Mobile Learning with Patterns

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Abstract

The identification and construction of patterns play a fundamental role in learning, but to date design patterns have been used for communication between professionals, rather than for learning purposes. We adapt the design pattern approach and develop software for mobile and other touch-sensitive devices in order to support design students to learn with patterns. We describe the multi-platform system and its gesture-based interaction for formal and informal environments, and present some application scenarios.

1. Introduction on patterns

Even though patterns play a significant role in the development of cognitive and design skills, they have rarely been systematically applied to support the development of such skills. Here we intend to take the first steps in that direction by looking at the role patterns play in various disciplines and presenting a mobile pattern collection system that helps students to communicate and learn about design in general.

Patterns are recurring models. The concept is based on a distinction between a set of phenomena exhibiting a pattern and an underlying model that can be inferred by analyzing its constitutive features. This is known as "pattern recognition," and is studied in computer science as well as in cognitive psychology.

Recognizing affective, social and communicative patterns and organizing perceptions into meaningful categories is one of the most fundamental aspects in even the earliest learning experiences. Developmental psychology shows evidence that early patterns of affect signaling and culturally mediated types of mother-child interaction lead to the core capacities of pattern-recognition, joint attention and intention reading. As preconditions for cognitive and language development these capacities then lead to the ability to speak and think logically and creatively [6], representing a fundamental aspect of various learning activities.

While other disciplines such as natural sciences and mathematics, and various design disciplines also work with concepts of patterns, the use of the term varies from field to field. Art has been described as "the imposing of a pattern on experience and our aesthetic enjoyment is recognition of the pattern" (Whitehead 1943), stressing that patterns are not predetermined by a perceptual, cognitive or computer system, but they are open for conscious construction and discussion. In order to provide a common format for such discussion, architect Alexander [1] proposed a notation for patterns and their compilation into networks or "pattern languages". Each pattern is made up from the same set components like name of the pattern, description of the problem it solves, solution, example and relations.

Within a range of creative and design disciplines, architecture, software development [5], interaction design [2] and education [11], his approach has been adopted in order to reason about and document reusable best practices. Even though Alexander had envisioned design patterns also as means to negotiate design problems and potential solutions with an engaged public, the participatory aspect was usually dropped with pattern collections becoming a complex tool for professionals for proposing, refining, evaluating and applying patterns.

Taking into consideration the fundamental role of patterns in various learning activities, we propose to make the identification – in terms of recognition and construction – and application of "design patterns" not only available for user participation, but also for learners of different design disciplines. In order to do so, we define a simple workflow and interaction design for mobile phones and other touch screen devices that allow students to communicate and learn about design solutions in both formal and informal settings.

2. Previous work

Mobile devices establish new opportunities for learning in the context of constructivist, collaborative

and situated learning theories by making it possible to collect data "in the wild", to work collaboratively, and to exploit location awareness [10]. In addition to supporting individual tasks such as note-taking, scheduling, address storage, etc., handheld devices can build ad-hoc wireless peer-to-peer networks and support collaborative face-to-face applications anywhere [9]. However, their reduced screen size and the necessary use of virtual keyboards or widgets for entering and handling information, introduce new complexities to the user-device interaction [4]. In order to overcome these problems, we propose the system's interface be based exclusively on sketching and gestures, minimizing the use of virtual keyboard and widgets. Sketching is a powerful means for supporting interpersonal communication [13, 7]. Face-to-face communication may involve the use of diagrams and drawings in a way that enables users to share views while they talk to each other. This process avoids ambiguities and helps to communicate new and complex ideas swiftly [8, 12]. With sketching, only a minimum of verbal exchange among those working on a design is required to achieve a common and fluid communication channel [8, 9, and 12]. Gestures can combine in one action a command and its arguments, thus avoiding errors. An interaction based exclusively on gestures, avoiding the use of widgets and virtual keyboard maximizes the available working space. Therefore, the patterns will primarily consist of free hand-writing input. Although free handwritten text may take more space than typed text, it allows a flexible combination of sketching and writing.

