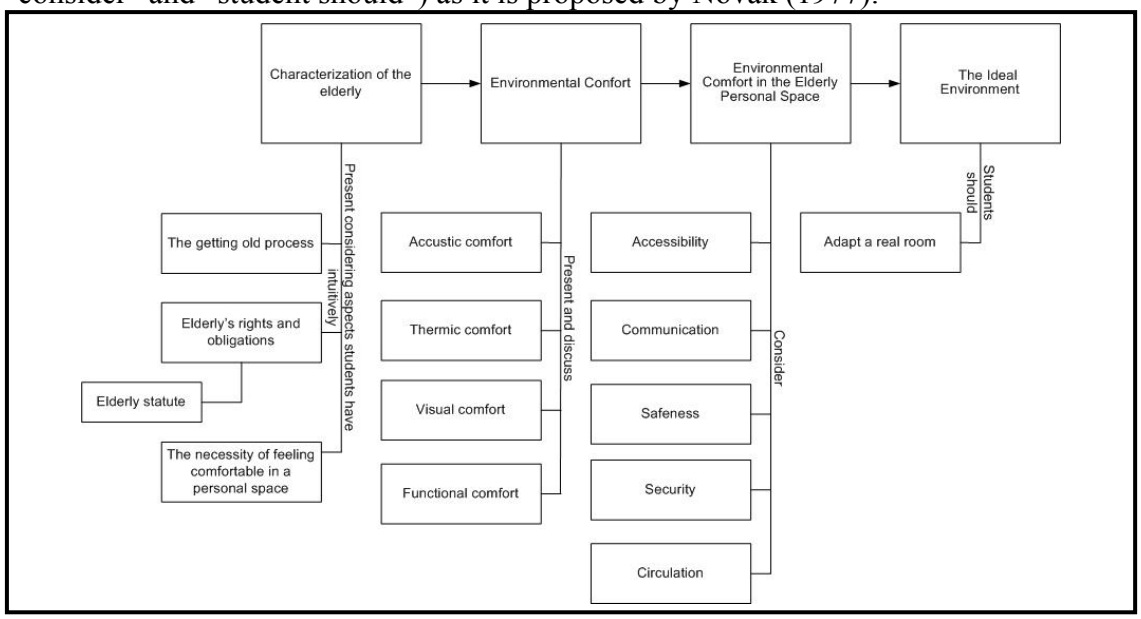

Figure 2. Part of the Conceptual Map for the Environmental Comfort in the Elderly Personal Space learning activity

Better results are obtained if warm-up activities not related to the main topic of the course (like a chat for people to know each other before starting the course) to promote interaction among people and computers are done. If technological problems happen or even if people get lost, they will not loose any important information.

The summary of the Environmental Comfort in the Elderly Personal Space learning activity was also completed with two sections: (1) "Go far", in which the students can find references and suggestions to complete the knowledge presented in the learning activity, and (2) "Next Steps" that allows students to be all the time conscious about the learning process status.

Step 3 – Choose a Pedagogical/Methodological Reference

As learning activities are considered in an educational context, it is extremely important that a pedagogical reference is chosen. This reference will guide the whole activities planning and also the learning material edition. It is important to stand out that the choice of the methodological and pedagogical reference does not depend on the technique used for detailing the summary. At the end of the step 2, teachers should have the topics that will be worked, so it is time to choose a pedagogical reference that will specify how to work on the topics. No matter what pedagogical reference is chosen (Behaviorism, Cognitivism, Collaborationism, Constructivism, Constructionism, see [Webb et al., 2004]), it is observed that better results can be obtained when a student does activities in which there is interaction with other students and gets involved in practical activities in which s/he can use theoretical concepts that were learned during the course. In the Environmental Comfort in the Elderly Personal Space learning activity, Gagne (1974) is the reference.

