End User Development: What Influences the Relationship between Satisfaction with Tools and Satisfaction with Applications?

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ABSTRACT
This study explored the possible role of four factors in the relationship between end user developers’ perceptions of their applications and their perceptions of the tools used to create them. Satisfaction with a user developed application was found to be significantly correlated with satisfaction with the tool used to create the application regardless of the provision of feedback about the application, or level of spreadsheet development knowledge. Previous experience with another spreadsheet development tool did however appear to influence the relationship, suggesting that end user developers would benefit from experience with a variety of development tools.

Keywords: end user computing, user satisfaction, development tools, user developed applications

INTRODUCTION
End users increasingly use development tools such as spreadsheets, database management systems and Web authoring tools to create applications to support organisational processes and decision making. Organisations rely heavily upon these applications (McLean, Kappelman, & Thompson, 1993). Organisations also rely very heavily on end users’ perceptions of the fitness of these applications for use, as little formal evaluation of the quality of user developed applications (UDAs) is undertaken (Panko & Halverson, 1996). However, end user developers often have little experience or formal training with the tools they are using (McGill, 2000; Taylor, Moynihan, & Wood-Harper, 1998), raising concerns about their ability to make realistic assessments about the accuracy, fitness for purpose and reliability of UDAs.

Research into end user development tools has tended to address their acceptance rather than their impact. Of the studies reviewed by Brancheau and Brown (1993), only two addressed tool dependent outcomes. One dealt with problems with mismatch in the task-tool fit (Pentland, 1989), and one with the potential longitudinal impact on task resolution (Carlsson, 1988). Brancheau and Brown also noted that ‘most studies tend to ignore the specific characteristics of tools employed by end users’ (Brancheau & Brown, 1993 p.459).

Innovation diffusion theory suggests that tool characteristics are important determinants of adoption and subsequent end user action (Moore, 1987). The results of a study by McGill (2000) suggest that some end users have difficulty perceiving their applications as separate from the tools used to create them. The relationship between end users satisfaction with UDAs and satisfaction with development tools was explored in a recent study (McGill, van der Heyden, & Hopkins, 2001), and satisfaction with a UDA was found to be significantly correlated with satisfaction with the tool used to create the application.

Attribution theory is concerned with the cognitive processes that people use to explain their performance in situations where causal relations are ambiguous (Weiner, 1986). Hufnagel (1990) used causal attribution theory to investigate the relationship between user satisfaction and performance in a computer-based business game and found that participants who were unsuccessful tended to blame their poor performance on luck and/or the quality of the system. Lin and Ashcroft (1990) also reported on a case where users attributed data problems to a new system and its developers, despite evidence that problems arose in user departments. These results suggest that the evaluation of development outcomes could have a causal attribution component. Moreover, since the tool is the key implementation component in the development process, causal attribution may appear all the more...
justified to a user developer. Thus end user perceptions of development tools may influence perceptions of the application developed, but perceptions of UDAs may also influence perceptions of development tools.

Amoroso and Cheney (1991) proposed a model of end user application effectiveness that included perceived quality of application development tools as a determinant of end user information satisfaction and found a weak positive relationship. However, causal attribution theory would suggest that satisfaction with an UDA could influence satisfaction with application development tools. Whilst the McGill, van der Heyden and Hopkins (2001) study mentioned above confirmed the relationship between perceptions of tools and perception of applications it provided no insight into the direction of the relationship nor into factors that might moderate or mediate it.

**RESEARCH QUESTION**

This study was designed to extend the investigation undertaken by McGill, van der Heyden and Hopkins (2001) into the relationship between end users’ perceptions of their applications and their perceptions of the tools used to create them. In particular, this study was intended to explore the possible role of four additional factors in this relationship. These factors of interest are: level of development tool knowledge, previous experience with other development tools, UDA quality, and feedback to developers on UDA quality and performance (see Figure 1 below). Therefore, the research question investigated in this study was:

How do development tool knowledge, previous experience with other development tools, UDA quality and feedback to end user developers influence the relationship between user satisfaction with UDAs and user satisfaction with development tools?

Besides being an important control mechanism, feedback also reduces uncertainty about user performance (Larson, 1984). Martocchio (1992) showed that feedback can increase both self-efficacy and the performance of users. In a study of user evaluation of task technology fit, Goodhue, Klein and March (2000) commented on the role of performance feedback. They noted that participants in their study lacked feedback on their performance and suggested that the link between user evaluations and performance measures might be stronger when feedback is present. Lack of feedback also characterised the study by McGill et al (2001) as perceptions of satisfaction with applications were obtained before the participants had received any external feedback about the quality and performance of their applications. A raised awareness of the success of their applications may have changed the relationship between perceptions of satisfaction with UDAs and satisfaction with tools. It was thus hypothesised that:

**H1:** An end users’ satisfaction with a UDA is only associated with their satisfaction with the tool used to create it in situations where there is little feedback about the application.

