Usability Investigation of E-Business Web-Based Forms

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ABSTRACT

Usability on Web sites is critical because almost no training is provided for users on commercial sites. Instead, Web design relies on standards and consistency across sites. Traditional usability results indicated that computer forms should follow paper-based forms. Yet, Web paradigms have evolved that are quite different from paper-based forms. Specifically, this study reveals that users commit fewer errors and prefer simple forms limited to a single concept per screen. This conclusion significantly alters the recommendations for designing business forms.

INTRODUCTION

A key mantra in systems development is that designers should build online forms to mimic the structure and format of existing forms. Initially, these forms were based on paper layouts. More recent implementations might simply be extensions or rebuilds of older online system forms—that were originally based on paper applications. A key element of the paper-based forms is that the layout is constrained and optimized for the size of paper. In particular, paper encourages the development of single-page forms. Multi-page forms are difficult to handle in paper, and the size of the page and time and expense concerns encourage placing multiple elements and blocks on one page (Ware, 2000; Couper et al., 2001).

In contrast, Web pages have followed a different design philosophy. The use of hypertext links and relatively small screen sizes has encouraged the separation of content into multiple pages. Designers and usability studies (such as those led by Jakob Nielsen) have emphasized the importance of simplifying individual pages and relying on links to perform more complex tasks.
These views might appear to be conflicting, and the two design philosophies have remained separate—largely because the Web is still a relatively new design media that has been used mostly to present static information to large groups of users. However, as Internet-based applications begin to replace traditional as well as client-server applications, these two conflicting views are beginning to gain importance. With the introduction of new Web

development tools such as J2EE and Microsoft .NET, firms will increasingly design new applications and rewrite existing systems to take advantage of the features of the Web-based approach (for example, see Lee et al., 2003). Consequently, it is important to evaluate these conflicting design issues to determine if there is a resolution to the design conflict. Should forms continue to be designed and built as monolithic pages that contain multiple sections and subforms, or should separate forms that deal with a single topic be built, and then linked to additional pages to collect related data?

This question does not have an obvious answer. There are benefits and drawbacks to both approaches. But, the specific question has not been tested in current research (e.g., a Web environment). Yet, it is a question that is implicitly asked every single day by Web designers. Examine a few data-entry forms on the Web and you will find a wide variety of answers to this question. How much data should be put onto each screen?

The methodology for answering this question follows procedures established in the science and medical disciplines for testing various treatments. Test a Web-based form in two formats—a long form that contains most options on a single page, and a form that is split across multiple pages. Find a collection of users to test both forms and treatments. Collect basic demographic data on the participants to evaluate and mitigate personal variances. Ensure that respondents evaluate the forms in a random ordering and measure learning effects due to ordering. Keep the experiment relatively short to minimize burnout and ensure completion. Reduce extraneous factors as much as possible, and try to measure the ones that cannot be eliminated. For example, the primary form tested represents a common business purchase form. The two versions were built using the same technology and run on the same server to ensure equivalent processing and latency. The forms may appear simple to readers familiar with business applications, and the point is to keep them simple so that the only difference lies in whether all data is entered on a single page or across multiple pages. This process has been used by other researchers of Internet design questions, such as Webster and Ahuja (2006).

REVIEW OF THE LITERATURE

In many respects, computerized form completion should be similar to self-administered questionnaires. The completion of such forms is similar, in that the forms require individuals to take information, reproduce it correctly, and put the information in the proper place on a form, or to select an appropriate answer and somehow indicate it on the form (through a checkbox, a list box, radio buttons, or other method). Prior research over many years shows that answers on self-administered questionnaires are related to the ways that the question and answer spaces are placed on the page (Wright & Barnard, 1973, 1978; Rothwell, 1985; Smith, 1993, 1995; Christian & Dillman, 2004). Yet, as Christian and Dillman (2004) point out, our understanding of these effects is not what it should be. Although many would agree that theoretically these effects should exist, the scholarly evidence for them is sparse (Sless, 1994; Jenkins & Dillman, 1997; Katz & Byrne, 2003; Tourangeau et al., 2004). Their review of recent literature on the verbal, numerical, graphical, and symbolic languages used in self-administered questionnaires relates to computerized form completion.

Research shows that the individual filling a form or questionnaire, who has no assistance from an interviewer or salesperson, must use the verbal and graphical cues given on the pages or forms themselves (Ware, 2000; Couper et al., 2001). If form items are clustered together or spread out on different web pages, it should make a difference to respondents. Graphical design features can assist or distract the respondent from both completing the form and giving correct answers. Tufte (1990) raises similar questions in terms of graphical design and layout. He suggests that "high information displays" are "frequently optimal," but that "showing complexity is hard work." The interactive nature of the Web creates new design forms by enabling people to choose what they want to see. But, there is still a question of whether all of the data and forms should be on a single page or spread across multiple pages. Becker (2004) discuses the need to design e-commerce and Web site pages to the specific needs of the elderly. The argument for a design paradigm for a population of this type is to allow for ease of use and access to information. Required design issues include font size, color selection, graphics, background images, navigation, and search mechanisms. This type of specialized Web site design supports the issues raised by Tufte (1990).

As emphasized by Webster and Ahuja (2006), splitting information across pages can also lead to disorientation. This paper contains an extensive literature review on design issues. With all information on a single page, users can see all of the tasks that need to be completed. If a form is split, the standard prescriptions are to keep the sequence linear and to show users the current location in the sequence. But, these two viewpoints do not resolve the question of which method is likely to be preferred by users and lead to fewer errors. Ivory and Megraw (2005) examined changes in Web site design over time. This research focused on graphics, links, and overall architecture, but it highlights the changing nature of usability and how paradigms that are successful at one point in time might change.

Research on Web surveys address similar issues to the ones presented in this study. Couper et al. (2001) point out that although the number of web surveys being done is increasing rapidly, and many claims have been made that web surveys should contain inherent advantages; there has been limited research on the impact of format and design on item response and data quality. In their study, Couper et al. compare results from showing sets of questions all on the same screen with results for one question per screen. They hypothesize that respondents will answer the survey more quickly when multiple questions are put on a screen. They say that even though there may be other reasons for combining question items on one screen, it is important to consider that it may be more efficient or faster partly because respondents are required to reorient themselves to particular item formats less often. Fuchs, Couper, and Hansen (2000) found that there were screen orientation effects in interviewer administered surveys (i.e. getting oriented to each screen takes time), and Couper et al. hypothesize that response will also be faster because download time will be reduced. Their results confirm the research hypothesis, but their study contained lists of individual survey questions that were in similar formats, not distinct form sections.

