

Workplace user frustration with computers: an exploratory investigation of the causes and severity

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When hard-to-use computers cause users to become frustrated, it can affect workplace productivity, user mood and interactions with other co-workers. Previous research has examined the frustration that students and their families face in using computers. To learn more about the causes and measure the severity of user frustration with computers in the workplace, we collected modified time diaries from 50 workplace users, who spent an average of 5.1 hours on the computer. In this exploratory research, users reported wasting on average, 42–43% of their time on the computer due to frustrating experiences. The largest number of frustrating experiences occurred while using word processors, email and web browsers. The causes of the frustrating experiences, the time lost due to the frustrating experiences, and the effects of the frustrating experiences on the mood of the users are discussed in this paper. Implications for designers, managers, users, information technology staff and policymakers are discussed.

1. Introduction

The US National Telecommunications and Information Administration reports 73% of employed people 16 and older used computers as part of their work (NTIA 2002). With the rising use of computers in the home, school and workplace, researchers have begun to focus on the possible consequences of such use (Murrell and Sprinkle 1993, Maurer 1994, McInerney, McInerney *et al.* 1994, Brosnan 1998, Chua, Chen *et al.* 1999, Smith and Caputi 2001). Research on computer anxiety, attitudes and frustration has shown that a disturbing portion of computer users suffer from negative affective reactions towards the computer, which can subsequently affect whether or not they use the computer, and whether or not they use the computer effectively. Research on frustration, both in individuals and organizations, has shown that frustration can lead to maladaptive behaviors that can subsequently lower effective goal-oriented behavior. In addition, research has shown that between one-third and one-half of the time

spent in front of the computer is lost due to frustrating experiences – when considering both the time it took to fix the problem and any additional time that was lost due to the problem (Ceaparu, Lazar *et al.* 2004).

Because computers are so prevalent in organizations, it is important to examine the role of computers in the organization and the possible consequences arising from their use. The purpose of this paper is to present exploratory research, with 50 workplace users recording their frustrations with computers, through the use of modified time diaries. The causes of the frustrating experiences, the time lost due to the frustrating experiences, and the severity of the frustrations are discussed in this paper. The first step in addressing the frustrations that computer users face is to understand the causes, which can lead to experimental testing of improved interfaces, and then implementation of these solutions in industry. Computers play an important role in affecting the performance of individuals within organizations; therefore, this research should be of great interest to businesses and

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other organizations, because improved interfaces can improve employee productivity and satisfaction, increase product quality, while reducing employee turnover.

2. Background research

2.1 Frustration

Frustration is often defined in different ways, making the subject itself somewhat ambiguous. Frustration was first introduced by Sigmund Freud as a concept both external and internal in nature, and related to the concept of goal attainment. Frustration occurs when there is an inhibiting condition that interferes with or stops the realization of a goal. All action has a purpose or goal, whether explicit or implicit, and any interruption to the completion of an action or task can cause frustration. For Freud, frustration included both external barriers to goal attainment and internal obstacles blocking satisfaction (Freud 1921).

This concept of frustration as a duality is continued in the analysis of frustration as both cause and effect (Britt and Janus 1940). As a cause, frustration is an external event, acting as a stimulus to an individual and eliciting an emotional reaction. In this case, the emotional response is the effect, and the individual is aroused by this external cause and a response is often directed towards the environment.

Dollard *et al.* define frustration as ‘an interference with the occurrence of an instigated goal-response at its proper time in the behavior sequence’ (Dollard, Doob *et al.* 1939). Because an instigated goal response entails only that the goal be anticipated, frustration is due to the expectation and anticipation of a goal, not the actual attainment of the goal (Berkowitz 1978). If the goal is unfulfilled, frustration is experienced because satisfaction was not achieved and hopes were suddenly thwarted. The thwarting or hindrance – terms often used synonymously with frustration – is not limited to the actual activity in progress, but relates to what the individual is expecting (Mowrer 1938a).

Frustrations, in all cases, are aversive events (Ferster 1957), having as their main defining feature the element of a barrier or obstruction. This barrier can take the form of an actual barrier, or an imaginary one such as the response to anticipated punishment or injury (Mowrer 1938b). A frustrating situation, then, is defined as any ‘in which an obstacle – physical, social, conceptual or environmental – prevents the satisfaction of a desire’ (Barker 1938). These blocks to goal attainment may be both internal and external (Shorkey and Crocker 1981), similar to the duality proposed by Freud. Internal blocks consist of deficiencies within the individual such as a lack of knowledge, skill, or physical ability. External blocks could include the physical environment, social or legal barriers such as laws or mores, or the behavior of other people.

2.2 Factors affecting level of frustration

The level of frustration experienced by an individual clearly can differ, depending on the circumstances surrounding the frustrating experience and on the individuals themselves. One major factor in goal formation and achievement is goal commitment, which refers to the determination to try for and persist in the achievement of a goal (Campion and Lord 1982). Research on goal theory indicates that goal commitment has a strong relationship to performance and is related to both the importance of the task or outcome and the belief that the goal can be accomplished (Locke and Latham 2002).