Step 4 – Planning Learning Activities

The activities should work on the topics defined in step 2 and agree with the pedagogical reference that was adopted in step 3. It is important to stand out that a same theme can be worked in different ways depending on the adopted pedagogical reference. So, considering the adopted reference, if at the end of the topic it is expected that students should be able to construct the knowledge, the activities should be proposed in such a way that students can realize the links among the concepts and construct a new knowledge structure. In the same way, according to the adopted pedagogical reference, if the concepts should be better worked by students before being storage in their long-term memory, the activities that allow concepts to stay more time in the short-term memory should be planned. So, it is important to clearly understand that the adopted pedagogical reference has to be followed up from the beginning until the end of the activities planning.

In the case of the Environmental Comfort in the Elderly Personal Space learning activity, to better reflect how the Gagne's events could be contemplated, or which activities should be planned in order to make possible the event occurrence, it was important to clarify the pedagogical target of the learning activity. The students should learn basic notions about the environmental comfort in the personal space of elderly. In this context, it is important that students learn concepts related to environmental comfort and the elderly needs, so they will be capable to develop intellectual abilities to generate more complex rules about environmental comfort in the personal space of elderly. The learning activity was divided in four modules. Table 1 illustrates the table with activities planned for module 1. In the first column, lie the eight learning events proposed by Gagné (1974), followed by the theoretical reference in column 2, which describes each event pedagogical goals. Finally, column 3 present the activities proposed by the teachers, in order to reach the pedagogical goals.

Some refinements of activities were done, thinking about the support material and computer tools that would be used. One table was generated with refined activities for each of the four modules. Table 2 is an example of the refined activities for module 1, where the refined activities and classification (G-group or I-individual) are presented.

Table 1. General activities for module 1

Instructional Events from Gagné	Theoretical Reference	General Activities
1. Active motivation	Active motivation pointing interesting topics to students, relating them with other important objectives in the same knowledge area.	Show why to know the elderly characteristics is important. List other nursing areas that use the elderly characteristics.
2. Tell the objective to student	Tell students the objectives and expected results.	Remember students about the module objectives and which tasks should be done.
3. Drive attention	Drive attention to relevant stimulus that be comprising the task	Show the well-being in family and the importance of the elderly.
4. Stimulate recollection	Recollect subordinate rules and concepts that are relevant to form the new rule.	List elderly characteristics and needs the students intuitively know. Start a collaborative construction of a document about the items identified.
5. Provide orientation to the learning	Use tracks that help students to form the new rule	A tutor should guide discussions about elderly characteristics and needs
6. Intensify the retention	The probability to retention increases by the time the process is repeated.	Read a text about elderly characteristics and needs. End the collaborative construction of the document about the items identified.
7. Promote learning transfer	Use knowledge in other contexts. The students should give the same answer or modified answers according to the new circumstances.	Read and discuss about the statute of the aged one. Indicate other references about the theme – section "Go far".
8. Provoke performance and supply feedback	Students should be called to show that can apply the acquired knowledge and should receive feedback.	Teacher should give feedback about the generated document elderly characteristics and needs. When students post comments about reading, the teacher should comment if another student hasn't done that.

Step 5 – Choose computer tools to support the activities execution

Once activities were defined, it is time to choose computer tools that will support their execution. The choice of the tools should consider the students' profile, the activity pedagogical goal, as well issues about technology and time. While considering the students profile, teachers should take into account their psychic, motor and social-cultural characteristics. For example, it is not viable to plan a text chat to students that cannot read or even choose tools that demand high computing efforts (like video streaming) if the students have old computers (like a 128 RAM memory PC) or low speed net (like a dial internet access). Otherwise, these characteristics should not make the execution of activities impossible. Teachers should only consider them and choose the more appropriated tool. Also, the pedagogical goal influences the choices. If the activity needs an immediate feedback, it is more interesting to use synchronous tools. Technological issues also influence once each tool has its purpose and peculiarity. So, it is necessary to have some knowledge about the computer tools that are available.

Table 2. Refined activities for module 1.