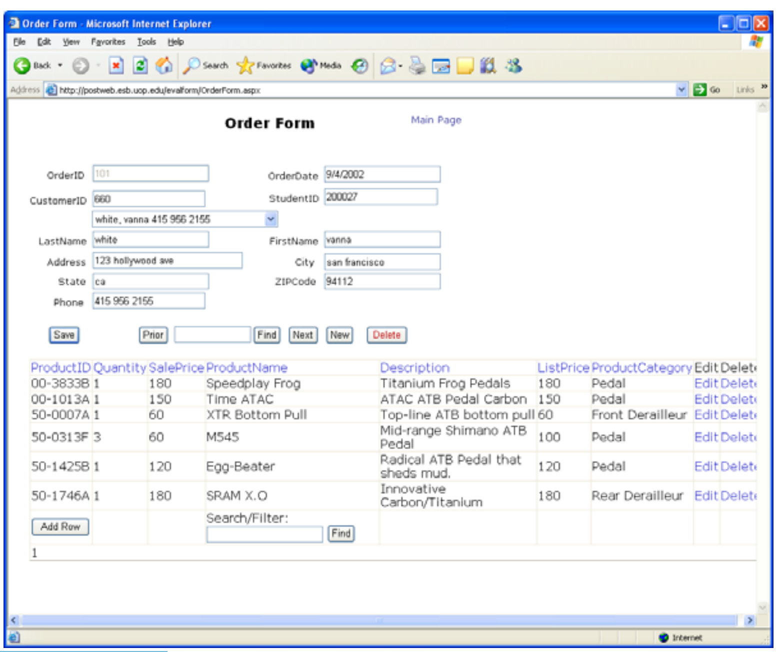
Some work has been done to evaluate Web sites from a high-level perspective, as exemplified by Palmer (2002). Most of these studies have focused on overall usability such as download speed and other items that emphasize overall attractiveness of the site from a consumer-oriented perspective. Similarly, Liu and Sun (2006) describe the process of transforming business activities into designs. But the question remains open as to how existing paper-based forms should be replaced with Web-based forms. This research focuses on an area that has received little or no attention: creating Web-based forms to replace traditional information system—often for in-house use. Thomas and Macredie (2002) postulate that new usability engineering and testing methodologies will be needed to facilitate the development of usable computer interfaces and technologies that support applications for future information system environments. McCarthy et al. (2004) emphasize the importance of considering long-term consequences in Web design. The implication being that input forms that are difficult to follow or hard to fill out could deter potential users from returning.

Much of the prior research on form design and Web page applications focused upon the user experience and retention. Luna, Peracchio, and de Juan (2002) reported on the degree of the user interaction and how this impacts the customer revisiting a Web site. Benbunan-Fich (2003) discussed how users can be confused maneuvering on a Web site due to improper design. Ahuja and Webster (2001) also reported a degree of user disorientation again based on improper navigation tool awareness. The concept of disorganization with respect to design inconsistencies appears in the work of Danielson (2002) and again in Danielson (2003). Web site usability and design remains and ongoing and open area for improvement based upon the work of Cukier and Middleton (2003). This research indicated that much design reallocation was necessary in the subset of web site reviewed in this study.

Lazar et al. (2003) discussed the frustration that overtakes Web site users when they are unable to perform the tasks required via Web navigation and movement. Again the concerns raised in this research centers upon proper design of the Web environment. Post et al. (2002) reported on attributes that would be preferred by end users of various commercial Web sites. The concern was how well a site is designed to ascertain user response and comfort to the experience based upon design facilitation.

The use of design principles tends to impact the user experience with a Web site which will affect the revisit and task completion process. This study views the design aspects of form development as an extension of proper design methods in an effort to support task operations as well as mitigating user disorientation which will reduce web use functionality.

Figure 1: Web Based form.



ILLUSTRATIONS OF THE ISSUES

Figure 1 shows a Web-based representation of a typical order form. In an actual company, the Student ID field would be replaced with a Salesperson (or other ID) field. Notice that the order form requires three basic elements: (1) The primary order information including the Order ID and Order Date; (2) The basic customer information including name, address, and phone; and (3) A subform handles the selection of the items being purchased. Typically, the form would also display the extended amount (or total cost of each ordered item) for each line as well as the order total, but these items are calculated and not entered by the order clerk, so these pieces of information are not appropriate (important) to this example. Following standard database design practices, the underlying database actually stores the data in normalized tables. Consequently, a drop down list box is used to select existing customers. Similarly, when a new row is added to the subform, or the Edit link is selected, a drop down list box presents the predefined list of items available.

POTENTIAL PROBLEMS

Even a relatively simple form that is displayed in Figure 1 demonstrates several important design issues. First, the form needs to be viewed from the perspective of a novice user. Systems developers of business applications have an inherent familiarity with this standard document. However, an inexperienced salesperson using this form could encounter difficulties. Also, think about the problems that would arise if this form is placed on a Web site and ask customers to enter their own data. Several elements of the form can present problems, principally because this form handles three topics.

One important complication is that the users need the ability to create and delete orders. However, they also need to be able to add new customers. Although several mechanisms have been developed over time to handle these tasks, the point is that both tasks need to be performed within the single form. In this example, it is not clear how to add a new customer. Placing another Add button on the form essentially means that there would be three add buttons on the form. There is already a New button and an Add button. Even with proper labeling, the probability of a problem arising is going to increase.

A second problem is the issue of handling errors. What happens if users generate errors in one section of the form? First, developers have to find a method to explain the specific problem and highlight the error so that it is understandable to the user. Second, if the error impacts a related section, it becomes even more confusing and difficult to highlight the source of the error. In this example, what if a user deletes an order (as opposed to an order item) or switches to a new order? The subform display will be updated to reflect the change, and this display takes up a large portion of the form. Users might focus on this section and not realize the cause of the change was the alteration at the main form level.

Figure 2: A Web Example.

