Can Evaluation Patterns Enable End Users to Evaluate the Quality of an e-learning System? An Exploratory Study

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Abstract. This paper presents the results of an exploratory study whose main aim is to verify if the Pattern-Based (PB) inspection technique enables end users to perform reliable evaluation of e-learning systems in real work-related settings. The study involved 13 Polish and Italian participants, who did not have an HCI background, but used e-learning platforms for didactic and/or administrative purposes. The study revealed that the participants were able to effectively and efficiently apply the PB inspection technique with minimum effort. However, in some cases, participants complained that, in some cases, the technique appeared time demanding. This work provides some valuable suggestions to redesign the evaluation tools of the PB technique, in order to improve the focus on specific elements of the e-learning system and to streamline better the evaluation process.

Keywords: usability, inspection technique, exploratory study.

1 Introduction

Internet and the recent developments in information technology have provided huge opportunities for education making *e-learning* one of the most used means for long-term personal and business education. Thus, practitioners working to the development of e-learning systems are required to create software tools that are both able to engage learners and to support their learning. This means that, as for any interactive system, usability is a primary requirement.

Evaluation of e-learning systems deserves special attention and usability inspectors need effective evaluation methods, which can be easily applied with delivering reliable outcomes. Literature reports various studies comparing analytical approach with usability testing in order to establish which approach is better. The results are contradictory, especially related to the relative power of different evaluation techniques in terms of problem count, severity rating and time requirements. They suggest that different techniques have strengths and weaknesses, and therefore should be used in combination [1, 2, 3].

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In e-learning domain, analytical methods have been proved to be the most adopted evaluation approach [4, 5, 6, 7]. This is due to the fact that such methods are cost-saving: 1) they do not require the involvement of final users and special equipment or lab facilities; 2) experts can detect a wide range of problems of complex systems in a limited amount of time [8]. On the other hand, analytical approach highly depends on the inspectors' skills and experience, as heuristics are often generic and underspecified [9, 10].

To counteract this problem, there is a need to provide tools able to guide inspectors, even not expert in usability engineering, in performing evaluations with objective and reliable outcomes. An inspection technique, named *Pattern-Based Inspection* (PB inspection) has been proposed; it exploits a set of *Evaluation Patterns* (EPs) to systematically drive inspectors in their evaluation activities [11]. Studies carried out to demonstrate the validity of a such inspection technique confirmed the effectiveness of the patterns to evaluate interactive systems in different domains (e.g. multimedia [12], e-learning [11]). In particular, Lanzilotti et al. in [11] present the results of comparative study aimed at investigating whether patterns can help "novice" inspectors. The study demonstrated that patterns improved evaluation on a number of measurement qualities, including reliability, validity, effective range, design impact and cost. An important result was that patterns have the potential to reduce the dependency on the inspector's skills and experience, thus simplifying the inspection process for newcomers. The authors in [11] wrote: "An obvious limitation [of the study] regards the nature of the sample and the evaluation context. More research is needed to understand how these findings extend to real work-related settings."

This paper reports the results of an exploratory study performed in a real context in order to verify if and how the EPs help end users, who use e-learning platforms in their work but do not have an HCI background, in assessing the quality of such educational tools. The participants discovered the more serious usability problems of the platform. They were able to apply the method and to perform the inspection with minimum effort. They found the PB inspection easy to learn, efficient, pleasant and reliable, even if in some extent time demanding. Despite it was a small-scale study, it delivered a set of valuable improvement suggestions, useful for further refinement of the PB inspection technique.

The paper has the following organization. Section 2 illustrates the role of usability processes and methods within the software life cycle. Section 3 briefly illustrates the PB inspection. Section 4 reports the exploratory study and Section 5 closes the paper.

2 Usability in the Software Lifecycle

Nowadays, Information and Communication Technology is providing everybody with the possibility of interacting with software systems for accomplishing tasks of their daily working activities and/or for pure entertaining. As a consequence, current software systems must provide enhanced user interfaces that support users to achieve their goals with *effectiveness*, *efficiency* and *satisfaction* in their context of use. In other words, an interactive system should be *usable*. Thus, practitioners are required to develop user interfaces, whose quality is primarily evaluated from the users' point of view. Usability Engineering Methods (UEMs) have to be applied in order to allow practitioners to understand who will be the users of the software system, the tasks they need to accomplish, the context in which they work.