In some of our previous works we developed software for interactive whiteboards and pen-tablets in the classroom and for PDAs in order to provide a consistent interaction framework across formal and informal learning environments [3, 14]. Following up on this previous work on touch-sensitive devices for formal and informal learning environments, the new mobile system provides:

- An open space for construction across devices
- A common format for documentation and communication.
- Flexibility for the teacher to define increasing levels of complexity for user progressing from novice to advanced and professional.
- An easy to use interface across devices that allows students to concentrate on learning tasks.

The system supports students as they explore potential patterns in their natural surroundings. Documenting and elaborating upon patterns, establishing links to related patterns and communicating them to their classmates naturally imposes the requirement of mobility.

3. Workflow and scenario

A class based on learning with patterns may start with the teacher giving an introduction into the design pattern approach, the structure of patterns and the creation of pattern languages within the respective field, in this case architecture. The teacher then gives a topic like entrances and exits and asks the students to collect examples of the best practices in the city. Students then explore their neighborhoods, taking pictures of felicitous examples of door design, with the functional and aesthetic context of the door, the door itself and its component details. In the field or at home they reflect upon why they find an example a suitable solution to the question of providing easy leave and access, and document what they found within the given categories. In the field or at home they may exchange and debate with peers for or against the patterns they want to propose and the examples they had found. Each pattern proposition is reviewed by two peers. Back in the classroom, they present their patterns on the whiteboard, and, moderated by the teacher, they evaluate their propositions and discuss the hierarchy, its distinctive levels, and the relations between the patterns they intend to work with in order to create their own pattern language. Design and architecture students would then go on to apply their own patterns by building models that represent ideal representations of these patterns and pattern languages for a specific context. In the end, they will not only have learned how to extract and work with patterns, but will have also addressed critical issues and trade-offs in designing entrances and exits. In an advanced scenario, students collect examples of people appropriating and modifying the architecture they live in (as illustrated below) and reflect upon the question of how these appropriations may provide inspiration to designing physical constructions more flexible or adequate to the needs of inhabitants.

Figure 1. **Application Scenario Illustration**

In an application scenario a student notices an interesting case of appropriation, takes a picture (a), and adds her notes to create a pattern proposition. She sends her rough pattern proposition to a friend for comments on a PC (b). In class her observations are presented and discussed on the whiteboard (c).

4. Implementation of the pattern collector

In order to support such activities we implemented a new system over our already existing platform, which supports the development of collaborative mobile applications with interfaces based on gestures [3]. This platform takes care of the recognition of the gestures, the discovery of partners in an ad-hoc mobile network and the synchronization of the information that is shared among them. The use of this platform allows the developer to concentrate on the implementation of the functionalities which are particular to the application being developed. In this case these are: creation of new patterns, browsing, editing, linking, comparing and sharing. As working with patterns is supposed to take place both inside and outside the classroom, it is expected that the application will be used with a number of different touch-sensitive devices like PDAs, Tablet-PC and electronic whiteboards. The application adapts the size of the user interface to the available screen; however, most of the functions (including gestures) remain the same in order to have a consistent interaction model.

4.1 Creation of patterns

Using PDAs or Tablet-PCs, the teacher creates a first a list of the components a pattern will have, defining a template in order to pass to the students (see "sharing patterns" in this section). In order to create a pattern, a user draws two lines of a rectangle in one stroke. This gesture is recognized by the system and a complete rectangle will appear on that place representing the new pattern (see figure 2a). Double-clicking on the rectangle the system enters into the mode where the components of the pattern are defined. In order to remain consistent with the requirement of an easy to use interface based on gestures and sketching the way to specify the content of a components are: a) hand-written text b) sketching, c) images (or icons) from a file, d) typed text entered with the virtual keyboard or the built-in text recognizer of PDA or Tablet-PC). For ending the addition of the component a horizontal line should be drawn at the bottom. Before starting the addition of the next component the name of the already created should be selected from the list the teacher has provided. For this, the user has to double-click on the grey line on the right border of the screen (see figure 2b). This will show the list of the components labels already created. One of them should be selected (Figure 2c). For the editing the content of a component gestures are used in order to select, delete and move content as well as for performing do and undo functions. These features are