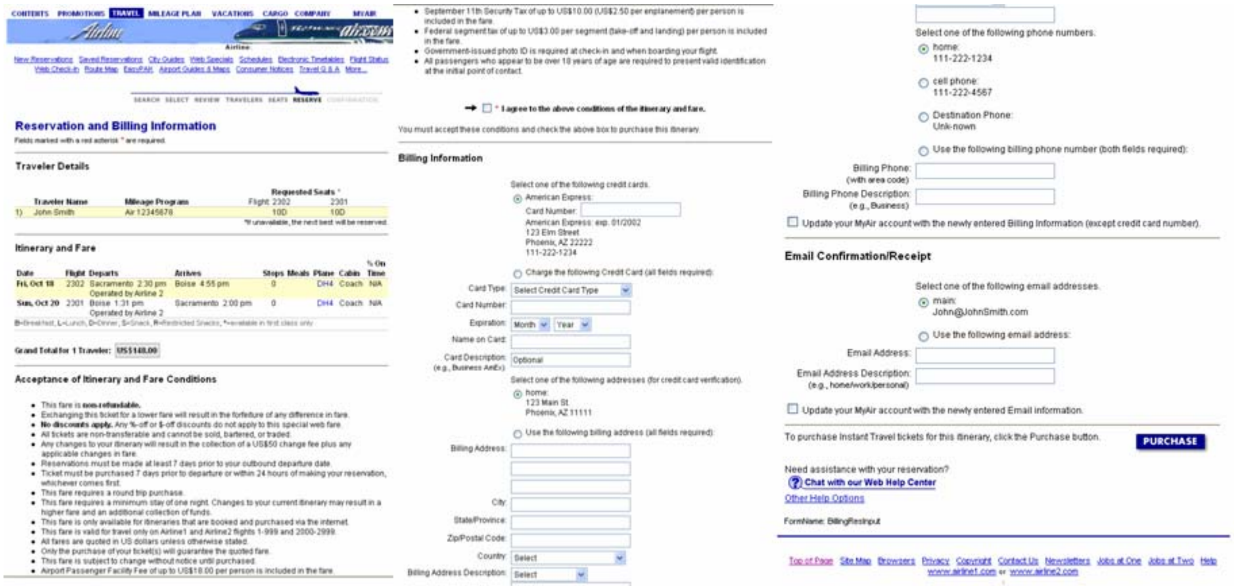


Figure 2 provides an example from an airline Web site that repeatedly caused problems even for one of the authors. The Web site has since been modified somewhat, but still exhibits similar issues. This single page payment screen is presented after the user has selected the basic flight data. The page is fairly large and it generally takes four screens to display. For the current discussion, a more important point is that the single form is used to handle several different data-entry tasks. Look closely at the figure and see if you can find all of them:

- Verify that the flight information is correct.
- Select an existing credit card by entering the number, (note: there could be multiple cards on file, making the selection list even longer.)
- Enter a completely new credit card.
- Select the billing address for the credit card.
- Enter a completely new address—for either the existing or new card.
- Select a phone number.
- Enter a new phone number, with a description.
- Specify that new billing information should be saved.
- Select from a list of e-mail addresses.
- Enter a new e-mail address and description.
- Specify that the new e-mail information should be saved.
- And one you have missed: check the box to agree to the travel conditions.

That last task was problematic at best in terms of user awareness. When users click the Purchase button, they are returned to this page, with the error message that the box must be checked. Although it is a minor inconvenience, it highlights the underlying problem with the form. The form contains too many different actions, and it is unlikely that customers will be able to handle all of them correctly. Of course, developers can add highlighting and error checking, but it is likely that a form that is too complex will slow down data entry and lead to errors. This form was based on a form used by a real airline. Since the initial study, the form has been changed (without our input) so that it is now split into multiple forms.

Figure 3: Another Real World Example and a Solution.

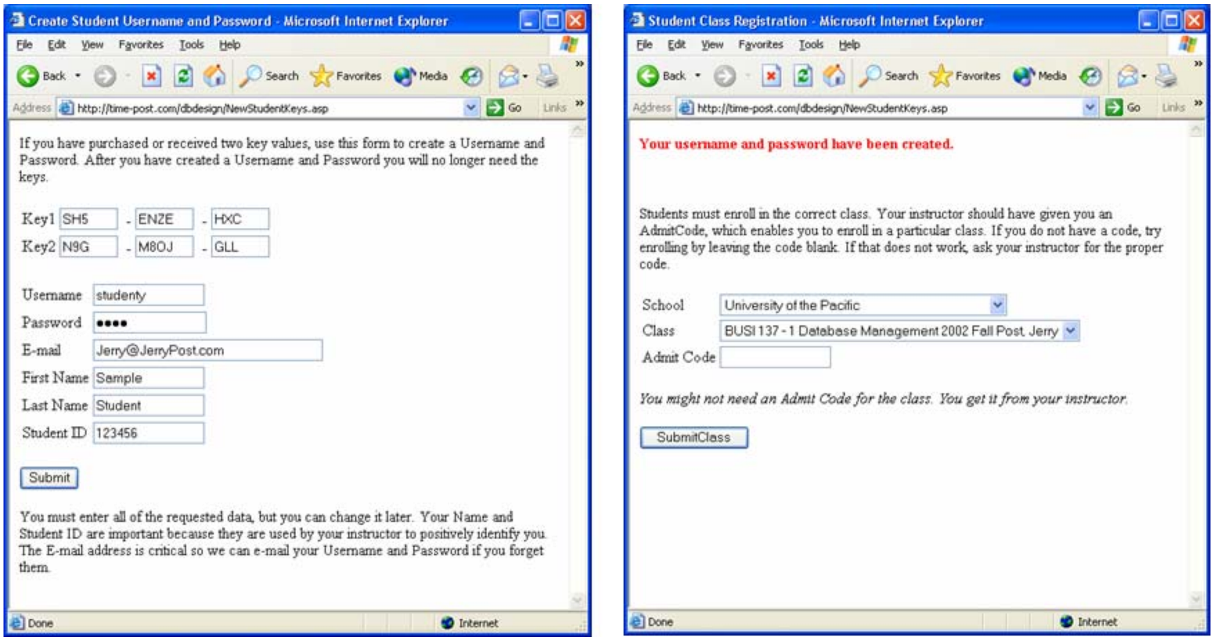


Figure 3 presents an even simpler version of the problem. In this university form, students are given registration keys and asked to create a new account by entering their personal data. Secondly, a student has to select their school and class and enter an Admit Code to register for the specific class. Initially, these two steps were handled on a single form. However, this process was generating 15-20 percent error rates—largely because students forgot to enter the Admit Code. Worse, as the error handling caused additional problems because users would rarely read the error message and simply assume that they had to re-enter all of the personal information and key codes—which simply generated even more error messages. Splitting the process into two steps has substantially reduced the errors. More importantly, error recovery is relatively easy and can be corrected immediately by the users. Consequently, exact total error rates are not available; however, support calls are down to 1-2 percent—largely because students still forget to enter an Admit Code, and subsequently ignore the error message.

