Novice Assistance Tool and Methodology: Design Decision and Task-Pattern Mapping

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Abstract— We present a possible method and tool to support the novice designers in the design tasks. Although in literature stated that practitioners depend on memory and experiences, novice designers would take time to learn to acquire sufficient experience. The purpose of this research is to help novice designers to fulfill the usability goals that have determined by the expert in designing a system. The proposed methodology and tool can be considered as an assistance tool for novice designer in decision making in regards to prototype selection as well as the task-pattern mapping template for pattern selection in fulfilling the usability goal targeted. The tool was designed to manage the decisions information and to recommend the chosen prototype based on the Analytical Hierarchical Process (AHP) technique. In overall, about 87% of expert evaluators and prospective users were agreed with the suggestion of prototype selection from the proposed tool. The findings from this study revealed that the cooperation from industry experts was valuable in determined the usability goal and direction and getting accumulative feedbacks both from users and experts.

Keywords— analysis hierarchical process; design decision; design pattern; usability goal

I. INTRODUCTION

Experienced designers rely on the available design guidelines, past design experiences, templates and problem-solution sets from previous experiences. This is concur to the study claimed that practitioners were depend on their intuition and experiences gained [1]. Subsequently, further research works have been explored on how knowledge and experience were used among experienced and novice designers such as in [2],[3] and [4]. Reference [4] suggested that design strategies, knowledge and information should be included in developing support methods for novice designers as a guide to them.

Previous works in [5] and [6] explored the use of guidelines and patterns as an aid to teach design. The result from [5] have showed the use of design patterns have greater impact on the novice designer’s performance than guidelines. We considered all design related knowledge and information such as design decision and design pattern in the proposed method that leading to the development of the tool.

This research aims to understand how the proposed assistance tool and method help the novice designers drive them in designing a usable system, and thereby contribute towards developing a reliable tool and method for them in making design decision, particularly in determining usability goals and patterns, and selecting the best prototype. This work was the extension from the prior research in [7] and had considered expert involvement in determining the ranking of usability goal and experts’ decision in selecting the best prototype. The proposed tool was adopting the application of AHP technique in prioritizing the common usability goals and prototypes. AHP, a multi criteria technique, has been applied in various disciplines. Recently, in engineering itself, the AHP technique was applied for the purpose of economic efficiency [8] and planning [9]. Relevant to the study, it is also applied in product design such as in [10].

A proposed task-mapping template drives the novice designer to achieve the targeted usability goals. The design and development of the tool is to capture users’ and experts’ decision in selecting the best prototype, thereafter helping the novice designer to know the best choice of prototype based on the targeted usability goals.

II. RESEARCH METHOD

In understanding the proposed approach, we were conducting experiment with private institution students who were taking the subject of designing user interface. There were 4 teams consisting of 6 students in each team. All students were in Year 2 software engineering program. Fig 1 gives a combination of an overall flow of the proposed goal-directed approach in an experiment design.

In order to understand the usage of the proposed approach and the proposed tool, the students-cum-novice designers were required to follow a user-centered approach in designing user interfaces for student’s organization management system based on the given general description. Data collection of the effect of the usage of the proposed approach and tools were conducted for all participants involved in the experiments. Table 1 shows the summary of data collection method conducted in the experiment.
### VIII. SUMMARY OF DATA COLLECTION METHOD

<table>
<thead>
<tr>
<th>Participants</th>
<th>Method</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novice designers</td>
<td>Group design reflection</td>
<td>To evaluate the appropriateness of the proposed approach in designing the prototypes.</td>
</tr>
<tr>
<td></td>
<td>Individual’s design diaries</td>
<td></td>
</tr>
<tr>
<td>Prospective users and experts</td>
<td>Quantitative and qualitative survey</td>
<td>To evaluate the appropriateness of the proposed tool assisting their decisions.</td>
</tr>
</tbody>
</table>

### III. PROPOSED METHOD AND TOOL

In the beginning, we acquired the priority rank of the usability goal for the system design from an industry expert. The result was served as a direction in the system design for the novice designers which assist them to determine the selection of patterns on the selected design tasks.