Although documented benefits of UEMs exist [3], practitioners devote scarce attention to it with the result that most software systems are very hard to use. Traditionally, practitioners are trained to judge software system by criteria, such as efficiency of code or flexibility of the programs, which have little to do with the users' needs. UEMs are applied only to a limited extent by practitioners, as shown in [14, 15, 16, 17, 18]. In particular, the results of a study we have carried out to understand how UEMs are addressed in current practices showed that still today too many companies neglect these important quality factors. Once again, the study confirmed that many companies complained that UEMs are very much resource demanding and that no methods suitable to companies' needs exist.

The gap between theory and practice has been studied by several researchers and several solutions have been suggested. In particular, Höök and Löwgren in [19] proposed a middle territory, called *intermediate-level knowledge,* in which the knowledge constructed through the interaction design practices exists. It is more abstracted than particular instances, yet does not aspire to the generality of a theory. This knowledge assumes different forms, such as guidelines, patterns, annotated portfolios, etc. The EPs, as they have been defined, can be considered a specific type of the intermediate-level knowledge, since they capture the knowledge of skilled inspectors and express it in a precise and understandable form so that this knowledge can be reproduced, communicated and exploited by other people.

With the aim to define a usability method enabling novice and not professional evaluators to perform reliable evaluation, the PB inspection has been proposed. Lanzilotti et al. in [11] presented a study whose results showed that EPs provide a systematic framework, which has the potential to reduce the dependency on the evaluator's skills and experience, increases inter-rater reliability and output standardization, permits discovering a larger set of different problems and decreases evaluation cost.

3 An Inspection Technique to Evaluate e-learning Systems

The Pattern-based inspection (or PB inspection) was defined with the aim to identify an inspection technique able to exploit the advantages of the inspection techniques (i.e. they are cost-saving, do not require any special equipment, nor lab facilities) and overcome their major drawbacks (i.e. dependence on the inspectors' skills and experience, heuristics driving the evaluation are often too generic and not adequate to inform the activities of less experienced evaluators). The EPs provide a structured guidance to the evaluators performing the inspection of an interactive application. As demonstrated in [11], EPs are able to provide support to novice inspectors. Furthermore, using the precise terminology suggested by the patterns, the resulting evaluation reports are more consistent and easier to compare.

Table 1. An example of evaluation pattern of quality in use category

QU_27: Availability of course evaluation tools

Focus of action: course evaluation tools (e.g. evaluation test, exercises, etc.)

Intent: verify the availability of course evaluation tools

Activity prompts: Using the evaluation tools:

- Change an answer, after you entered an answer
- Do not answer to some questions
- Repeat the same test several times
- Check if the evaluation tool considers all the theoretical aspects presented in the course
- Use again the evaluation tool to determine if the test result is updated
- Verify if the obtained results are explicative

Output: a description reporting if:

- The evaluation tools are not available
- It is difficult to identify and use an evaluation tool, that is:
  - It is not possible to modify an answer
  - It is not possible to not give an answer to some questions
  - It is not possible to use the evaluation tool again and again
- The evaluation tool does not consider all the theoretical aspects presented in the course
- The student's improvements are not updated
- The evaluation tool is not explicative

Table 2. An example of evaluation pattern of the educational quality category

EQ_05: Quality of the authoring tools

Focus of action: authoring tools that allow lecturers to provide didactic material

Intent: evaluating the authoring tools

Activity prompts: choose an authoring tool:

- Modify/update a document already available
- Create a new document, also testing all the available functions
- Check if an appropriate feedback about the procedure is provided
- When the document has been created, verify if the result complies with the expectations

Output: a description reporting:

- If the authoring tool is not available
- If important functions are not available
- If modifying/updating a document is not easy
- Which are the difficulties in inserting new documents

The PB inspection is a general method, applicable to the evaluation of any interactive system, provided that a proper set of EPs is defined. Different sets of EPs have been defined, i.e. for hypermedia system [12], for virtual reality systems [20], and e-learning system [11]. EPs are formulated by an iterative approach that consists of the following four phases: a) Observations of evaluators at work, focusing on their main activities; b) Observations of end users using the system; c) Reviews of literature in the domain of the system; d) Executions of brainstorming sessions with professional evaluators and domain experts. During such sessions, an initial set of EPs is identified by considering all the gathered information. This set is then tested through pilot studies asking novice evaluators to use them and provide comments about their clarity, utility, guidance, etc. Based on these comments, the patterns were refined iteratively.