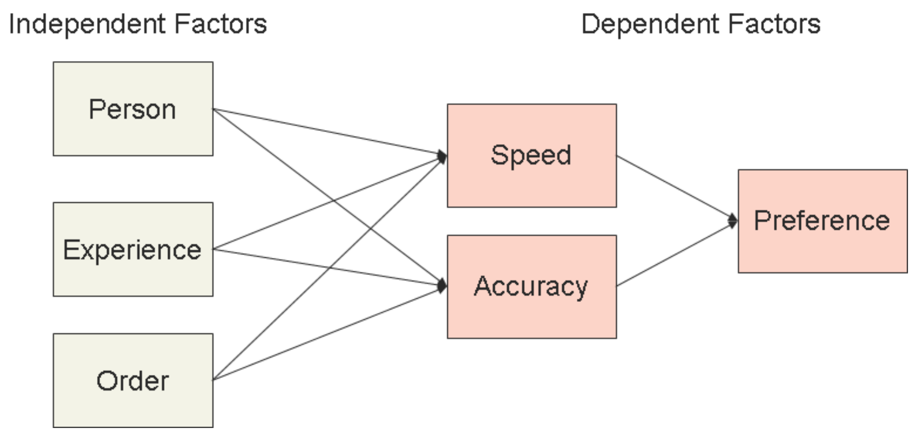
The point of this example is that the original form was relatively short, appeared to be fairly simple, and required only 11 simple data-entry items. Yet, because the process involved two distinct steps, placing both concepts on the same screen led to input difficulties.

MODEL

Illustrations presented in the prior section help to highlight the various form design issues. But, an obvious question remains to be answered: Has there really been a significant change in design usability? Do systems developers need to alter their design philosophies? Answering these questions is a complex process. It is doubtful that a single study can provide a definitive answer. However, an initial study can be used to provide some directions, and help guide future studies.

The basic idea is that users will enter data into two types of forms representing the same concept. One form will be a complex multi-part form, the other a set of linked forms. For example, the order form shown in Figure 1 represents the complex form and one part of the experiment. This form could be split and built as three related forms connected by links. Users can enter data into both sets of forms to compare them. Note that the two sets of forms are identical except that in one set the major functions are traditionally grouped on a single form and split into separate pages on the second set.

Figure 4: Basic Model.



As shown in Figure 4, the basic model is straightforward. Begin with the dependent factors. To answer the questions, an evaluation of the effect of the standard and split forms in terms of data-entry speed and accuracy is required. Additionally, users might have a preference for one approach. Logically, this preference should be related to the perceived speed and accuracy.

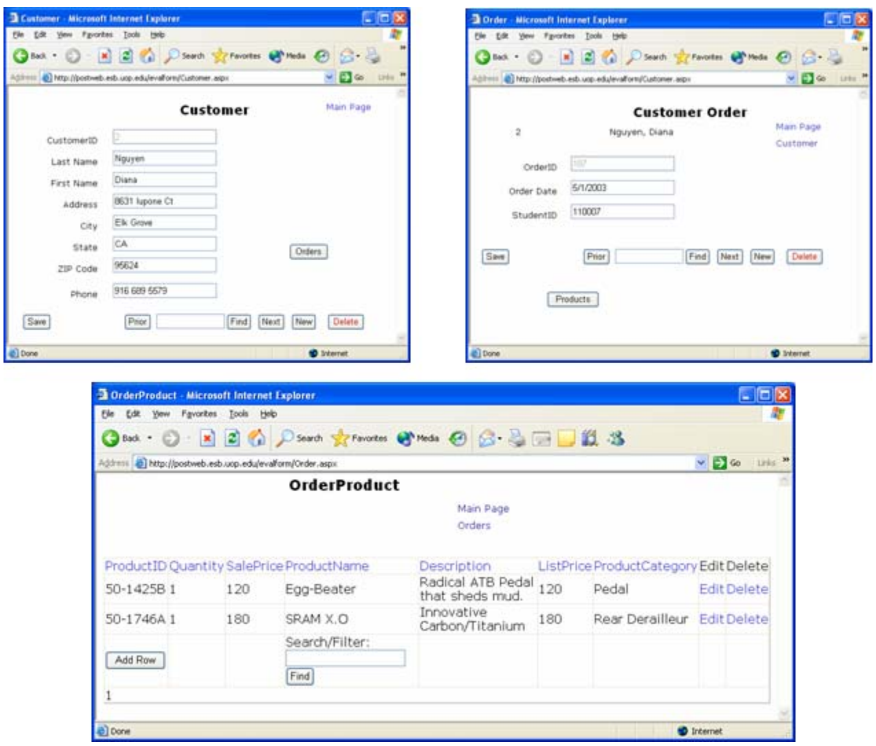
Several experimental variables need to be controlled to compensate for individual user differences in the experimental participants. In particular, prior knowledge and experience might play a role in individual preferences. For example, a person who has worked with several standard paper-based order forms might be accustomed to handling data in a particular format. On the other hand, a person who has spent considerable time on the Internet and is comfortable with hyperlinks and multiple pages might respond better to the disjoint approach. Of course, other personal differences might affect preferences and performance as well—such as intelligence. Finally, whether the person fills out the complex form first or last might also affect the dependent variables. These factors can be used to determine if there are complex relationships that might influence the results.

When using the simpler form, it is also important to determine whether there is an average difference between the two approaches. Do users prefer one approach to the other, and is there a significant difference? This difference can be measured using much simpler, distribution-free tests.

THE STUDY

The basic objective identified in the Model section is to create two versions of a form and have a sample group enter data into both sets of forms. The sample group will provide some basic background data, including experience in business and experience with computers and the Internet. Study participants were also asked to identify which form approach they preferred as an indicator of the value of the two methods. Additionally, the online forms system tracked time spent on completion of each input form. Each participant was randomly assigned to the first and second form types to mitigate and support measurement of any learning effect.

Figure 5: Online System Forms.



One of the challenges with this study is the need to build the online system—the forms had to be functional. The forms also needed to be consistent—each version had the same style and secondary features, such as drop down lists. That is, the forms differed only in the fact that the second set splits the first form into linked sections. The design tested consisted of the basic order form. Figure 5 shows the three forms used for the order form task.

It would be desirable to test the two approaches in terms of accuracy and speed. Measures were integrated into the system to track these two variables. But the accuracy is difficult to measure in the order form—mostly because the forms contain typical measures to prevent errors. The system does track data entry time from the first form to the final submission within the order form applications. To reduce the learning effect, no error messages were given on this measure.

After completing data entry for both forms, participants were asked to evaluate each approach in terms of accuracy, ease of use, and speed. At the end of the study, they were also asked to indicate their preference for the two approaches. All questions were phrased using a typical 5-point Likert scale.