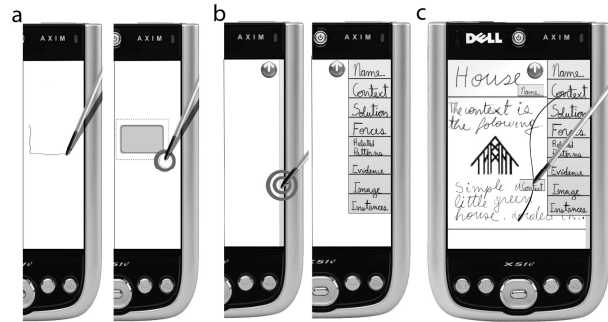inherited from the platform used to program this application [14].

Figure 2. Creating a pattern and editing content.

4.2 Actions on an existing pattern

After a pattern has been created, following actions can be executed on them:

Browse and modify the pattern: A pattern is presented as a column of (graphic) elements separated by a horizontal line. The elements can be browsed with a scrolling function (see figure 3a). An icon containing the name of the element is displayed at the bottom-right corner. By clicking on this icon the element can be modified. A pattern can be modified by its author or group of authors. If the teacher specifies a pattern it can be browsed, but not edited, by the students.

"Cloning" patterns: Students record their findings and create new patterns. For this, they take the original template defined by the teacher and create "clones" of them which will inherit the structure. They can add or modify descriptions of its components. A user can create clones of patterns by clicking on the respective icon when browsing an already created pattern.

Instantiating patterns: Instantiations of certain pattern will consist of photographs or handmade sketches of a certain object found which complies with the pattern definition. An instantiation is created by clicking on the respective icon while browsing the pattern. A pattern template will display the number of clones and instantiations with "buttons" attached to the pattern's node with an "I" for instantiations and a "C" for clones followed by the number of instantiations and clones respectively (see figure 3b). By clicking on these buttons, the nodes corresponding to the instantiations or clones are shown and can be browsed and edited.

Linking patterns: An essential aspect of working with patterns is to understand and to manage relations between them. The system supports this by allowing the definition of relations between two or more patterns. This is done by handwriting a line from a node identifying a pattern to the node of another. This

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relation will be "understood" by the system, creating a logical link between them for easing the navigation among linked nodes (see figure 4).
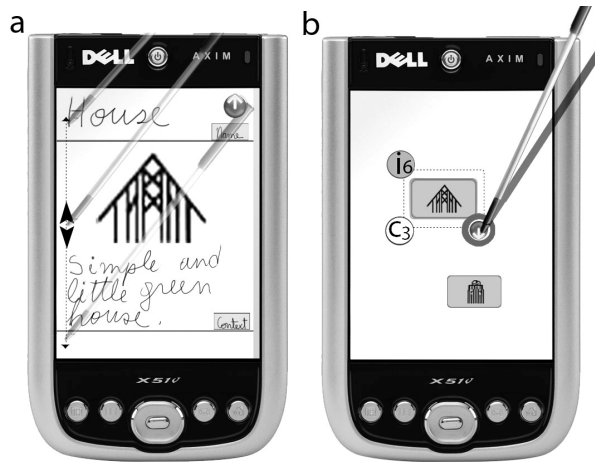

Figure 3: actions on a learning pattern

4.3 Sharing patterns

A key requirement for the system is that the information generated can be shared with others under the following circumstances:

- Teacher can distribute an initial pattern to the students so that they can search for instantiations and/or generate new ones based on them. Since each pattern is saved as separate file, this can be done by usual means over any available network.
- Students will additively synchronize the set of patterns they have if the patterns, instantiations and clones correspond to the ones distributed by the teacher as a single set. This will happen automatically every time two students' PDAs get connected by a wireless ad-hoc network (see Figure 3a, 3b and 3c).
- Students may also exchange patterns selectively and work collaboratively on the same pattern by synchronously editing it. This can be achieved by putting together the students' PDAs and activating the IRDA communication feature between them. This will create a common working area where they can edit the pattern synchronously.