Each pattern is formulated by means of a common template composed of 5 items: 1) the *Classification Code and Title* that identify the pattern; 2) the *Focus of Action,* that indicates the application components to be evaluated by it; 3) the *Intent,* which clarifies the specific goals to be achieved through the pattern application; 4) the *Activity Prompts,* which prompts the activities to be performed by evaluators; 5) the *Output,* which suggests a standardized terminology that inspectors has to use for reporting the inspection results. Evaluators choose the set of EPs to be used during the inspection by reading the first three elements of the pattern template, i.e. *title, focus of action* and *intent*. The patterns were carried out one at a time. Inspectors perform the activities suggested by the *activity prompts* and report their finding according to the *output*.

The set of EPs considered in this study has been defined to evaluate e-learning systems. It consists of 69 EPs, divided in two broad categories: *quality in use*, consisting of 33 patterns, deals with technological and interaction characteristics of the system (an example is in Table 1); *educational quality*, consisting of 36 patterns, refers to the degree to which a system supports effective teaching and learning (an example is in Table 2).

4 The Exploratory Study

In the following sub-sections we illustrate the method adopted to verify if and how the EPs can help people, who use e-learning platforms in their work but do not have an HCI background, in assessing the quality of such educational tools. The method follows the one of the study reported in [11].

4.1 Participants and Design

A total of 13 participants evaluated the EDUX platform described in Section 4.3. They were university lecturers, who used e-learning platforms in their courses, and university administrative staff members, whose role was to manage through the e-learning platform students' profiles and learning material provided by professors. They never had any previous experience in evaluating any software systems. 9 out of 13 participants performed the evaluation in a quiet research laboratory of the Faculty of Management and Economics of the Gdansk University of Technology. The remaining 4 participants were Italian participants, having the same role as their Polish counterparts; they performed the evaluation of EDUX in a laboratory of the Department of the Computer Science of the University of Bari.

4.2 Procedure

A couple of days before the study session, a training session of about thirty minutes introduced participants with the EPs to be used for evaluating EDUX platform. Then, they participated in a thirty-minute demonstration of the platform. A few summary indications about the platform content and its main functions were introduced, without providing too many details. Data were collected in a group setting, but every participant worked individually. The study consisted of two experimental sessions lasting three hours each. During the first session, participants evaluated the EDUX platform applying eight EPs that, in our previous studies, had been demonstrated an adequate number for an experimental session lasting three hours (see Table 3). The selected EPs mainly addressed the operational activities permitted by the platform that are the significant aspects to which academics are interested for evaluating if a platform is adequate to their needs. The EPs were essential to guide inspectors in the analysis of the main application elements of the e-learning platform.

Table 3. The eight evaluation patterns tested in the study

Code	***Title***
QU_01	Availability of communication tools
QU_02	Quality of the graphical interface elements
QU_27	Availability of course evaluation tools
QU_06	Ease of use of the system
QU_08	Errors management
QU_20	Availability and quality of the help
EQ_24	Topic prerequisites[1]
EQ_05	Quality of the authoring tools

Participants had to find usability problems and to record them on a booklet. The booklet was composed of 8 evaluation forms, each one for an EP, where the participant had to indicate the start time and end time of execution of the EP, the number of the discovered and a description of the problems detected through the specific EP, where they occurred, and a proposal of design solution to the problem. Only after the participants had applied all the EPs, they had to assign a rating from 1 to 5 to each problem (1 = Slight, 5 = Catastrophic). A day after, each evaluator was asked to type their discovered problems in an electronic form. This was required in order to avoid readability problems during data analysis. At the end of the second session, participants were invited to fill in the evaluator-satisfaction questionnaire also proposed in the other studies in which the PB inspection was tested [11, 12]. Differently from the other study, in this case, the participants participated in additional focus group aimed at gathering subjective feedback from the evaluators on the PB inspection technique.

[1] Topic prerequisites: compulsory topics for understanding the course content.

4.3 The e-learning Platform

The EDUX e-learning platform has been used for a few years in the Polish-Japanese Institute of Information Technology in Warsaw, Poland. It was developed as an internal project by the IT staff of the Institute and it was intended to support both distance learning and regular courses.

The EDUX platform is now quite expanded, covering many modules typical for this type of systems (e.g. uploading lectures and exercises, executing evaluation tests, assessment of students' progress, etc.). Assigning students to specific courses is the duty of system administrators, while other activities - as configuring specific course modules and updating the content - belong to the teachers. Unfortunately, only a small part of the EDUX's capabilities is used in practice. The lecturers usually use EDUX only as a repository of teaching materials, therefore communication functions of the system have been used to a very small extent.