In terms of protocol, participants were given a brief background survey, to be answered with Likert-scale questions. Several items evaluated the participant experience with business, computers, and the Internet. These items are used as indicators for an overall experience factor. With sufficient observations, it might be possible to estimate three separate factors. One of the questions asked study participants (students) to self-rate their GPA—higher values indicate higher GPA, which is a proxy variable for intelligence and perseverance. Students were assigned a random number to ensure confidentiality. Participants then followed instructions to enter data into the form and answer various evaluation questions at the end of the required task.

Table 1: Study participant's demographic information.

Item	Description	Mean (Std Dev)
UseC	Use computer	4.59 (0.66)
UseI1	Use Internet	4.51 (0.71)
UseI2	Comfortable Internet	4.56 (0.70)
Pur3	Internet purchases	4.07 (1.13)
LikeIT	Like computers	4.44 (0.77)
BusExp	Business experience	3.19 (1.25)
GPA1	High GPA	3.93 (0.86)
ISClass	Taken IS courses	2.95 (1.15)
PurI4	Successful Internet purchases	4.19 (0.89)
PurI5	Multiple Internet sources	3.85 (1.18)
Forms	Experience with business forms	3.35 (1.26)

Study participants were recruited from three different universities. The results presented here are generated from a total of 203 responses. In all cases, students were randomly split into two groups, determining which forms were examined first. It was important to get observations from different perspectives, in part to see if people with more experience with Web applications and less experience with traditional business forms might have different capabilities.

Participant background and experience results are summarized in Table 1. The scale for the items contains 5 as strongly agree, 3 as neutral, and 1 as strongly disagree. In general, a 5 indicates a higher valuation of the item. Glancing at the table, the means appear reasonably representative. Most have relatively high computer and Internet experiences, with somewhat lower actual business and office experience. For example, all of the computer and Internet usage questions have means significantly higher than the neutral level. The business experience and IS class indicators are not significantly different from the neutral level. This latter measure is important, because the study might be distorted if a large portion of the students had experience with systems design and development. GPAs were self-reported as above average—which is likely to be true. Most students were juniors or seniors. For this initial study, the business and Web experience numbers are the most important.

Study Reliability

This study was given to several different groups of participants in dissimilar locations at different times. The various groups are tracked through a variable (Experimental Set). A few differences arise with the groups in terms of experience level, but overall experience level had minimal impact on the study. The interpretation is that the methodology and survey instrument are consistently interpreted and applied across a variety of subjects, providing one measure of external reliability.

In terms of internal reliability, Cronbach's alpha (Cronbach, 1951) measures the internal consistency of responses across sets of variables. Because this study was designed to elicit information in several distinct category groups, it makes the most sense to compare responses within those groupings. The experience variables (UseC, UseI1, UseI2, Pur3, LikeIT, PurI4, and PurI5), generate 0.876 as an alpha value, which is quite high—particularly since the variables measure actual experience, which could be quite diverse. The preference data (EasierA, FasterA, AccurA, and PreferA) exhibits an even higher consistency alpha of 0.885, which is important since these values are the main focus of the study. More specific background variables (GPA, business experiences, number of IS classes, and experience with forms), yield a lower alpha value (0.616) because the respondents truly are diverse, and there is no a priori reason to believe that these variables should be related. The Cronbach alpha coefficients are consistent with Nunnally (1967) and Post and Kagan (2005) who suggests that alpha values in the range of 0.80 are acceptable for applied studies.

In total, the reliability values are quite high. The results of the study presented in the next section will further confirm the consistency of the data.

RESULTS

Order Forms: Basic Results

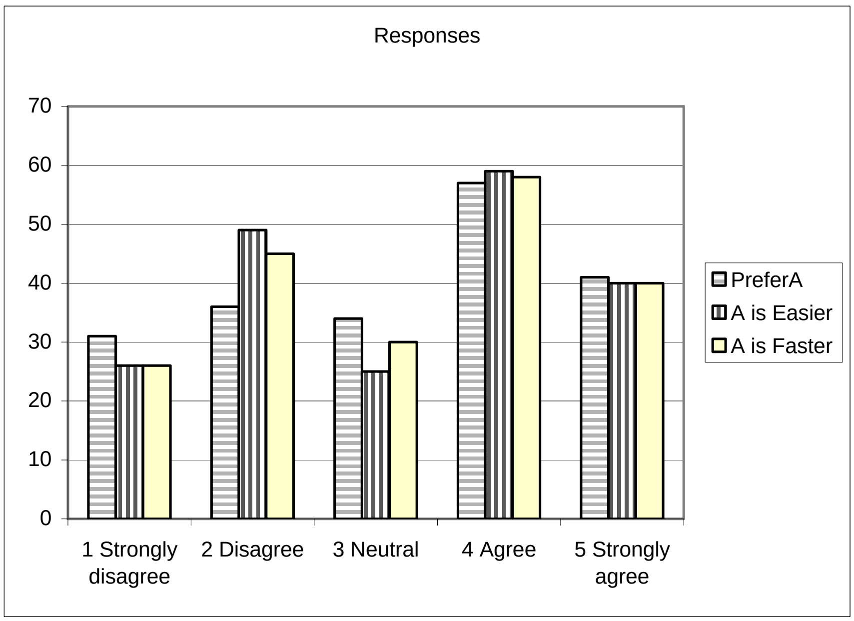
Study participants using the Order forms filled out a short survey section to evaluate both applications. Table 2 presents the basic data. Many of the means are significantly different from the neutral level as indicated by one asterisk for 5 percent error rate and two for a 1 percent error. In general, the participants believe that both forms are at least somewhat useful. Remember that Form A is the single combined form containing the order, customer and order details. Form B split each application into separate forms.

Table 2: Order Forms results.

Item	Description	Mean (Std. Dev.)
EasierA	FormA (single) is easier	3.19 (1.36)
FasterA	FormA is faster	3.21 (1.35) *
AccurA	FormA accuracy	3.81 (1.04) **
AccurB	FormB accuracy	3.53 (1.16) **
PreferA	FormA is preferred	3.21 (1.37) *
BothBad	Neither form was helpful	2.65 (1.14) **
TimeDiff	Time difference (A-B seconds)	-54.14 (208.9)

* significant at a 5 percent level.
** significant at a 1 percent level.

Figure 6: Combined Forms.



Respondents indicated a significant advantage for the combined form, both in terms of speed and accuracy. Overall, the combined approach was slightly preferred to the split approach. The difference is statistically significant, but represents only a slim margin. Figure 6 breaks down the number of responses for each category for the three main questions. First, notice that the responses are highly consistent across the three questions. Second, observe the relatively high standard deviation. Although it is clear that more people preferred the single Form A approach, a substantial number expressed a preference for the split approach in method B (disagree or strongly disagree). For the Prefer A question, 98 of those with a preference (not neutral) selected A while 67 selected B).