Activities	G/I
1.1 Knowing the group – The first contact with the classmates.	G
1.2 Summary presentation	G
1.3 Identifying the elderly characteristics and needs	G
1.4 Finishing the characterization – reading a text	I
1.5 Finishing the characterization – Relevant points	I
1.6 Reading the Elderly Statute interesting points	I
1.7 Discussion the Elderly Statute interesting points	G

1.8 Reading a text about well-being	I
1.9 Discussion about the well-being	G

Time is another item that has to be considered while selecting tools. Typically, the activities have a certain period to occur and students are asked to dedicate some time for that. These hours should be respected. So, it is necessary to consider the time for interaction with the tool while planning to use it. The result of the step 4 can be a table with the tools selected and the time planned for the activities. Table 3 illustrates the results obtained for the module 1 (where G – group, I – Individual).

Table 3. Computer tools to support activities.

Activities	G/I	Time	Tools	Support material
1.1 Knowing the group – The first contact with the classmates.	G	15 min	Chat	Identification cards
1.2 Summary presentation	G	15 min	Chat Portfolio	Summary
1.3 Identifying the elderly cha racteristics and needs	G	30 min	Collaborative editor	
1.4 Finishing the characterization – reading a text	I	45 min	Portfolio Forum	Text– How is to be old?
1.5 Finishing the characterization – Relevant points	I	15 min	Collaborative editor	
1.6 Reading the Elderly Statute interesting points	I	45 min	Portfolio	Text – Elderly Statute
1.7 Discussion the Elderly Statute interesting points	G	30 min	Chat	
1.8 Reading a text about well-being	I	30 min	Portfolio	Text – Well-being in a personal space
1.9 Discussion about the well-being	G	15 min	Forum	

Step 6 – Learning Objects Edition

Learning objects can be hyper documents, images, texts, videos, games, virtual environments, experiments to be done in remote access labs and so on. The learning objects that will be developed in this step were already defined in the previous step of PACO. Especially for teachers that are not familiar with computers; the re-use of learning objects already done is a great opportunity. Actually it is possible to find repositories where teachers can find different types of learning objects, as videos, images, virtual environments and others, and also learning objects about really different subjects [ARIADNE, 2007; MIT,2007; Apple, 2007]. There are general repositories, covering different subjects, and also those that offer learning objects about only a subject (more examples, see [LOC, 2007]).

Also, if a teacher does not find a learning object about the subject s/he wants, this teacher can also develop his/her own learning object. The development of learning objects for e-learning involves a multidisciplinary team. However, because of economical restrictions, some times it is not possible to have this team. So researches from different areas study how to help teachers to develop content using colors [Buchdid *et al.*, 2005], techniques to organize content [Neris *et al.*, 2005], databases with relevant information [Anacleto *et al.*, 2006], tools for edition [Webb *et al.*, 2004].

For the Environmental Comfort in the Elderly Personal Space learning activity, we used some news articles and papers available on the Internet and also developed a hyper document about the basic notions on Environmental Comfort. The hyper document was developed using Cognitor – a tool for editing of hyper document for education that considers some cognitive operators [Talarico *et al.*, 2006]. The use of

cognitive operators in hyper documents reflects a concern about how to facilitate the information understanding and knowledge keeping. Further Almeida's studies (2005) suggest that the use of these operators enhance the usability of hyper documents. Figure 3 illustrates part of the hyper document developed and some operators considered.