In order to discover reasons of such a situation (and to evaluate user experience of EDUX considered as an internal on-line service [21]) a questionnaire survey was conducted among faculty and students of the Institute in the mid-2013, well before this PB study was started. The survey revealed that in addition to complaints about usability problems, in fact very few teachers used this platform, as it was not compulsory, moreover no training was provided and on-line help was very limited. The survey also showed that the graphical user interface of EDUX is unclear and the interaction is not intuitive. Respondents indicated that the purpose of some modules was unclear, there was ambiguous and inconsistent labelling of icons, names, etc., as well as many modules had rather similar functionality, so they seemed to be redundant.

The results of the survey were forwarded to EDUX's developers, but they have not yet implemented the changes. Therefore, because the EDUX system has still many visible usability flaws, it was considered as a suitable object for testing the PB inspection technique. Moreover, some additional factors supported this choice:

- Experiment participants (both from Gdansk and from Bari) had no previous contact with the evaluated system, hence no prior experience bias had to be considered;
- The user interface of EDUX at the first glance seems transparent and appealing, and its basic functions seemingly are easy to use and encouraging for novice users;
- Formerly identified usability problems are easily perceptible even by non-experienced users in very simple operations, and – most importantly - are not critical for completing evaluators' task scenarios, what supports the idea of using EDUX for PB inspection experiment;
- Serious usability problems arise only in more complex operations, which were not included in the scope of this study.

It was also very important that due to rather easy start provided for novices in EDUX, the participants were able to perform their testing tasks within the PB inspection experiment without any previous training.

As a result, the EDUX system was found as a very convenient object to be evaluated by novice experts with PB inspection technique, whose verification was the primary main objective of this experiment.

4.4 Data Coding

Two expert usability evaluators independently examined all the electronic forms in order to identify single and unique usability problems. The inter-rater reliability was .75 and all differences were solved by discussion.

4.5 Results and Discussion

The analysis of the data collected during the study identified 115 unique problems and 31 non problems, i.e. statements reported in the evaluator's booklet containing not understandable content or unverifiable information.

Usability problems were classified into 4 categories: 1) *graphical design*, i.e. adverse comments on aesthetic aspects of the interface; 2) *feedback*, i.e. problems in the dialogue, mediated by the interface, between the user and the platform; 3) *navigation*, i.e. problems referred to the appropriateness of mechanisms for accessing information and for getting oriented in the system; 4) *functionality*, i.e. problems related to functions need to support the fruition of online courses but are not present. Table 4 reports frequencies and percentages of these categories.

Table 4. Frequency and percentage of usability problems classified by category

Category	*F*	*%*
Graphical design	40	35%
Feedback	22	19%
Navigation	17	15%
Functionality	36	31%
Total	115	100%

Participants frequently addressed the poor graphical design of the platform; they complained about confusing field names, too intense colors, inconsistent icons, etc. The platform often does not give any feedback during critical tasks, for example, at the end of the authoring of a quiz. The lack of tooltips makes it impossible to interpret the meaning of inappropriate icons. Navigation is hampered by a confusing navigational menu.

Table 5 reports the distribution of the problems in the five severity categories that were based on the coding of the two experts that coded the data. The most serious problems reported by the evaluators where related to the difficulties experienced using tools which are fundamental in a e-learning platform. For example, they reported that the authoring tool for creating and managing online tests had severe problems: adding or removing questions, limited types of questions, previewing authored tests, results management.

Table 5. Distribution of problems in the five severity categories

Severity 1 Not serious at all	*Severity 2*	*Severity 3*	*Severity 4*	*Severity 5 Very severe*
13	27	43	30	2

A thoroughness index was analysed to verify the completeness of the evaluation results with respect to the total number of real usability problems affecting the system [22]. This value was computed by the following formula:

$$Thoroughness = Mean\frac{P_i}{P_t}$$

where P_i is the number of problems found by the i-th inspector, and P_t is the total number of problems existing in the application (n = 115). The thoroughness index was 0.12 (std dev = 0.04) was very low. This is due to the high variability of the problems discovered by each participant and the many problems present in the platform. However, it can be considered a good result if it is compared to the PB inspection thoroughness index reported in [11], i.e. 0.09. This showed that even if evaluators are non expert in HCI discipline, they are able to perform reliable usability evaluation through the use of EPs, as novice evaluators could do.