Prior to designing the interface, novice designers were conducting user and task analysis with their peers in other course, in relating to the designed system. Based on the users analysis result, we analysed the top 5 important tasks that their peers required were as follows: register to join a society or club, join an organized event, invite peers, withdraw from the society joined, and post an event. These 5 tasks were used in their focus in applying usability patterns. However, they were free to add in any possible functions that could support the best usage of the system. This was followed by designing an interactive prototype using a prototype tool. In the evaluation stage, they were required to arrange the potential users to provide feedbacks on their design and selection of prototype. The decisions of usability goal prioritization and prototype selection were assisted by the proposed tool.

The design of the proposed tool was divided into four main modules. There were namely: usability goal prioritization, prototype selection to aggregate all the consistent decisions made by users and experts after walk-through all prototypes, calculation to check for consistency decision and determine the most inconsistency decision in the matrix for re-evaluation, and administration module to setup project description and evaluators’ profile of users and experts. Fig 2 depicts the overall view of the proposed tool. The system would help the designer to efficiently know the ranking of the usability goal and determine the prototype selection. The 3 main activities in the proposed approach were discussed in the following section.

**Prioritizing Usability Goal**

An industry expert from the software development centre of a private education institution was selected to prioritize the four common usability goals. The selection of the chosen usability goal for prioritization was adopted from the analysis made by [11] that showed learnability, efficiency in use, reliability in use and subjective satisfaction were the most commonly cited. The method of prioritization and selecting prototype were adapted from [12] and [13] multi criteria analysis approach called Analytical Hierarchical Process (AHP). Further discussion on the methodology in the prioritization and prototype selection can be found in [7] and [14]. The result of the prioritization was served as a goal for novice designers to target to.

**Designing of User Interface Following Pre-determined Usability Goal**

Following approaches in design for usability discussed in [15] we required the students or novice designers to follow user-centered design approach. The design assignment was started to understand users and tasks in the system design. The novice designers gather user information and performed task analysis of the system. During the development of design, the novice designers started with sketches or wireframe prototype and improved their design as they went on designing the prototypes to a higher fidelity. The novice designers were provided a list of usability patterns supported with some usable design solutions, to help them to meet the pre-determined usability goal prioritization. The novice designer decided the appropriate patterns for all the 5 important tasks and matched the targeted usability goal set by the expert in previous activity, in the given template. The user interface pattern served as a reference and guided them to achieve the usability goal. The user interface patterns were adopted from 19 user-perspective patterns of interaction patterns from [6], 21 architectural usability patterns by [11], and 10 functional usability pattern from [16], are categorized into the 4 common usability goal or usability attributes and are mapping with the 5 important selected tasks. Fig 3 shows a partial template screen of a task-pattern mapping for efficiency goal. The task-pattern mapping is to drive their design solution to meet the targeted usability goals.

A matrix of task scenario and usability goal was used to assist the novice designers to determine the possible usability goal to be designed to achieve the determined percentage of usability goals. The percentage of each usability goal related pattern adopted in the important tasks design is defined as:

\[
PUGP = \left[ \frac{\sum UGP - \sum UGP}{P} \right] \times 100
\]

(1)

where \(UGP\) is number of pattern related to a usability goal, \(IUGP\) is number of pattern that has inverse effect with the related usability goal, and \(P\) is total pattern applied in the important tasks design for the system.

This was served as an approach for the novice designers to plan their design. Table II shows the result of the usability goal fulfillment determined by the novice designers in a team. Even though certain target of usability goal were quite far from the percentage weighting given by the expert, the ranking of usability goal over the number of tasks implementing the goal was similar in the order of importance, that was, efficiency in use was placed in the highest importance, followed by reliability, satisfaction and learnability was in the lowest importance. Designers can start their work with these goals in mind and based on the decided usability properties in tasks scenario.

**Evaluating and Selecting the Best Prototype**

The novice designers were briefed on conducting usability testing. They have been practiced on conducting usability test during the pre-testing day in order to familiarize with the steps and data to collect during user observation.
In order to conduct the prototype selection, invited users and experts were walk-through in all pre-determined prototype designs based on the testing scenario in the observatory usability testing. In this case, there were 2 and 4 prototypes used in the evaluation for users and experts respectively. Quantitative measures such as time taken to complete the tasks, errors made and comments from the evaluators were also recorded. However, based on the usability measurements, novice designers may find difficult to decide which best prototype to select for further improvement. We extended the short usability testing and walk-through design to let the evaluators to judge their decision on the prototype selection using AHP.