Individuals will have a high commitment to a goal when the goal is important to them and they believe that the goal can be attained (Locke 1996). The importance of the goal, in addition to the strength of the desire to obtain the goal (Dollard *et al.* 1939), will affect the level of goal-commitment as well as the strength of the subsequent reaction to the interruption. Self-efficacy – the belief in one’s personal capabilities – can also affect goal-commitment (Locke and Latham 1990) in that the belief about how well a task can be performed when it involves setbacks, obstacles, or failures may affect how committed individuals are to that goal (Bandura 1986).

Judgments of efficacy are related to the amount of effort expended, how long they persist at the task, and resiliency in the case of failure or setback (Bandura 1986, 1997b). Self-efficacy influences emotional states as well; how much stress or depression people experience in difficult situations is dependent on how well they think they can cope with the situation (Bandura 1997a). The level of frustration that people experience, therefore, would be influenced by how important the goal was to them, as well as how confident they are in their abilities. ‘Because goal-directed behavior involves valued, purposeful action, failure to attain goals may therefore result in highly charged emotional outcomes,’ (Lincecum 2000) including frustration.

Cultural factors can also play a role in the level of frustration experienced by individuals when coming across obstacles to their path of action. Social Learning Theory (Bandura 1973, p. 53) states that ‘rather than frustration generating an aggressive drive, aversive treatment produces a general state of emotional arousal that can facilitate a variety of behaviors, depending on the types of responses the person has learned for coping with stress and their relative effectiveness’. Ways of coping with frustration are therefore learned from the society and are governed and constrained by the laws of a society. This can contribute to the level of frustration tolerance that individuals have, which is also affected by their prior experience and task specific self-efficacy.

According to Freud, it is not simply the nature of the frustrating incident that determines how people will react to

it. Rather, there is an interplay between the situation and the psychological characteristics of individuals. The level of maturity of the individual also plays a part in the reactions to frustration (Barker, Dembo *et al.* 1965). With maturity, there is an increase in the variety of responses to a situation employed by individuals, in the control of the environment, and in their ability to employ problem-solving behavior and plan steps to obtain the goal. It would appear that learning, which is culturally determined, is a major factor in developing socially acceptable responses to frustration.

Two additional factors that may influence the force of the frustration are the severity of the interruption and the degree of interference with the goal attainment (Dollard *et al.* 1939). All obstructions are not equally frustrating, and the severity and unexpectedness of the block will also factor into the strength of the response. In addition, if individuals perceive that the thwarting was justified by socially acceptable rules, as opposed to being arbitrary, the frustration response may be minimized (Baron 1977). This may be due to the lowering of expectations because of extra information available to the individual. As stated above, it is the anticipation of success that affects frustration, and not the actual achievement of the goal. Therefore, if individuals expect to be thwarted or have a low expectation of success, frustration may be minimized.

2.3 Responses to frustration

The responses to frustration by individuals can be either adaptive or maladaptive (Shorkey and Crocker 1981). Adaptive responses are constructive and are implemented to solve the problem that is blocking goal attainment. They may include preemptive efforts to avoid the problem, or once the problem is encountered, problem-solving strategies to overcome or circumvent the problem. Freud lists two types of adaptive responses: (1) transforming stress into active energy and reapplying this energy towards the original goal; and (2) identifying and pursuing alternative goals. Maladaptive responses, on the other hand, are characterized by a lack of constructive problem-solving and often make the frustrating experience worse by creating additional problems. These maladaptive responses may be further categorized into objective (aggression, regression, withdrawal, fixation, resignation) and subjective (extra-punitive, intropunitive, impunitive) responses (Britt and Janus 1940).

2.4 Organizational frustration

Organizational frustration has been defined by Paul Spector in a very similar fashion, and refers to an interference with goal attainment or maintenance that is caused by some stimulus condition within the organization

(Spector 1978). It has been further narrowed to be defined as the interference with an individual's ability to carry out their day-to-day duties effectively (Keenan and Newton 1984). The sources of organizational frustration put forth by Spector include the physical environment (both natural and man-made), the organizational structure and climate, the rules and procedures of the organization, and individuals both in and out of the organization. In addition, the concept of situational constraints (Peters and O'Connor 1980) has been hypothesized to contribute to organizational frustration (Storms and Spector 1987). Spector (1978) suggested four reactions to organizational frustration: (1) an emotional response of anger and increased physiological arousal, (2) trying alternative courses of action, (3) aggression, and (4) withdrawal. Of the behavioral reactions, only the second one – that of trying alternative courses of action to obtain the goal – is an adaptive response, while the other three are maladaptive. It is likely that the emotional reaction accompanies one of the three behavioral reactions, although the emotional reaction may be maladaptive by itself and become a further impediment to goal attainment. Clearly, should an individual become frustrated, it is in the best interests of the organization to have the individual respond in an adaptive way and attempt to find another solution to the problem in a clear decisive manner. Spector also put forth the idea that some mild forms of frustration may be seen as challenges rather than problems for some individuals, thus causing a motivational effect rather than a hindering effect and increasing the likelihood of an adaptive response rather than a maladaptive one.