Participants carried out the 8 EPs worked on average 73 minutes. This result is very different from that reported in [23], i.e. 177 minutes. In our opinion, this difference can be explained by two reasons. The first one is related to the *motivation* that stimulated people in participating in the study. Participants of the study reported in [23] were students of an HCI course who participated in the experiment as part of their course-work for an advanced HCI course. During that study we observed a sort of competition among the three groups involved. Each group used a specific usability evaluation technique, i.e. PB inspection, heuristic inspection, and user testing, to evaluate an e-learning platform. Thus, each group wanted to do right. Furthermore, during that study we observed a sort of competition among the three groups: they wanted to discover as many problems as possible to demonstrate the primacy of the technique they were adopting. In the current study, the participants' final goal was to decide if the platform was adequate or not to their needs and they stopped applying each EP when they believed that they had enough information about a specific aspect.

However, the efficiency index, which reflected the average number of problems each participant found in 10 minutes, was 1.43 (std dev = 0.47). Again, this can be considered a good result, since the efficiency index reported in [23] was 1.19. Thus, even if participants spent on average less time, the results of their evaluation are considerable. The efficiency was measured also through the cost-benefit curve, proposed by Nielsen and Landauer [24], which analyzes the minimal number of evaluators for a reliable evaluation. In our study, 5 evaluators were able to find the 30% of the problems (see Fig. 1). In [11], 5 evaluators applying heuristics specific for

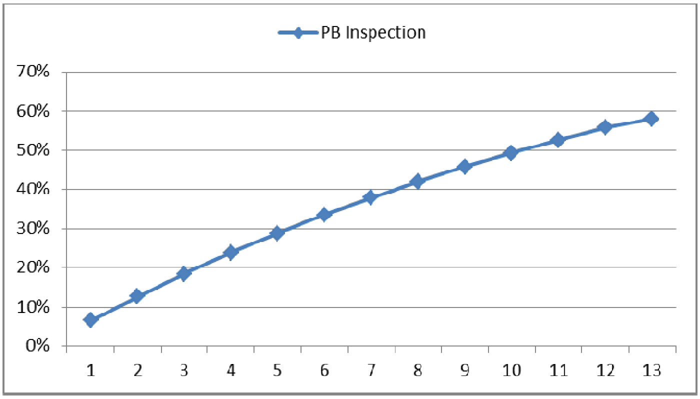

Fig. 1. The cost-benefit curve for the PB inspection

e-learning systems, discovered about the 22% of the problems. This demonstrates that EPs reduced the dependency on the evaluators' skills and experience which affects all the inspection methods.

The participants' satisfaction was assessed by both the data collected with the questionnaire administered at the end of the evaluation session and their comments during the focus group. The perceived satisfaction of the use of the PB inspection was assessed by using a semantic differential scale requiring users to judge the method on 11 items (e.g. easy to use, usual, efficient, reliable, etc.). The participants could modulate their judgment on each item through a 7-point scale (1 = negative, 7 = positive). A satisfaction index, computed as the mean value of the scores across all the 11 items, was 3.25 (std dev = 0.76). Participants' dissatisfaction was confirmed during the focus group: they complained that, in some extent, the technique made more complicate their task of assessing the EDUX platform. They felt tired applying the EPs requiring long explorations of the platform.

The participants were asked to judge their performance as evaluators on a 5-point scale (1 = negative, 5 = positive). The participants were slightly satisfied by their work (mean = 3.75, std dev = 1.58). This was confirmed by the answers to the question asking participants to indicate the percentage of the problems they thought to have discovered respect to the total number of problems the e-learning platform really had. On average, the participants stated they were able to discover 51% of the problems.

5 Conclusion

Since 2002 one of our main research goals is to identify an inspection technique able to support inspectors in performing reliable usability evaluation. To reach this goal, the Pattern-Based inspection was defined and in 2011 a comparison study has demonstrated that the technique is able to support novice evaluators in performing reliable, valid and economic evaluations. The study reported in this paper investigated how the PB inspection works in a real work-related setting. The results provided some answers about the question we posed in the title of the paper. EPs enable end users to evaluate the quality of an e-learning system. However, the study also demonstrated that the current definition of the EPs makes the technique difficult to be applied in some extent by people with no experience in usability evaluations. In the focus group, the participants reported that, even if they felt guided in the exploration of the system, they judged the execution of an EP time demanding since a variety of platform elements have to be considered. They would have preferred a larger set of patterns, but focused on a restricted number of elements. Another difficulty they experienced was related to problem reporting: they were not familiar with usability reports and they would have appreciated a more schematic and faster output layout. Some of them proposed a checklist. As future steps of our research, we are redesigning the EP template to improve the focus on specific elements of the e-learning system and to streamline the evaluation process.

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