Learning Effects and Time

Table 3: Average time for task completion of the input forms measured in seconds.

	Time A	Time B	Paired Diff
Start A	234.7	182.4	55.3
Start B	149.2	362.5	189.1

With any experiment of this type, there is likely to be a learning effect, which allows for a level of understanding of the purpose of the forms, and the interaction design using the computer. Consequently, the actual time data for each form type will depend on which form was provided first. Table 3 shows the average times recorded for the two groups (start with Form A versus Form B) for each of the completed forms. Notice that in both cases, the time on the second form was less than the first form, indicating a learning effect.

The third column provides the data necessary to measure the overall average learning effect. Appendix 1 provides the theoretical derivation of the learning effect. Essentially, the learning effect is estimated by averaging the paired time differences across both groups of participants. Based on the data shown in Table 3, the resulting value of the learning effect average is 122.2 seconds.

Table 4: Input form completion times (without learning effect).

	Time A	Time B	Paired Difference
Average	146.8	207.0	-45.7
Std Dev	146.8	220.6	302.4
N	175	175	164

This average learning effect can now be subtracted from the time each individual spent on the first set of forms (A or B as appropriate). Table 4 shows the resulting averages and standard deviations (of the data points, not the mean). There is a difference between the times spent on Form A versus Form B (multiple forms), and Form A appears to be completed slightly faster. This difference of completion time can be tested by looking at the significance of the paired difference. Although it is negative (indicating that Form A requires less time than Form B), the T-value is only 1.94, which indicates that the value does not significantly differ from zero at the 5 percent error level (but it is at the 10 percent level). So there is slight evidence that the single form (A) is faster to complete than the split form.

Order Forms: Structural Equation Modeling

Following the basic model ideas, it is possible to construct a structural equation model (SEM) from the Order form results. Loehlin, (1992) and Muthén and Muthén (2001) discuss the applications of SEM within a modeling structure. Figure 7 shows the primary SEM. Most of the demographic indicators are used to identify the Computer Experience latent variable. Forms

Experience is a separate category because potentially people with more experience with business forms would prefer the version they are familiar with, which in this example is Form A. GPA and the true order in which respondents completed the forms stand as independent variables.

Indicators for the dependent latent variable Selection (Prefer A, Faster A, etc.) are straightforward. Larger values of these variables represent a stronger preference for selecting Form A over Form B. Of course, the indicator variables exhibit several correlations that are not displayed on this diagram but were tested during the estimation procedure.

Note that the one quality latent variable is perceived quality—identified by the respondent preference votes. The data collection system also maintained two actual performance measures: time to complete each form and data-entry accuracy. Time is evaluated as the difference in seconds between completing Form A and Form B. This variable was standardized by subtracting the mean and dividing by the standard deviation so that the range of data is closer to that for the other variables. The quality measure was assigned on a scale from 1 to 10 (10 being completely accurate) based on the number of errors or missing data elements. These two measures are used to identify a second latent variable that attempts to measure actual quality.

Once the latent variables are identified, these variables can be used to estimate the structural relationships that determine the best model form. Before examining the results, it needs to be noted that the actual quality variable is identified and measurable (differences between sample input data and data entered), but the R^2 values are relatively low. This result is important because it affects the choice of the model. It would be tempting to use actual quality as the dependent variable, or perhaps even both of the exogenous variables. But, because of the high variance associated with these two variables, it is not possible to use the "actual" data as a dependent variable. Nonetheless, it is important to leave the variables in the model to observe their effects. The overall objective of the SEM system is to examine the effects of the personal measures on the choice of the preferred type of form.

Table 5: SEM variables with associated coefficients.

Latent/Label	Indicator	Std. Coefficient
Computer Experience		
UseC	Use Computer	0.471 **
UseI1	Use Internet	0.529 **
UseI2	Comfortable with Internet	0.502 **
PurI3	Internet Purchases	0.884 **
PurI4	Successful Internet Purchases	0.671 **
PurI5	Multiple Internet Sources	0.858 **
LikeIT	Like Computers and Internet	0.478 **
ExperSet	Indicator for experimental set	0.681 **
Forms Experience		
BusExp	Business Experience	0.676 **
ISClass	Taken IS Classes	0.598 **
Forms	Used Business Forms	1.114 **
ExperSet	Indicator for experimental set	-0.617
Quality A Perceived		
PreferA	Prefer Form A	1.291 **
FasterA	Faster Data Entry with A	1.215 **
AccurA	Accurate Data Entry with A	0.434 **
EasierA	Form A is easier	1.253 **
AccurB	Accurate Data Entry with B	-0.474 **
Quality A		
Time DS	Time A – Time B standardized	0.144
QCD	Quality A – Quality B	0.719

A first step in understanding the SEM is to look at the measurement model—the estimation of the latent variables. Table 5 shows the coefficients estimated from the SEM. The coefficients are generally significantly positive. The two negative values are easily explained. Two asterisks on a value indicate significance at a 1 percent error level, while a single asterisk shows significance at a 5 percent level.

Latent: Computer Experience

A latent variable that represents computer experience is the strongest of the variable associations, which is expected since it has several indicator variables. All of the indicators are strongly positive, so the latent variable does measure the respondent's degree of computer and Internet experience. Higher values indicate more experience using computers and the Internet, and with more detailed interactions. All of the coefficients are reported in standardized values. Intercept terms were also generated, and they are generally significant (and usually positive), but these terms are not reported here because they merely serve to anchor the means.

An experimental set indicator variable is used to control for potential differences arising because the experiment was performed with several sets of respondents at different times in different locations. It does have a significant effect in this variable, indicating that the later sets of respondents had higher levels of computer and Internet experience. This result does not have any strong meaning, but the significance does necessitate that the variable be included to control for the effect.

Latent: Forms Experience

Experience with forms is also a prominent latent variable. The significantly positive relationships indicates that this variable represents respondents with more business experience, who have taken several IS classes, or who have used business forms extensively. The forms experience variable represents familiarity with common business forms. It is important to include the variable in the model because people experienced with business forms might have developed a preference for a particular layout. These users are likely to be more familiar with the terminology and purposes of the forms, so they might have faster times and higher quality responses. Consequently, this variable is included to test and control for these potential effects of user experience and any confounding that is associated with this level of computer familiarity. The negative coefficient on the experimental set is not significant, but it would indicate that later participants had less experience with forms. The variable has only a slight effect on the model, and could be removed. This variable is maintained in the model as a safety check in terms of controlling for this potential effect.

Latent: Quality A

This variable is the weakest within the measurement model. The coefficients are low and not significantly different from zero. The main problem impacting the strength of this variable is the high variances of the indicator variables—particularly the time difference. The estimation was also tested using the time values after the learning effect was subtracted. The results were almost identical and so are not reported.