In his model, Spector describes behavior exemplifying two of the three maladaptive responses, in an organization. Examples of withdrawal behavior in an organization could include the abandonment of a goal, absenteeism, or turnover. Examples of organizational aggression include interpersonal aggression, sabotage and withholding of output. Both of these maladaptive responses are thought to lead to a decrease in job performance. However, evidence for the frustration-performance link is mixed, as some cases of mild frustration are found to increase task-performance, presumably due to increased arousal (Spector 1975), whereas other studies find that frustration actually inhibits both task-performance and learning of a new task.

Other relationships with organizational frustration have also been tested. In a sample of employed individuals, significant relationships were found between both self-reported sabotage and interpersonal aggression with level of frustration as measured by the Organization Frustration Scale (Spector 1975). Frustration was also found to be strongly correlated to a self-reported desire to leave the place of employment. In another study of 401 employed engineers, Keenan and Newton found that organizational climate, role stress and social support all correlated

positively with environmental frustration (Keenan and Newton 1984). Additionally, they found that frustration was significantly related to angry emotional reactions, latent hostility and job dissatisfaction.

Additional research has shown that organizational frustration is positively correlated with several negative behavioral reactions – aggression, sabotage, hostility and complaining, withdrawal and intent to quit (Storms and Spector 1987). In an effort to examine the antecedents of the response choice (adaptive or maladaptive) Storms and Spector also tested for the moderating effect of locus of control, hypothesizing that individuals with an external locus of control would exhibit more counterproductive behavior during times of frustration than those with internal locus of control. Using the same Organizational Frustration scale, Jex and Gudunowski examined the role of self-efficacy beliefs and work stress (Jex and Gudunowski 1992). They found that individual efficacy beliefs were significantly negatively correlated with level of organizational frustration, indicating that those with less belief in their abilities at their job suffered more frustration than those with high efficacy beliefs. However, they did not find that efficacy beliefs mediated the relationship between stressors and frustration, indicating that self-efficacy does not affect the level of frustration experienced due to external stressors such as situational constraints.

2.5 Computer anxiety

The reactions of people to computers have been studied extensively, particularly attitudes towards the computer (Loyd and Gressard 1984, Murphy, Coover *et al.* 1989, Nash and Moroz 1997) computer anxiety (Glass and Knight 1988, Cohen and Waugh 1989, Torkzadeh and Angulo 1992, Maurer 1994, Schumacher and Morahan-Martin 2001), and computer self-efficacy (McInerney, McInerney *et al.* 1994, Compeau and Higgins 1995, Brosnan 1998). Each of these variables, combined with the factors listed above, can affect how frustrated individuals will become when they encounter a problem while using a computer.

The number of times a problem has occurred before can affect their perception of the locus of control, and therefore influence their reaction as well. This may be related to anxiety, as people with low computer self-efficacy may be more anxious (Brosnan 1998) and more likely to view the computer suspiciously and react with great frustration when something occurs, especially when they have run into it before. Different levels of anxiety will affect performance when something unforeseen or unknown occurs, causing anxious people to become more anxious (Brosnan 1998). On the other hand, the level of experience may temper this if the prior experience increases computer self-efficacy (Chua, Chen *et al.* 1999) by lowering anxiety and reducing

frustration when a problem occurs. The perceived ability to fix problems on the computer, as well as the desire to do so may also affect levels of frustration. If instead, these problems are seen as challenges, they may not be as frustrating, which is most likely directly related to level of prior experience as well as computer self-efficacy.

2.6 Computer frustration

Frustration with technology is a major reason why people cannot use computers to reach their goal, hesitate to use computers, or avoid computers altogether. A recent study from the Pew Internet and American Life study found that a large percentage of people choose not to go online, because they find the technology to be too frustrating and overwhelming (Pew 2003). Currently, 42% of Americans do not use the Internet, in large part because they find it to be frustrating and confusing. This is not surprising; previous research on user frustration found that users wasted nearly one-third to one-half of the time spent on the computer, due to frustrating experiences (Ceaparu, Lazar *et al.* 2004).

Unfortunately, computer applications are often designed with interfaces that are hard to use, and features that are hard to find. Even government websites, which are supposed to provide easy access to government information for all citizens, are frequently hard to use and produce high levels of user frustration (Ceaparu and Shneiderman 2004). Frustration with technology can lead to wasted time, changed mood and affected interaction with colleagues. When users in a workplace are frustrated with their computers, it can lead to lower levels of job satisfaction (Murrell and Sprinkle 1993). In some cases, user frustration with technology can even lead to increased blood volume pressure and muscle tension (Scheirer *et al.* 2002).