End users vary greatly in their levels of experience with end user development and in the amounts of training they have had to prepare them for application development (Chan & Storey, 1996). This range of backgrounds leads to a wide range of levels of knowledge about application development (McGill & Dixon, 2001). In the absence of a solid understanding of the development tool being used, and of processes for application development, it would not be surprising if end users had trouble separating their perceptions of tools from their perceptions of the applications created by these tools. Similarly, those end user developers creating applications of low quality (because of lack of development tool knowledge) may also have trouble separating their perceptions of tools and applications. Therefore it was hypothesised that:

**H2:** An end users’ satisfaction with a UDA is only associated with their satisfaction with the tool used to create it in situations where they have little knowledge of the development tool.

**H3:** An end users’ satisfaction with a UDA is only associated with their satisfaction with the tool used to create it in situations where the UDA is of low system quality.
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Figure 1: Possible factors influencing the relationship between end user developer satisfaction with development tools and satisfaction with UDAs.

End user developers tend to have limited had exposure to the range of possible development tools, and once they are familiar with a tool hesitate to adopt another tool regardless of whether it might be more appropriate (Chan & Storey, 1996). In the McGill et al. (2001) study, only 29.5% of participants had used another type of spreadsheet package. This lack of exposure to the variety of possible development tools may make it difficult for end users to separate their perceptions of tools from their perceptions of the applications created by these tools. It was therefore hypothesized that:

H4: An end users’ satisfaction with a UDA is only associated with their satisfaction with the tool used to create it, when they do not have previous experience using another development tool of the same type.

METHOD

Participants

The participants in the study were 149 undergraduate students (48% male, 52% female) enrolled in a second year information systems service course intended primarily for business students. The course was designed to prepare students to participate in end user computing activities in organisations once they graduate and join the workforce, rather than to become information technology professionals. The participants had an average of about 4.4 years of experience using spreadsheets with a minimum of just a few weeks and a maximum of 18 years. Although 149 students completed at least one of the questionnaires, only a subset of them completed both and hence could be included in each analysis.

The user developed applications

Prior to the study, each of the participants had completed a case that required them to design and develop a spreadsheet application to provide decision support to a business. The case was selected because it represented a realistic problem for an end user to analyse, and the scope and complexities were typical of the type of applications that end users would be likely to tackle in a ‘real’ work situation. It also involved the application of spreadsheet software, which is the most popular end user tool in organisations (Taylor et al., 1998). Applications were required to be developed in Microsoft Excel® in the Microsoft Windows® environment. The case description was approximately 4 pages long and the finished spreadsheet required at least 4 linked worksheets and the creation of a macro. It was anticipated that it would take the subjects at least 2 days to plan and develop the application. This application constituted 15% of each student’s overall course grade.
Procedure

The research project was designed as a longitudinal study. Table 1 below summarises the sequence of activities. The initial phase was undertaken after all participants had submitted their completed UDAs for assessment, but before they had received feedback on them. Participants were recruited during tutorials and lectures and asked to complete an initial questionnaire that asked for background information, tested spreadsheet development knowledge, and measured satisfaction with both their own UDA and with Microsoft Excel©.

1. UDAs submitted for assessment
2. Questionnaire 1 completed
3. Feedback received on application quality (comments and grade)
4. Questionnaire 2 completed
5. Information obtained about system quality from instructors

Table 1: Research procedure

After all participants had received feedback on their UDAs via both a grade and written comments from their tutor, the participants were again surveyed. The second questionnaire measured both satisfaction with the UDA and satisfaction with Microsoft Excel© again. System quality assessments were obtained later from the unit coordinator.

Constructs of interest

User satisfaction refers to the attitude or response of an end user towards information, an information system or a development tool. User satisfaction with an application has been defined as ‘the affective attitude towards a particular computer application by an end user who interacts with the application directly’ (Doll & Torkzadeh, 1988). In this study, user satisfaction with a UDA was measured using 10 items from the 12 item end user computing satisfaction scale developed by Doll and Torkzadeh (1988). This instrument was chosen as it has been commonly used in the end user computing domain (e.g. Gelderman, 1998; Igbaria, 1990; Rahman & Abdul-Gader, 1993) and because it was used in the study to which this was a follow up. Two items were not included in either study because they were not appropriate to the case study situations, and minor adaptations to wording were also made to reflect the terminology used in the case and the environment in which application development and use occurred. Each item was measured on a 5 point Likert-type scale ranging from (1) ‘almost never’ to (5) ‘almost always’. The instrument was shown to be reliable with a Cronbach’s alpha of 0.90 when used to measure satisfaction before feedback, and 0.93 when used to measure satisfaction after feedback. The scores for each item were totalled to produce an overall satisfaction with the UDA score (both before and after feedback).