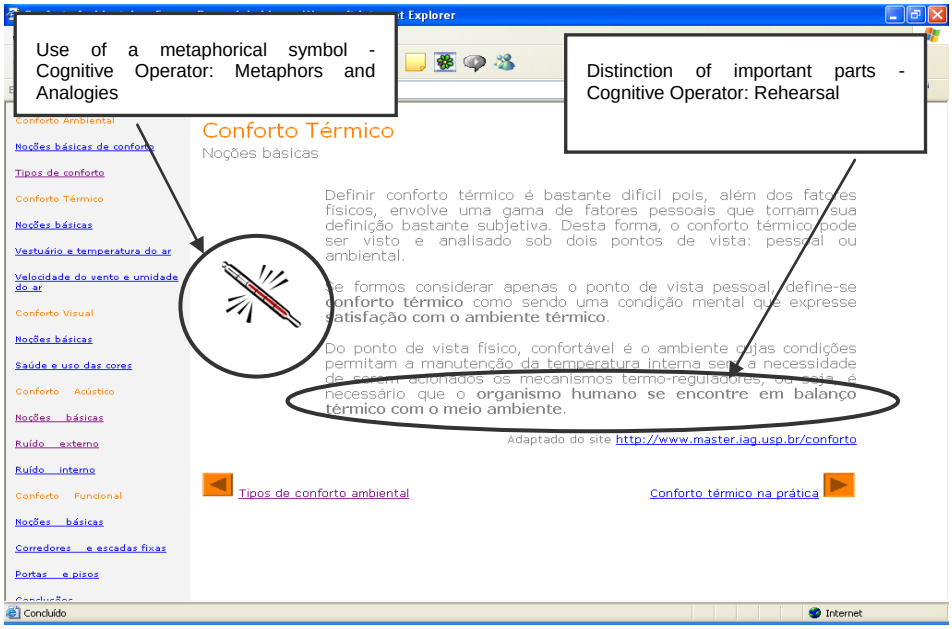

Figure 3.Part of the Hyper document for the Environmental Comfort in the Elderly Personal Space learning activity

Step 7 – Test – Pedagogical and Technological Aspects

Once the learning material has been developed, it is necessary to test everything, pedagogical and technological aspects. Pedagogical tests include verifying if all the set is adjusted to what you have defined in step 1. Teachers should verify if the activities proposed reach the objective of the course. Also it is necessary to evaluate if the computational tools are in accordance with the abilities of the target public. Here, evaluate previous experiences in literature and do tests with students can help. Some tests can be done as warm up activities considering other subjects different from the main theme. It must also be evaluated if the total time is not bigger than what was planned. Teachers not familiar with learning activities supported by computers can have difficulties in setting time for each activity. Tests and experience help to adjust time.

Technological tests include verify if computer tools are working properly. If a chat session was planned, verify if a student can post his/her opinion. Test if files can be downloaded correctly, if there are no broken links, if all students are registered. If a game will be used, test if pre-conditions are necessary. Remember to clarify to students which computational resources (memory, net speed) are necessary or suggested to execute the activity. However, even testing everything before some problems can happen during the activity execution, especially about technical aspects. If the activity demands Internet connection, sometimes the service can not be available. Think about a second plan is also necessary.

For the Environmental Comfort in the Elderly Personal Space learning activity, although we have tested chat sections, whiteboard and other computer tools, during

execution, we had problems with the whiteboard tool. In the last module, students should present their final projects using the whiteboard. Each student would have 15 minutes to present it and all the other students and teachers would participate in the section. However, the whiteboard tool was not working properly. We asked students to post their projects at portfolio tool and discussed the projects by a chat session.

3. PACO in Use

PACO was first used by 12 Computer Science master students that had to plan learning activities for the first time. For each of the steps, the master students answered a questionnaire, where they related: the sub-activities they had to do and the time spent in each of them to conclude a step of PACO; the doubts they had during that part of planning and if the doubt was answered by PACO. Also, they classified the transition from one step to the next, as without noise, with little noise, or much noise; they also classified how they were feeling to go to the next step, as really confident, not so confident and no confident at all. After the analysis with the Master students, teachers from Computer Science, Nursing and Occupational Theory also used the framework proposed here. Computer Science teachers used PACO to plan classes for post-graduate students. Nursing teachers used PACO to plan learning activities to under-graduate students. Once, the learning activity developed by Occupational Therapy teachers was about Daily Activities and the Promotion of Babies' Development. This last activity was performed by 110 people that work at daycare schools.