Given the fact that both coefficients are positive presents a slight complication to interpreting the latent variable. Longer times mean slower speed, so the positive coefficient on the time differential would indicate that a higher latent variable means respondents were slower at filling out Form A (Form A is somewhat less valuable). Conversely, the positive coefficient on the quality rating indicates that higher values of the latent variable generate higher quality ratings for Form A. This difference might be explained by observing that quality and time could be inversely related. Spending more time could lead to greater quality. Ultimately, the variances are too high to make that claim statistically, but it could explain the difference. Given that the standardized coefficient on quality is substantially larger than for time, and because of the high variance in the times, this latent variable is treated as a quality measure.

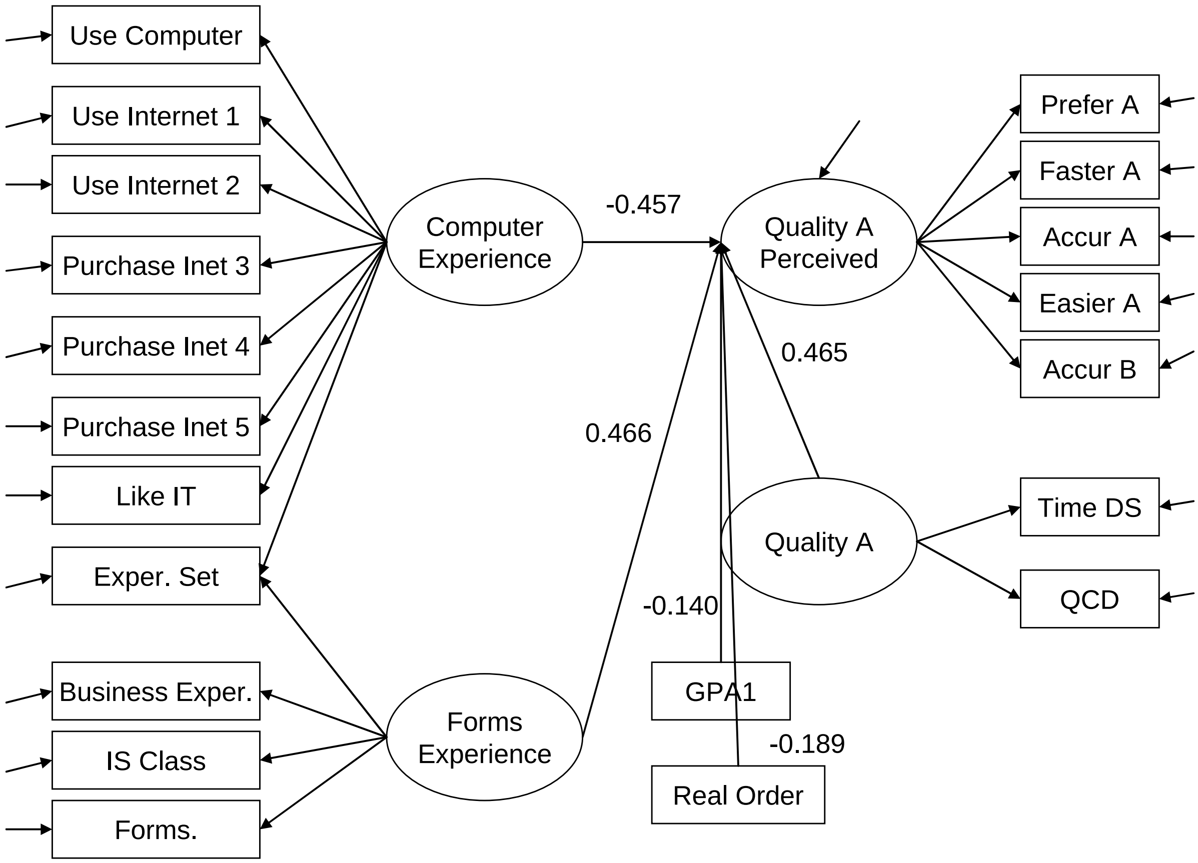
Latent: Quality A Perceived

This variable represents the respondents' perception of the quality of Form A versus Form B. Factors comprising this grouping is speed, accuracy, ease-of-use, and ultimate preference. In effect, this variable defines the respondent's choice of forms. The measurement model is strong, with all coefficients significant. Note that the AccurB coefficient is negative—which is expected, since it represents the accuracy of the opposite Form B approach. The R-squared values on all of the FasterA, EasierA, and PreferA variables are all over 82 percent. The accuracy R-squared values are both around 17 percent; therefore, the perception of quality of a particular form is largely driven by the ease-of-use and speed indicators.

Structural Model Results

Figure 7 presents the estimated coefficients for the model on the lines leading to the predicted variable (Quality A Perceived). Note that the Chi-Square probability is good and the RMSEA is relatively low—indicating the model is reasonable. The R-squared value for the overall model is 0.20, which is moderate for cross-sectional data, but affects the significance of the coefficients. Nonetheless, with more observations, it is conceivable that some of the coefficients could ultimately be significant. If so, the negative value on the computer experience coefficient would become important. This indicates that users with more Internet experience prefer the Form B approach of multiple forms. Participants with more experience with business forms prefer the Form A single form method. Both of these results are important, and understandable. People who have been trained with business forms can see the benefit to that approach. On the other hand, most Web sites use multiple forms for customers—to reduce errors. Therefore; as future employees gain more experience with the multiple-form approach, they are going to reject the existing single-form approach. Even training might not be enough to overcome user objections given that the sum of the two coefficients is about zero—placing them in a neutral position.

Figure 7: Quality A Perceived.



Chi-Square: 149.0 137 df, P-value=0.2278; RMSEA = 0.021

CONCLUSIONS AND INTERPRETATIONS

One of the more important conclusions from this study is that many of the participants preferred the multiple-form approach to entering business data. Although on average, more people preferred the traditional single-form method, a substantial number did not. In particular, this group appears to be influenced by Internet experience with multiple forms. As more people gain experience with this approach, it is possible that they will learn to expect it in all forms—even when they are employees entering traditional business data. There is some evidence that training and experience with traditional forms can convince employees to prefer the single form approach. There is also some evidence that respondents are faster at entering data on the single-part form instead of using multiple screens. Overall, these results need additional research.

The potential implications of these conclusions could be enormous. Traditional business system design discusses the importance of building forms that mimic existing paper-based forms. When people (employees, customers, suppliers, and so on) no longer have experience with these paper forms, it is important to change the way the systems work. As Couper et al. (2004) indicates, the interactive nature of data collection over the Web, and the greater variety of design features available to the form designer, increase the importance of studying the impact of changes in these features. Many other aspects of online form design require research. For example, it is known that the color of a form has an impact on response rates in surveys. How does Web page color and design impact response rate and accuracy?