Research on computer frustration has shown that computer self-efficacy and attitudes play a significant role in reducing the frustration levels in computing. Level of comfort with the computer and the determination to fix a problem, which are associated with a high level of computer self efficacy, both appear as important factors in both the immediate experience of frustration as well as the overall frustration level after a session of computer use. In the previous study on computer frustration, computer attitude variables mediated the experience of frustration, but experience did not. Simply using a computer, therefore, does not lessen user frustration; rather it is one's attitude towards it and comfort with it.

There is a measurable benefit to improved usability of user interfaces for lower user frustration (Bias and Mayhew 1994). Many well-known companies, such as IBM, Staples, the National Football League and Macy's focus on improving their interface design, which leads to measurable

improvement of the bottom line (Tedeschi 1999, Clarke 2001). For instance, when Macy's made their website search engine easier to use, the conversion rate (the rate at which site visitors are 'converted' into buyers) went up 150% (Kemp 2001). Staples.com used feedback from users to improve their online registration pages, to make them easier to use. After improving the usability of the registration pages, the registration drop-off rate (the number of people who begin registering but fail to complete the registration) decreased by 53% (Roberts-Witt 2001). After losing market share, AOL yielded to customer complaints and removed a majority of the pop-up advertisements from their service (Hu 2002). Companies that have redesigned interfaces for log-on screens and for user forms have seen improvements in employee productivity that can be measured, in tens or hundreds of thousands of dollars (Nielsen 1994). User frustration with computers does have a major impact on the bottom line of companies, and therefore, it is important to study this phenomenon.

3. Research methodology

To learn more about user frustration with technology in the workplace, data was collected through the use of modified time diaries. Users recorded data about their frustrations as the frustrations occurred. Surveys would not be an appropriate data collection methodology for this research, since users trying to recall frustrations from their past experiences might overestimate or underestimate the level of frustration and the time wasted (Fowler 1993). Data logging, such as clickstream data, cannot effectively measure frustration, since these data only show user operations and system errors, but many frustrating experiences do not generate detectable error reports. There are many events that are frustrating for users (such as spam or pop-up advertisements), and occur when the system is operating in a correct state. Confusing menu items or misleading link labels are not detectable by any automated means; they must be reported by users. This same methodology and similar pre- and post-session forms were used in the previous study of computer frustration in students (Ceaparu, Lazar *et al.* 2004). The Frustrating Experience Report form had some modifications and is included in Appendix A.

Subjects in this study were encouraged to perform their typical work-related tasks, and record, as a part of their time diaries, any frustrating experiences. Tasks are not pre-assigned to subjects, because user frustration is correlated to the importance of the task. When tasks are important to users, users report higher levels of frustration than when tasks are not important. Pre-assigned tasks would therefore not accurately model the user frustration in an average workday. The following protocol was used:

1. Fill out demographic information (age, gender, computer experience, etc.).
2. Fill out a pre-session survey (noting current mood).
3. Perform work-related computer tasks of their choosing, for a minimum of one hour total.
4. Fill out frustration experience forms, whenever the subject feels frustrated. These forms describe the cause, nature and severity of the frustrating experience (see Appendix A).
5. Fill out a post-session survey (measuring frustration after the session ended).
6. After completing the post-session survey, subjects fill out a reimbursement form and return all of the materials via postal-mail to the researchers.

Due to the compounding impact of filling out forms on a computer when already frustrated, all of these forms were filled out on paper.

4. Results

Data collection took place from mid-2002 through 2003. Participants were recruited through listservs and word of mouth in the Baltimore/Washington professional community. Participants had to be college graduates and use computers as part of their work. Data collection was required to be at their workplace for work-related tasks. A total of 50 subjects took part in the study. Each subject was a workplace user of computers, and was paid \$25. The workplaces represented in this study include healthcare (15), law (3), education (8), information technology (11), non-profit-other (5), for-profit-other (2), government (3) and 3 subjects did not indicate their workplace. The average age of users was 35.95 years (with a range of 23 to 76 years old). The average number of years of computer experience was 2.38 years (with a range of less than a year to 25 years of experience). A total of 149 frustrating experiences were reported, with each participant reporting between one and six experiences. Users recorded their experiences, in time diaries, for a period of 5.1 hours, on average. This paper reports the causes and severity of the frustration, highlighting the responses to frustration, as well as the time lost. Due to the amount of data collected, a separate paper addresses how the frustration impacted on the individual's mood and interaction with others (Lazar, Jones *et al.* 2005).

Word processing and email produced the largest number of frustrating experiences, probably reflecting that these applications were used most often (see table 1). There were several frustrating experiences involving moving data from one application to another application, such as email content into word processing and even moving content among similar applications, such as Word to WordPerfect. Many frustrating experiences were

Table 1. Applications that were the source of frustrating experiences.

Problem source	Frequency of problem sources
Web browsing	17
Email	28
Other Internet use	11
Video/audio software	1
Word processing	34
Chat and instant messaging	1
File browsers	1
Programming tools	2
Spreadsheet programs	9
Graphic design programs	1
Presentation software	1
Database programs	6
Other	37
Total	149

inhibiting, but did not ultimately prevent the task from completion.