User satisfaction with a development tool refers to the end user’s affective attitude to its suitability for use. In this study it was measured using a 4 item 7 point semantic differential scale. Seddon and Yip’s (1992) 4 item user satisfaction instrument was used as the starting point for the item development as it attempts to measure user satisfaction directly rather than confounding it with information quality and system quality. The instrument had a marginal reliability (Cronbach’s alpha of 0.67) when used to measure satisfaction with Excel before feedback and a satisfactory Cronbach’s alpha of 0.81 when used to measure satisfaction with Excel after feedback. The scores for each item were totalled to produce an overall satisfaction with Microsoft Excel score (both before and after feedback).

Spreadsheet development knowledge refers to the knowledge that end user developers make use of when developing UDAs. In this study it was measured using 5 representative questions from the 32 item instrument developed by McGill and Dixon (2001). Each item was presented as a multiple choice question with 5 options. In each case the 5th option was ‘I don’t know’ or ‘I am not familiar with this feature’. Although the full item set was shown to have acceptable reliability in the McGill and Dixon study (Cronbach’s alpha of 0.77), the items had a Cronbach’s alpha of 0.57 in this study; this is below that usually considered as acceptable reliability (Nunnally, 1978). Nunnally (1978) argued that at least
30 items are needed to ensure high reliability in tests of achievement, hence the reduction in number of items was probably responsible for the reliability problem, and means that results of the hypothesis about spreadsheet development knowledge should be interpreted with caution.

System quality relates to the quality of the information system developed and is concerned with matters such as the accuracy and reliability of the system, its ease of use and the quality of any supporting documentation. A wide range of measures of system quality has been used in previous empirical studies. These range from direct measures of system quality from a software engineering perspective, such as defects per 1000 lines of code (e.g. Low & Jeffery, 1990), to perceptual measures such as Amoroso and Cheney’s (1992) system quality measure which incorporates aspects of end user information satisfaction and application utilisation. In this study, system quality was measured using the mark out of 100 given to the UDA by the tutor marking it. All tutors used a detailed, standard marking scheme covering many aspects of system quality.

As discussed above, feedback is a valuable tool for reducing uncertainty. In this study participants received formal feedback on UDA quality and performance when their assignment was returned to them. Previous experience with another development tool was assessed in this study by asking participants if they had ever used another spreadsheet package.

Results and Discussion

The first hypothesis for this study related to the possible role of feedback on the relationship between satisfaction with a UDA and satisfaction with the tool used to create it (in this case Microsoft Excel©). This hypothesis was addressed using Pearson correlations (see Table 2 below). Satisfaction with a UDA was found to be significantly correlated with satisfaction with Excel both before (r = 0.364, p < 0.001) and after feedback to the developer (r = 0.524, p < 0.001). Those end users who were satisfied with a UDA were also satisfied with the development tool used to create it. This result is consistent with the findings of Rivard and Huff (1988), Amoroso and Cheney (1991) and McGill et al. (2001). However, despite this support for previous research, hypothesis H1 was not supported. The provision of feedback about system quality and performance did not remove the association between satisfaction with a UDA and satisfaction with the tool used to create it. A comparison using paired-samples t-tests, of the levels of both kinds of satisfaction before and after feedback showed that whilst the provision of feedback did not significantly change the participants levels of satisfaction with their UDAs (n = 51, 5.26 vs 5.88, t(50) = 0.842, p = 0.404), it did significantly reduce their levels of satisfaction with Excel (n = 51, 3.88 vs 3.06, t(50) = -4.526, p < 0.001). This result provides some support for the idea that causal attribution plays a role in this process. If participants were disappointed in the feedback they received about their applications, it was attributed to the tools they used.

Hypothesis 2 related to the possible role of system development knowledge in the relationship between satisfaction with UDAs and satisfaction with Excel. This was again addressed using Pearson correlations. Participants were categorised based on their score on the items testing spreadsheet development knowledge. Five items that tested spreadsheet knowledge were included in the questionnaires. Participants who scored either 1 or 2 out of 5 on the spreadsheet knowledge items were included in the low knowledge group. Participants who scored 4 or 5 out of 5 were included in the high knowledge group. Those who scored 3 out of 5 were excluded from the analysis for this hypothesis. As can be seen in Table 2, satisfaction with the UDA was significantly correlated with satisfaction with Excel in both the low and high knowledge groups, both before (r = 0.500, p = 0.003; r=0.390, p = 0.005) and after feedback (r= 0.480, p= 0.013; r=0.571, p< 0.001). Therefore hypothesis 2 was not supported. Level of spreadsheet development knowledge did not appear to influence the relationship between the two kinds of satisfaction.