IX. SUMMARY OF USABILITY GOAL FULFILLMENT IN DESIGN PLANNING

<table>
<thead>
<tr>
<th>Usability Goal</th>
<th>Efficiency</th>
<th>Learnability</th>
<th>Reliability</th>
<th>Satisfaction</th>
<th>Total patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total pattern</td>
<td>17</td>
<td>3</td>
<td>10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Total task affected (negative effect)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Net total pattern (with positive effect)</td>
<td>17</td>
<td>3</td>
<td>10</td>
<td>9</td>
<td>39</td>
</tr>
<tr>
<td>% achieved</td>
<td>43.6</td>
<td>7.7</td>
<td>25.6</td>
<td>23.1</td>
<td>100</td>
</tr>
<tr>
<td>Targeted (%)</td>
<td>41</td>
<td>7</td>
<td>39</td>
<td>13</td>
<td>100</td>
</tr>
</tbody>
</table>

Majority of the users were not familiar putting their preferences scale in the AHP’s matrix. We provided a guided dialogue for the evaluators to make their decision. Fig 4 shows a guided dialogue of pair-wise comparison scale for 4 prototypes in efficiency in use. Besides calculating for consistency ratio, the system was also checked for inconsistency ratio, which was more than 0.10. Inconsistency ratio found in a decision matrix will allow the evaluator to re-evaluate their decisions made. This is based on the discussion on the Saaty’s theory on satisfying consistency matrix in [12]. We adopted the theory and identified three locations on the matrix to evaluate based on the highest differences value between the user preferences scale and the satisfactory value from the consistent pair-wise comparison matrix.

The button label ‘reevaluate’ in Fig 5 will lead the evaluator to the related guided dialogue to re-evaluate their decisions. However, evaluator can opt to continue to evaluate or define their decision as final. After completing receiving all the evaluators’ decision, the consistent evaluators’ decision result will be aggregated and the chosen prototype will be determined which is shown in Fig 6. In Fig 6, prototype 2 is chosen based on the highest total weighted evaluation. This is achieved by multiplying the factor weight for each usability goal with factor evaluation for all prototype designs.

IV. RESULT AND DISCUSSION

There were 4 educators from a private institution, with 7-30 years of experiences in teaching design related subject and 4 design practitioners in a national research centre who are mainly involved in the usability evaluation process. Each of them took about 1 to 1.5 hours to complete the whole evaluation process. Each of them needs to go through all the 4 prototypes with test scenario and ended with their individual decision to make comparison for each prototype in each usability goal. All evaluators’ preferred prototype decisions were similar to the system suggested except for an evaluator which has relative inconsistent in their decision in most usability goals.

75% of them were agreed the method would help them to make decision in choosing the preferred prototype. Those were not agreed were due to the need of recall the designs to make the decisions. We find that this is necessary as the pair-wise comparison of prototype lead the evaluator to thorough thought on what rationale the prototype was chosen or was rejected. An experienced designer or experienced educator may not depend on this method to analyse their decision as they have their own criteria in evaluating and choosing their preferred prototype. Experienced practitioners preferred to allow the users to evaluate the system for a longer time to engage their usage experience of each prototype before a decision is made.

Result from 30 prospective users who were prospective users in the same education institution showed that 90% has similar preference prototype as what the tool suggested. 87% of them found that the method used in the system helped them to choose their preferred prototype. In contrary, 57% of them showed that they could easily know which prototype to select without the help of the system. This was because they would use their visual impression to select their preferred prototype in which this was not the purpose of the study. A lot of users’ comments for improvement were related to the aesthetic values in the design that comprising colors, graphics, and pictures. Thus, we believe the method in the system would assist them to judge their decision mainly based on the usability goals that discussed earlier.

Extracting from the 4 groups of novice designers’ design reflections write-up and individual’s design diaries, the flow of the designing interfaces is depicted in Fig 7. The novice designers explored the related interface design sources to get some idea on the visual design arrangement. Novices’ behaviors of design were always needed to refer to external sources for ideas to assist them in designing.