Most participants were already familiar with the frustrating experience from previous experiences and know how to solve it (see table 2). Most solutions involved simply redoing the task or rebooting and then redoing the task. Other solutions involved work-arounds and as a last resort finding help externally. The type of solution taken was independent of demographic differences. In only one frustrating experience did the user consult a manual, and only in two experiences did the user consult online help.

The time lost due to frustrating experiences was one of our key measures. Users, in general, spend more time recovering from an incident than initially working through the incident. Both the initial time spent on responding to the frustrating experience, as well as the time to recover from any work lost due to the problem, contribute to the total time lost. The method for computing percentage of time lost per user is as follows:

$$\text{Percent Time Lost} = \frac{\text{MS} + \text{MR}}{\text{MT}}$$

Where MS is minutes spent to solve the problem, MR is minutes spent to recover lost work, and MT is total minutes spent on the computer (Ceaparu *et al.* 2004).

For each user, the amount of time lost to respond to the initial problem, as well as the time lost to recover from the problem, was added for all frustrating experiences reported by that user and then divided by the overall time spent by that user on the computer. The final figure represents the percent time lost by that user of the time that they spent on the computer. Table 3 gives a sample of these data calculations from one user.

The percentages for time lost to solve the problem, time to recover lost work and time lost, after being normalized

Table 2. Solutions taken by participants.

Solution taken	Frequency of solutions
I knew how to solve it because it happened before	35
I figured out a way to fix it myself	9
I was unable to solve it	16
I ignored the problem or found an alternative	20
I tried again	5
I restarted the program	15
I consulted online help	2
I asked someone for help	16
I rebooted	29
I consulted a manual or a book	1
Total	148

Note: participant left some responses blank.

for each user, were then averaged over the population of 50 users (see table 4). Readers should note that, because of a highly skewed distribution, this approach gives a more representative result than simply totaling time lost over all users and dividing by total time spent by all users (more than 250 hours of computer work by 50 users).

All three columns in table 4 are calculated from the data itself. This means that the third column is slightly different from the sum of the first two columns. Percentages are given for all users, and for all users minus the one outlier frustrating experience (see paragraph below).

One user reported an extremely long duration frustrating experience, which we considered to be an outlier. The one outlier frustrating experience was reported as 540 minutes to solve the problem, and another 540 minutes to recover lost work. The cause of the frustrating experience was a hardware problem, where the user reported assigning interrupt requests to hardware, and every time that the computer rebooted, the operating system would reassign those interrupt requests. The user reported disabling the problem devices to complete the current task. Due to the large amount of time wasted, we therefore felt that this one frustrating experience should be separated out as an outlier. The user reported two other frustrating experiences, but those were well within the typical range reported. The other frustrating experiences from the same subject are therefore included (see table 4).

Problems with word processing cost participants the most amount of time in total (1,225 minutes lost), followed by problems with email (666 minutes lost) (see table 5). This did correlate with the applications that caused the highest number of frustrating experiences. The applications that were uncommon sources of frustrating experiences (such as programming tools, database software and presentation software) often required more time per incident, as the problems were rare and complex to solve.

Table 3. Sample of time lost statistics for one user.

	Minutes spent to solve problem	Minutes spent to recover lost work	Total minutes lost	Total minutes spent on the computer	Percent time lost to solve problem	Percent time to recover lost work	Percent time lost
A sample user	30	50	80	183	16.4%	27.3%	43.7%

Table 4. Averages for percent time lost to solve problem, time to recover lost work, and time lost for all users. These values are based on summing the percent time lost for all users and dividing by the number of users.

	Percent time lost to solve problem	Percent time to recover lost work	Percent time lost
Total without outlier	20.3%	20.2%	42.7%
Total with outlier	21.5%	22.2%	43.7%

Table 5. Breakdown of total minutes lost and average minutes lost per frustrating experience by application problem source.

Problem source	Reports		
	Total minutes lost	# of frustrating experiences	Average minutes lost per frustrating experience
Email	666	28	23.8
Web browsing	244	17	14.4
Other Internet use	105	11	9.5
Word processing	1225	34	36.0
File browsers	4	1	4.0
Video/audio software	20	1	20.0
Programming tools	140	2	70.0
Graphic design programs	5	1	5.0
Database programs	335	6	55.9
Chat and instant messaging	2	1	2.0
Presentation software	105	1	105.0
Spreadsheet programs	604	9	67.1
Other	865	37	23.4
Total	4320	149	28.9

Categories of frustrating experiences were based on a previous study (Ceaparu *et al.* 2004) with minor changes to accommodate terms used by our participants (see table 6). There was no controlled vocabulary or checklist; users supplied their own terms. Major categories were grouped by the behavior described in each frustrating experience. System crashes were the most commonly-reported frustrating experience, accounting for 21 of the 149, and were

caused by specific programs as well as the operating system itself. While many of these problems are hardware-related or technical-related (such as printing problems and system crashes), there were a number of frustrating experiences that were caused by interface-related issues (such as uncontrollable pop-up windows, hard-to-find features, and unpredictable behavior of application, and unclear error messages). For instance, there were 19 experiences with missing/hard-to-find/ unusable features, four experiences with uncontrollable pop-up windows and five experiences with unclear error messages. These interface-related causes of user frustration are easily solvable, when attention is paid to appropriate user interface design. As discussed in previous portions of the paper, when these interface improvements are made, it leads to improved user productivity and organizational profitability.