Another case study using PACO was performed in a partnership between researchers from the Nursing Department and the Computer Department of the Federal University of São Carlos [Anacleto *et al.*, 2006]. The results suggest that teachers felt more secure knowing how to start and also what they should do next. All of them could plan learning activities although they have never had any experience like that before. Also results show that PACO can be used to plan learning activities that will be performed by students from regular courses or even by people from community.

4. Computational support based on PACO

In order to help teachers in planning learning activities according to the PACO's approach, a computational support is under development. It consists in a seven-step assistant which asks questions to teachers, related to the issues which might be defined in each step of the framework, in order to guide them towards the framework's artifacts building. Figure 4 presents the computational support's first step user interface, which is related to the target group's profile definition. In this interface, teachers might answer questions about the target group's age, gender, geographical location and special interest. Furthermore, teachers provide information about which knowledge is pre-requisite to students participate in the learning activity. More details about the computational support can be found in [Carvalho, 2007].

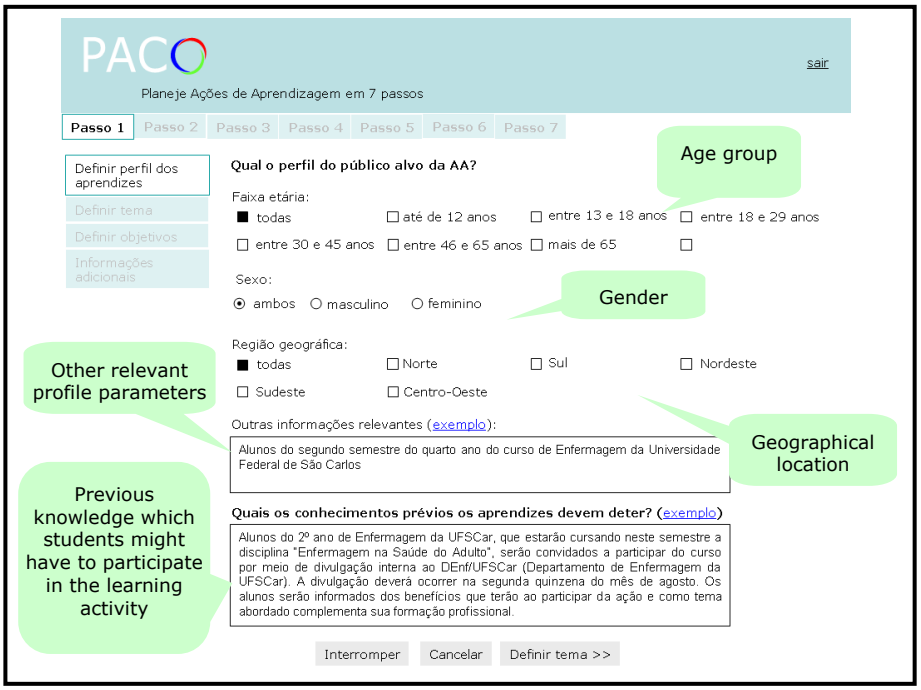

Figure 4.Computational support for PACO – First step – Defining the target group's profile

5. Conclusions

This paper presented PACO - a seven-step framework that intend to help teachers to plan learning activities supported by computers from the definition of the target public and general objective to the final tests using pedagogical aspects. PACO guides teachers showing what to do. More specific questions about how to do are generally answered by the pedagogical approach that will be chosen. Teachers from different areas have already used PACO to plan and execute learning activities and reported they felt more confident using the framework to execute that task. Also, the case studies showed that even those that have never planned learning activities felt that they could do that, and did! It is expected that this framework can help other teachers to plan learning activities that can be executed using the most different computer devices and for students from different ages and regions, with different profiles, and also community in general. It is expected that this work will contribute to digital inclusion, helping teacher in the challenge of converge technology and pedagogy. Other learning activities will be planned and the computational support will be improved.

Acknowledgment - Authors thank all the teachers and students involved in the case studies and FAPESP (proc. 03/08276-3, 05/60799-6, 05/60799-6 and 06/52412-7) and CAPES for the financial support.

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