Feedbacks gained from the novice designers that follow the proposed method of task-pattern mapping need to improve as to give better guidance and provide more flexibility. This had inevitably become their goal in achieving the usability during system design. The designers decided themselves which pattern that deem necessary to select and design. All 4 groups have their own different percentage for each usability goals.


Only 1 group could meet the targeted rank of usability goals. This is shown in Table III. The participants claimed that it was a tough task to achieve the targeted percentage of the usability goal as the requirement. Achievement of certain percentage in each usability goal is difficult as a pattern is related to other usability goals. Selecting patterns used requires decision and experiences. Thus, decision to select appropriate patterns need to be coordinated with an experienced designer or project manager in a design team. The task-pattern template can served as a guide to fulfill the priority rank of determined usability goals.

**SUMMARY OF USABILITY GOALFULFILLMENT (IN %) FOR ALL TEAMS**

<table>
<thead>
<tr>
<th>Group</th>
<th>Efficiency</th>
<th>Learnability</th>
<th>Reliability</th>
<th>Satisfaction</th>
<th>Total patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43.6 (1)</td>
<td>7.7 (4)</td>
<td>25.6 (2)</td>
<td>23.1 (3)</td>
<td>39</td>
</tr>
<tr>
<td>2</td>
<td>34.5 (1)</td>
<td>6.9 (4)</td>
<td>34.5 (1)</td>
<td>24.1 (3)</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>32.3 (2)</td>
<td>6.5 (4)</td>
<td>25.8 (3)</td>
<td>35.5 (1)</td>
<td>31</td>
</tr>
<tr>
<td>4</td>
<td>32.4 (1)</td>
<td>13.5 (4)</td>
<td>32.4 (1)</td>
<td>21.6 (3)</td>
<td>37</td>
</tr>
<tr>
<td>Targeted % (rank)</td>
<td>41 (1)</td>
<td>7 (4)</td>
<td>39 (2)</td>
<td>13 (3)</td>
<td></td>
</tr>
</tbody>
</table>

In overall, 75% of all evaluators both from a private institution and a national research centre were agreed with the proposed tool suggestion on the ranking of prototype. Their own prototypes ranking was exactly the same as the ranking proposed by the tool based on the weight of the 4 common usability goals. This was also similar to 90% of the 30 prospective users. Novice designers found the quantitative result from the tool would assist them to determine which prototype to select. Depending on the usability measurements on error made, time to complete and questionnaire sometimes may not help if there is similar result in the prototypes. Collective decision both from experts as well real users will give an absolute result. In evaluating the appropriateness of the proposed approach, all 4 teams in the experiment claimed that they have difficulty in getting the targeted percentage of the pre-determined usability goal in selecting the patterns mapping to the 5 important tasks. We perceived that novice designers needed all related usability patterns mapping to the important tasks were determined by experienced person as a guide in the designing.

**V. CONCLUSION**

The propose method in the development of the novice-assistance tool had shown a cooperation of expert in providing direction to the novice designers in achieving usability requirement in the system design. It provides a way to novice designers how trade-off of usability pattern is made in the deciding the pattern used. However, guidance to select appropriate pattern needs to come from experienced designer. In deciding the best prototype fulfilling the usability goals in the evaluation process had shown a collective decision both from prospective users and experts. It could give a clear decision of a particular prototype was chosen supported with the weight of preference for each usability goals. Result from 8 experts both from private institution and national research centre had shown that the tool was able to assist in the evaluation process in deciding the best prototype taking into the consideration of the consistency of all decision makers. Further work will look into on what basic a particular prototype is selected by users and experts. This will lead to another research question of whether the number of usability patterns adopting into the design work would influence the selection of the prototype.

**ACKNOWLEDGMENT**

We would like to thank all the software engineering students in Year 2 who had taken the subject User Interface Design in semester 2 (2013/2014) as well as lecturers and industry experts for their cooperation and feedbacks throughout the study. Without their collaboration, the study would have been impossible.

**REFERENCES**


Fig 1: Overall flow of proposed goal-directed approach for user interface design

Fig 2: Overall view of the proposed tool

Fig 3: An example of a partial screen of the task-pattern mapping for efficiency

Fig 4: A guided dialogue to assist expert’s making decision on prototype

Fig 5: Example of expert’s judgement result on prototype selection

Fig 6: A result screen of an expert’s decision on prototype selection