4.4 Comparing pattern

Comparing patterns in order to highlight their differences and similarities is also an important part of the process of learning with patterns. In order to help users in this process, the system can show the components of selected patterns in parallel columns,

adjusting the width of each column to fit the total width of the screen of the device being used. Figure 5 illustrates this functionality for the case of three patterns being compared on a Tablet-PC. Scrolling as well as zoom-in and zoom-out functionalities are provided in order to help the visualization of the patterns.
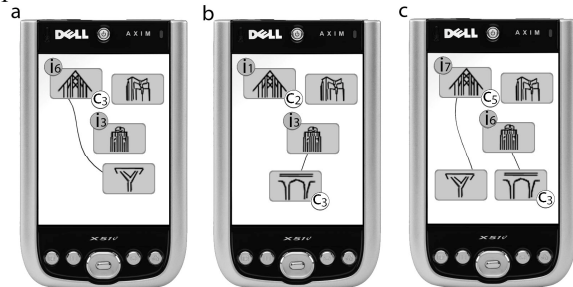

Figure 4: additive synchronizing of patterns, a) and b) show the content of two users before synchronizing, c) the content of both after the synchronization.

5. Working with PDAs, tablet-PCs and electronic whiteboards

As we already mentioned, the application supports work inside and outside the classroom. Outside the classroom, mobile devices are without doubt the best choice, but inside the classroom Tablet-PCs or even electronic boards will certainly be more useful, as they have more capabilities, bigger screens and mobility is not necessary. Instead of developing separate application for the different devices we opted for a solution in which the application adapts itself to the available screen size. The first solution would have given the possibility to better take advantage of the particular possibilities each device offers, but the latter helps to maintain the unity of human-computer interaction. This is especially important since there are gestures that have to be learnt and appropriated by the user. In this modality, the user has a single interaction model in all platforms. This also avoids possible data incompatibility problems between versions and makes the management of the source code easier.

The various actions described in the previous section are supposed to be performed in different scenarios and probably with different devices. The comparisons of different patterns or pattern instantiations will most probable take place in the classroom during a discussion and therefore, it might be done with an electronic board or a Tablet-PC. However the electronic board might be not suitable for the editions of new pattern templates. A Tablet-PC has the advantage of the built-in handwriting recognition. Its screen size makes it also suitable for the pattern comparison process. However Tablet-PCs are not

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inherently mobile devices and its screen size may hinder face-to-face contact. On the contrary, PDAs can be easily transported anywhere but their reduced screen makes them inappropriate for comparing patterns and the limited battery duration does not allow longer working sessions.
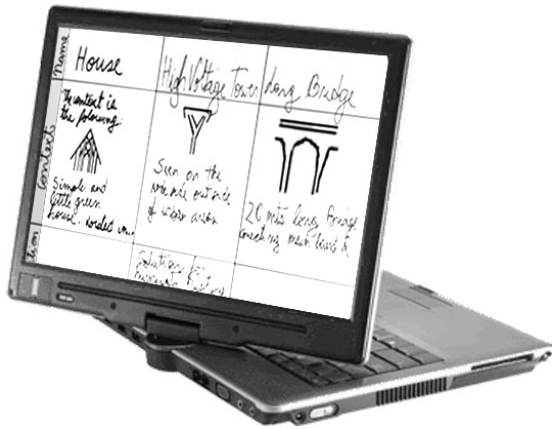

Figure 5: comparing instantiations of a pattern

6. Conclusions and extensions

In order to easily apply patterns within design-related learning activities we developed a mobile system to document design solutions within their natural environment and to discuss and work with them collaboratively.

Initial informal, formative evaluations of the individual gestures and the dynamic information architecture of the system have been conducted in order to ensure their usability. Within a controlled study we now intend to accompany two groups of architecture students that collect and discuss design patterns over the course of one semester, one working with pen and paper, the other working with our system for PDAs, their home PC, and with interactive whiteboards. Afterwards we ask for user feedback regarding acceptance and satisfaction and compare independent evaluations of a final exam.

Currently focusing on architecture the system could be adapted for design disciplines such as fashion, interface or industrial design. Enabling an integration of formal and informal activities future applications could even combine aspects of social computing and mobile strategy games with participatory approaches to large design projects, e.g. in urban planning.

7. References

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