<table>
<thead>
<tr>
<th></th>
<th>Correlation</th>
<th>Sign.</th>
<th>N</th>
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</thead>
<tbody>
<tr>
<td>Whole group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before feedback</td>
<td>0.364</td>
<td>&lt; 0.001</td>
<td>110</td>
</tr>
<tr>
<td>After feedback</td>
<td>0.524</td>
<td>&lt; 0.001</td>
<td>87</td>
</tr>
</tbody>
</table>
Table 2: Correlations between satisfaction with UDAs and satisfaction with Excel

<table>
<thead>
<tr>
<th></th>
<th>Low knowledge</th>
<th></th>
<th>High knowledge</th>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Before feedback</td>
<td>After feedback</td>
<td></td>
<td>Before feedback</td>
</tr>
<tr>
<td>Low system quality UDAs</td>
<td>0.329</td>
<td>0.027</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.624</td>
<td>&lt;0.001</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>High system quality UDAs</td>
<td>0.305</td>
<td>0.018</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.202</td>
<td>0.188</td>
<td>44</td>
<td></td>
</tr>
</tbody>
</table>

|                          | Before feedback | After feedback | | Before feedback | After feedback |
| No other spreadsheet used | 0.406         | <0.001 | 77             |       |
|                          | 0.573         | 0.001  | 32             |       |
| Other spreadsheet used   | 0.285         | 0.120  | 31             |       |
|                          | 0.267         | 0.301  | 17             |       |

Hypothesis 3 related to the possible role of system quality in the relationship between satisfaction with UDAs and satisfaction with Excel. This was again addressed using Pearson correlations. Participants were split into two groups, those with applications of below average quality and those with applications of above average quality. For the group of participants with UDAs of below average system quality there was a significant positive correlation between satisfaction with the UDA and satisfaction with Excel, both before (r=0.329, p=0.027) and after feedback (r=0.624, p<0.001). For the group of participants with UDAs of above average system quality, the picture was slightly different. Whilst the two types of satisfaction were significantly related before feedback (r=0.305, p=0.018), this relationship was not present after feedback (r=0.202, p=0.188). The knowledge and recognition that they had developed good quality spreadsheets may have enabled the participants to view their UDA and the tool used to create it more clearly as separate entities, and hence loosened the relationship between the two types of satisfaction.

Hypothesis 4 related to the impact lack of exposure to the variety of possible development tools may have on the ability of end users to separate their perceptions of tools and applications. Only 28% of the participants in this study had ever used another spreadsheet package. The relatively limited range of experience with different spreadsheet packages in this sample is consistent with the previous study and indicative of the broader end user population. Hypothesis 4 was addressed using Pearson correlations. Participants were divided into two groups based on their answer to the question ‘Have you ever used a spreadsheet package other than Microsoft Excel®’. As can be seen in Table 2, satisfaction with the UDA was significantly correlated with satisfaction with Excel for the group that did not have previous experience with another spreadsheet package, both before (r= 0.406, p < 0.001) and after feedback (r=0.573, p = 0.001). However, this relationship was not significant in the group with previous experience with another spreadsheet package either before (r=0.285, p=0.120) or after feedback (r=0.267, p=0.301). Therefore hypothesis 4 was supported. Previous experience with another spreadsheet package appeared to loosen the relationship between the two types of satisfaction. This result raises questions about the role of variety in end user learning. If end users are only exposed to only one product their ability to recognise quality in software development tools may be limited.
CONCLUSION

The results of this study provide further support for the view that end user developers may often not clearly differentiate between the applications they develop and the tools used in the development process. Neither feedback about the quality and performance of a UDA nor level of spreadsheet development knowledge appeared to influence the strong relationship between satisfaction with UDAs and satisfaction with the tools used to create them. This lack of clear differentiation may be a confounding factor when end users evaluate the outcomes of user development of applications. End user developers may not take responsibility for ensuring the quality of the applications they develop if they are unable to clearly distinguish their contribution from that of the underlying tool. Previous experience with another spreadsheet development tool did, however, appear to influence the relationship, suggesting that experience with a variety of development tools could enable end user developers to gain valuable insights. However, this study is only exploratory, using student participants who may not be representative of the wider end user developer population. Future research is needed to further elucidate the relationship between satisfaction with development tools and satisfaction with UDAs. An understanding of the directions of the relationship and mechanisms by which it operates will provide valuable insights into end user development and the processes by which end users evaluate their own applications.

REFERENCES