The participants express strong emotional reactions to the frustrating experiences (see table 7). For instance, in 60 of the frustrating experiences users felt angry at the computer, in 34 experiences users felt helpless/resigned, and in 15 experiences users felt angry at themselves. Since users may have more than one emotional reaction, these numbers for table 7 add up to more than the 149 frustrating experiences reported. Using a 1 to 9 numeric scale, 106/149 of the frustrating experiences were reported to have frustration levels of 7, 8, or 9 (see figure 1). This can be interpreted that when something goes wrong, users get very frustrated. Alternatively, it is possible the low frustration experiences were simply not reported by these users. From other observations, we believe that many users deal with minor annoyances by finding work-arounds that they did not report. These high levels of frustration can have an impact on physiological variables. For instance, in a previous study of user frustration, researchers found that when typical users get frustrated with their computer, it affects blood volume pressure (Scheirer *et al.* 2002).

Unfortunately, it seems that these frustrating experiences are not rare occurrences. From the frustrating experiences reported, users were asked to indicate whether this same event had occurred previously, and if so, how often (see table 8). For instance, for 25 of the frustrating experiences, users reported that the same event occurs

Table 6. Specific causes of frustrating experiences.

Internet	Applications	Operating system	Hardware	Other
Lost/dropped connections {7}	Missing/hard-to-find unusable features {19}	System crash caused by operating system {21}	Printing problems {10}	User kicked from system {5}
Sending/receiving email and accessing attachments {6}	Application crash {11}	File browser operations {2}	Hardware conflicts {3}	Multi-user file access and permission issues {5}
Uncontrollable pop-up window {4}	Buggy, incorrect behavior of program {10}	Multitasking failure {1}	Device failures {3}	Password not working {2}
Internet login failures {3}	Excessive slow operation {8}			Virus/malicious program {1}
Browser failure {2}	Unpredictable response of program {6}			Local network connection access failure {1}
File download failures {2}	Unclear error messages {5}			Power failure {1}
Plug-in failure {1}	Installation issues {4}			
	Application crash that froze the entire system {4}			
	Unknown file format {1}			

Note: participant left some responses blank.

Table 7. User feelings per incident.

Expressed feeling	Number of reports
Angry at the computer	60
Angry at yourself	15
Helpless/resigned	34
Determined to fix it	27
Neutral	17
Other	26

Note: Some participants had multiple feelings per incident.

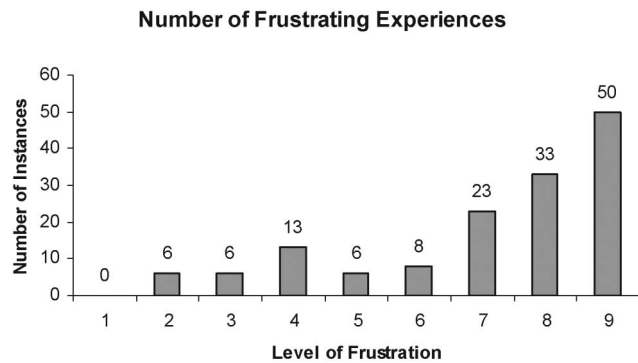


Figure 1. Bar graph of reported frustration levels.

more than once a day. For 21 of the frustrating experience, users reported that the event occurred several times a week.

5. Discussion

From the results of this study, it is clear that user frustration is a problem in the workplace. Since users lose

more than 40% of their time, these frustrating experiences have an impact on the individuals *and* their organizations. From an individual point of view, users waste a large amount of time, which slows their completion of work, limiting their time with family, friends and co-workers. It also can affect their emotional state. These frustrating experiences also harm organizations by undermining productivity, lowering quality and raising stress levels. The investment in improving user interfaces would yield large payoffs; several studies suggest that the cost of the interface improvement is made up 5, 10, or 20 times over (Bias and Mayhew 1994).

It is clear from this study and previous work that user frustration is a major problem. In the previous study (Ceaparu *et al.* 2004) of 111 subjects, the subjects were university students and their friends and family members. This current study was limited to workplace users. However, the results of the two studies were surprisingly similar.

Table 9 reports the top three applications causing a frustrating experience from both the previous study and the current study. The applications causing the most frequent frustrating experiences for the student frustration study were web browsing, email and word processing. In the workplace frustration study, the top three application sources encountered by the users were the same, but in reverse order: word processing, email, web browsing. The top three solutions taken by the participants to solve the problems that occurred in the student study were: they knew how to solve it from previous experience, they figured out a way or they were unable to solve it. For the workplace study, the top three solutions cited were that they knew how to solve it from previous experience, they rebooted, or ignored the problem/found an alternative.

Table 8. Frequency of problems.