FUTURE DIRECTION

In assessing the nature of this research with respect to future direction and managerial application it is important to note that systems design and methods will continue to deploy new technologies. Although it might sound simple, the question of whether to split a form into multiple pages is difficult to answer. And, the answer can change over time—if people become familiar with complex forms, and if designers adopt standard control features; it might be possible for users to adapt to complex forms. Or, if screen-sizes shrink (e.g., mobile platforms), or attention spans drop, it probably would be useful to shift to split pages. A single study cannot completely answer all questions. This study shows that the question is important and that more work is needed along these lines. For example, it would be helpful to study different task elements and see if certain types, or certain types of users are better handled with single complex forms. For now, the results of this study suggest that split forms can be useful for reducing data-entry errors—by focusing attention on single items at a time. But, they might not be the most efficient data-entry methods for experienced users. Additionally, the study has indicated that experience with Internet forms leads people to prefer split forms. Even a simple scan of forms on the Web shows that most user data-entry is handled by split forms today. Which raises the question of whether there is a longitudinal effect? As customers and employees spend more time on the Web, will they become conditioned to prefer split forms with simple concepts on each page?

The implications of the changing preferences of forms design are potentially huge. Historically, design wisdom stated that forms should mimic the old paper forms and include all relevant data on one page (partly to minimize page turning and lost paper pages). With Web-based forms, this conclusion appears to be shifting. Focusing a single page on a single task simplifies the data entry and reduces clutter on the screen. Because the question of page-turning and searching is mitigated by hyperlinks, disorientation could actually be reduced by splitting the input form into pieces. However, the transition (if it happens) is only beginning, creating bifurcated groups. Some users prefer the single-page approach (largely for speed of data entry), others are happier with split forms. Conceivably, it might be possible to create both types of forms and allow users to select a version. For complex tasks with in-house users, this approach might be feasible. For open Web sites, it is likely to be better to stick with a single method. The split-form approach is likely to be better because it improves data-entry accuracy.

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APPENDIX A

COMPUTATION OF LEARNING EFFECT

Define the time for one individual to complete Form A as T_i^A and Form B is defined similarly but with a B superscript. Then, for a person who completes Form A first, the total time would be:

$$(1) \qquad T_i^A = \mu^A + LE_i^A + \varepsilon_i^A$$

Where μ^A is the average time to complete Form A, LE_i^A is the learning effect time to understand the goals and system, and ε_i^A is the deviation of the individual time from the mean. The time for participants who begin with Form B would be similar, but with a B superscript instead. More importantly, for participants who begin with Form A, the time spent on Form B will be lower because it will not include the learning effect (LE) term.

Estimating the learning effect component is important, because it needs to be removed to provide a better estimate of the actual time required to perform each task. To estimate the average LE term requires looking at the paired differences (Time A – Time B). For those who start with Form A, that computation is:

$$(2) \qquad T_i^A - T_i^B = (\mu^A + LE_i^A + \varepsilon_i^A) - (\mu^B + \varepsilon_i^B)$$

Because the smaller term should be subtracted from the larger one, individuals starting with Form B lead to:

$$(3) \qquad T_j^B - T_j^A = (\mu^B + LE_j^B + \varepsilon_j^B) - (\mu^A + \varepsilon_j^A)$$

To reduce the equations, compute the average of both by summing the times in each group and dividing by the number of respondents in each group (n^A and n^B) to obtain:

$$(4) \qquad \Sigma(T_i^A - T_i^B)/n^A = \mu^A + \Sigma\, LE_i^A/n^A - \mu^B + \Sigma\, \varepsilon_i^A/n^A - \Sigma\, \varepsilon_i^B/n^A$$

$$(5) \qquad \Sigma(T_j^B - T_j^A)/n^B = \mu^B + \Sigma\, LE_j^B/n^B - \mu^A + \Sigma\, \varepsilon_j^B/n^B - \Sigma\, \varepsilon_j^A/n^B$$

Note that the mean terms arise because they are constants that are added n^A times and then divided by n^A. The final step is to add these two averages together and subtract the matching mean terms to get:

$$(6) \qquad \Sigma\, LE_i^A/n^A + \Sigma\, LE_j^B/n^B + \Sigma\, \varepsilon_i^A/n^A - \Sigma\, \varepsilon_i^B/n^A + \Sigma\, \varepsilon_j^B/ n^B - \Sigma\, \varepsilon_j^A/n^B$$

Following standard statistical definitions, the expected value of the errors terms is zero. Also note that the paired subtractions further reduces the values. In both cases, the error terms are zero on average, so equation (6) reduces to the two average learning effect terms:

$$(7) \qquad \Sigma\, LE_i^A/n^A + \Sigma\, LE_j^B/n^B$$

Since two values are being combined, the final step is to divide by 2 to produce the overall average learning effect. Looking back at the first couple of steps, this value is computed by averaging the paired time differences (positive in both cases) over the respective number of respondents. Then adding these two values and dividing by two, the mean of the two averages is computed.

APPENDIX B

SURVEY/BACKGROUND

Scale: Strongly disagree, Disagree, Neutral, Agree, Strongly Agree

1. I have been using computers for many years. (UseC)
2. I have been using the Internet for many years. (UseI1)
3. I feel comfortable with using the Internet. (UseI2)
4. I have purchased several items over the Internet. (PurI3)
5. I like computers and the Internet. (LikeIT)
6. I have worked in business or office jobs for several years. (BusExp)
7. I have a high GPA. (GPA1)
8. I have taken several IS or computer classes. (ISClass)
9. My use of the Internet for purchases has been successful. (PurI4)
10. I have bought items from several different Internet sources. (PurI5)
11. I have used business order forms several times. (Forms)

1. The **first** set of forms was much easier to understand. (Ease1)
2. I could enter data faster with the **first** set of forms. (Speed1)
3. I am confident that the data was entered correctly in the **first** set of forms. (Accur1)
4. I am confident that the data was entered correctly in the **second** set of forms. (Accur2)
5. I prefer the **first** form(s). (Prefer1)
6. Neither form was helpful for data entry. (BothBad)

Notice that the result questions are expressed in terms of sequence to make it easy for respondents. These variables were recoded based on the sequence of forms filled in by each student to generate new variables expressed in terms of FormA and FormB (EasierA, FasterA, AccurA, AccurB, and PreferA).

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Supporting the Virtual Community: Social bookmarking as a user-based classification scheme in a knowledge library

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