Frequency of problem	Number of reports
More than once a day	25
One time a day	7
Once a week	15
Once a month	11
Several times a week	21
Several times a month	29
Several times a year	9
First time it happened	29

Note: Some responses left blank by participant.

Table 9. Applications causing the largest numbers of frustrating experiences.

Student study—causes of frustration	Workplace study—causes of frustration
1. Web browsing	1. Word processing
2. Email	2. Email
3. Word processing	3. Web browsing

In both studies, the levels of frustration were at the high end of the scale. For instance, 7, 8 and 9 are the highest scores on the frustration scale, and in both studies, large percentages of subjects reported their frustrations being in that range. In the student frustration study, 63.3% (236 out of 373) of the frustrating experiences caused high levels of frustration. In the workplace study, 71.1% (106 out of 149) of frustrating experiences caused high levels of frustration.

The amount of time lost was also similar in the different frustration studies. Table 10 describes the time lost in the various studies, both with and without outliers. The numbers are very similar. In the previous study with students, there were two phases: self-reports and observations. These data points are listed separately. In the previous study with students, the average percentage of time lost ranged from 38.9% (for self-reports without the five outliers) to 50.1% (for self-reports with the five outliers). In this workplace study, the average percentage of time lost ranged from 42.7% (without outliers) to 43.7% (with outliers). We think that the difference in ranges was logical, due to the numbers of subjects involved in the two studies. In the previous student study, 111 subjects took part, whereas in this workplace study, only 50 users took part. With a larger number of users taking part, it logically follows that there will be more outliers, and therefore, a wider percentage spread.

When looking at the specific causes of the frustrating experiences that occurred, the student study finds that the

Table 10. Time lost in the three studies, with and without outliers.

	Average time lost (with outliers)	Average time lost (without outliers)
Student study self-reports	50.1%	38.9%
Student study observations	49.9%	41.9%
Workplace study	43.7%	42.7%

top five were: error messages, timed out/dropped/refused connections, application freezes, missing/hard to find/unusable features, long download time. The workplace study finds that the top five were: OS crashes, missing/hard to find/unusable features, application crashes, hardware problems, buggy/undesirable behavior of program. Many of these problems (such as error messages, hard-to-find features and undesirable behavior) are caused by poorly-designed interfaces, and therefore can be solved with more usability testing and more user involvement in the interface development. The contributions of this paper are to provide a better understanding of the causes of frustration. It is interesting to note that some of the causes of frustration for the student participants, such as timed out/dropped connections, and long download times, did not appear as frequent frustrations for workplace participants. It is likely that the network connection at a workplace is of higher quality and speed, therefore less likely to cause frustration, due to either response time or dropped connection. However, many of the software applications are the same, regardless of user population or location, and are highly likely to cause frustration.

6. Conclusion

This exploratory study with 50 workplace users adds to the growing evidence that user frustration is a major problem. Further studies with a narrower focus may isolate and measure contributing factors, but there is enough evidence to cause concern and encourage change in the industry.

When this exploratory study is viewed in the context of other studies on user frustration, it is clear that improving user interface design is one clear opportunity because the payoffs will be immediate and benefit many users. To build better interfaces, more user involvement is needed in the interface design process. Designers should follow the interface guidelines that exist. User training will also help, especially if it addresses problem-solving strategies that will help build self-efficacy. Even small changes in the interface can make a big impact on user satisfaction. For instance, in recent studies of the FedStats website, changing the interface of a governmental website increased user satisfaction

and performance nearly 100% (Ceaparu and Shneiderman 2004). If link titles are unclear or are not where the users expect, they may not be able to complete their tasks. Unclear wording has been found as a major problem in interface design, regardless of the user population or the task. For instance, in a usability study of a university website, five users all failed to find the information that they were looking for (current course schedules) because the information was listed under an unclear heading ('Student Life'). From a technology-coding point of view, changing the words displayed is relatively simple. In addition, the usability methods needed to find out that the wording is unclear, are also relatively simple. Paper-based usability testing methods such as card sorting or paper prototypes can help find flaws in interface wording. Since many users reported being frustrated by unclear error messages or by hard-to-find features, interface designers should be directed to review all messages and instructions. Good guidelines for error message design have existed since 1982, but these guidelines are rarely followed (Shneiderman 1982). Error messages should be positive, provide information for users (in their language) on what occurred, and offer suggestions on how to continue. Current error messages rarely assist users (see figure 2 for an example of this). Improved error messages can reduce user frustration while making users more satisfied and productive (Lazar and Huang 2003). While all causes of user frustration are not as easily solvable, a large percentage of user frustrations *are* solvable. And there are many resources out there to help improve interface design, such as books, automated software tools, guidelines and other resources (see www.hcibib.org or www.hcirn.com for more information).

The implications for stakeholders might be separated out by:

- *Designers* can build more productive systems by learning what frustrates users in the workplace. Systems can be modified not only to have fewer errors but also to be more helpful. This may include better error messages, better and helpful descriptions of problems which can reduce the time needed to fix

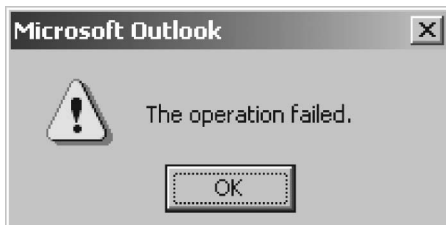


Figure 2. An unclear error message.

an issue, as well as designs based more closely on the way users work particularly with respect to how end-users handle errors. This would improve efficiency overall as systems would be better equipped to handle problems faster and allow for the system to get back to operating normally (without problems), and in general make things more usable.

- *Managers* can benefit by learning where frustrations occur within computing systems of their employees. This would help them to construct a more productive workplace, reduce workflow bottlenecks and produce more satisfied employees. They can recommend training for employees and make more appropriate choices in software acquisitions.
- *Users* of computers will appreciate learning that they are not alone in their frustrations. They can take steps to improve their training and increase their knowledge, but they can accelerate improvement by being consumer activists who report problems, complain to designers and suggest improvements.
- *Information Technology Staff* can be better prepared to handle frustrated users and learn which type of technical problems produce the largest frustration. This can help things move more smoothly and even help IT staff make better recommendations to managers and policymakers. IT staff should also be better situated as the middleman and be able to get better information between users and vendors when understanding frustration in the workplace.
- *Policymakers*, in industry and government, should recognize the severity of the productivity loss due to user frustration. Increased research funding, improved training, better data collection and increased public awareness of the problems will help produce appropriate changes.

Acknowledgements

The lead author of this article was partially supported by Training Grant No. T42/CCT310419 from the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health. The contents are solely the responsibility of the author and do not necessarily represent the official views of the National Institute for Occupational Safety and Health.

We appreciate partial support from National Science Foundation grant for Information Technology Research (#0086143) Understanding the Social Impact of the Internet: A Multifaceted Multidisciplinary Approach and National Science Foundation grant for the Digital Government Initiative (EIA 0129978): Towards a Statistical Knowledge Network.

We thank Katie Bessiere and Irina Ceaparu for their work in developing the survey that was used in the initial

data collection and that we updated for the workplace data collection that is reported on in this paper. In addition, Katie Bessiere provided the first draft of the literature review. However, both of these students have been away for more two years and have not responded to requests for them to review the drafts. We greatly appreciate their contributions, but without their approval, we do not feel it appropriate to list them as authors.

We acknowledge the assistance of Deborah Carstens and Robert Hammell, who both provided comments on an earlier draft of this paper.

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Appendix A

Frustrating experience form

Please fill out this form for each frustrating experience that you encounter while using your computer during the reporting session. This should include both major problems such as computer or application crashes, and minor issues such as a program not responding the way that you need it to. Anything that frustrates you should be recorded.

1. What were you trying to do?
2. On a scale of 1 (not very important) to 9 (very important), how important was this task to you?

Not very important 1 2 3 4 5 6 7 8 9 Very Important

3. What software or program did the problem occur in? If the problem was the computer system, please check the program that you were using when it occurred (check all that apply).

<input type="checkbox"/> email	<input type="checkbox"/> file browsers	<input type="checkbox"/> presentation software (e.g. powerpoint)
<input type="checkbox"/> chat and instant messaging	<input type="checkbox"/> spreadsheet programs (e.g. excel)	<input type="checkbox"/> media (audio/video software)
<input type="checkbox"/> web browsing	<input type="checkbox"/> graphic design	<input type="checkbox"/> other <input type="checkbox"/>
<input type="checkbox"/> other internet use	<input type="checkbox"/> programming tools	
<input type="checkbox"/> word processing	<input type="checkbox"/> database management/ searching software	

4. Please write a brief description of the experience:

5. How did you ultimately solve this problem? (please check only one)

I knew how to solve it because it has happened before I ignored the problem or found an alternative solution
 I figured out a way to fix it myself without help I was unable to solve it
 I asked someone for help. Number of people asked I tried again
 I consulted online help or the system/application tutorial I restarted the program
 I consulted a manual or book
 I rebooted

6. Please provide a short step-by-step description of all the different things you tried in order to resolve this incident.

7. How often does this problem happen? (please check only one)

more than once a day one time a day several times a week once a week
 several times a month once a month several times a year first time it happened

8. On a scale of 1 (not very frustrating) to 9 (very frustrating), how frustrating was this problem for you?

Not very frustrating 1 2 3 4 5 6 7 8 9 Very frustrating

9. Of the following, did you feel:

angry at the computer angry at yourself helpless/resigned
 determined to fix it neutral other:

10. How many minutes did it take you to fix this specific problem? (If this has happened before, please account only for the current time spent.)

11. Other than the amount of time it took you to fix the problem, how many minutes did you lose because of this problem? (If this has happened before, please account only for the current time lost, e.g. time spent waiting or replacing lost work.)

Please explain:

12. Until this problem was solved, were you able to work on something else?

Yes No

Please explain:

