

Understanding Computer User Frustration:
Measuring and Modeling the Disruption from Poor Designs

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Abstract

User frustration in the use of information and computing technology is a pervasive and persistent problem. When computers crash, network congestion causes delays, and poor user interfaces trigger confusion there are dramatic consequences for individuals, organizations, and society.

These frustrations not only cause personal dissatisfaction and loss of self-efficacy, but may disrupt workplaces, slow learning, and reduce participation in local and national communities.

We propose a Computing Frustration Model with incident specific and individual variables to guide research. Our study of 108 computer users shows high levels of frustration and loss of 1/3 to 1/2 of time spent. The importance of the users' goals and the severity of the disruption were correlated with frustration. Those who had strong self-efficacy, indicated by a willingness to stick to solving the problem, reported lower levels of frustration. Implications for users, software developers, managers, and policymakers are discussed.

Keywords: user frustration, user interface design, training, helpdesk, computer experience, computer anxiety

Introduction

Everyone is familiar with computer problems and the ensuing frustration that results when, yet again, your program crashes with no warning, taking the last thirty minutes of work with it. Frustration is a common theme among computer users. As technology rapidly advances, we the users must deal with the ensuing error messages that invariably result, as well as annoying delays, incompatible files, and indecipherable menus.

These challenges are well-known by individual users, but less is known about the workplace consequences of these frustrating experiences. How much time is lost on a daily basis as we struggle with our machines? How do these experiences affect our mood, our days, our being? What role does our prior experience with technology play?

The challenge of the “digital divide,” a gap between those who have access to and can effectively use information technology and those who do not, was originally identified by the U.S. Department of Commerce (U.S. Department of Commerce, 1999). A recent report released by the U.S. Department of Commerce, *A Nation Online: How Americans Are Expanding Their Use of the Internet*, claiming that the digital divide gap is disappearing, has resulted in funding being cut for two digital opportunity programs: The U.S. Department of Education’s Community Technology Centers Program (CTC) and the U.S. Department of Commerce’s Technology Opportunities Program (TOP). Both of these programs were designed to create and improve technology access and use in under-served and low-income communities. A policy brief released by the Benton Foundation (Dickard 2002) demonstrates that these programs were vital to the reduction in the technology gap existent in America today. In addition, a reexamination of the same data by the Consumer Federation of America (Cooper 2002) claims that the perception that the “digital divide is disappearing” is wrong, and that the data actually show the opposite.

We believe that user frustration is a significant issue that is closely tied to the digital divide. Even if universal access to technology is attained, users will still struggle with using the technology (Kling, 2000). For the effective use of technology, careful attention must be given to documentation, tutorials, training, online user assistance, and helpdesk support (Lazar and Norcio, 2001). Kling (2000) recognizes that easy-to-use interfaces, user support, technical skills, and a network of people who can help, are part of the *social access* to technology, as opposed to technological access. Even with the most up-to-date hardware, software and network connections, users may still find poorly-designed technology hard to use (Kraut, Scherlis, Mukhopadhyay, Manning, & Kiesler, 1996). Simply providing the technology to those who cannot afford it, will not ensure that people can actually use it, and will therefore not solve the digital divide (Kling, 2000).

For the effective, on-going use of information technology, free hardware and software alone are not sufficient to allow users to become productive and satisfied. Systems must be designed for ease of use. For all users to be effective in their tasks, there must be support for users in many forms, including documentation, tutorials, training, online user assistance, and helpdesk support. The use of well-designed, easy to use software, along with sufficient support and training, can make a measurable impact on the lives of users. The community networking and software project developed at MIT for the residents of Camfield Estates, a low-income housing community in Roxbury, MA, is a good example of using technological resources to improve the economic situations and overall lives of people (Pinkett, 2002). Successes can only occur when users have interfaces that are not frustrating, and support to help them utilize the technology effectively.

This study examines the factors that moderate the experience of frustration in computer usage. In this study, the computer frustrations of 108 users are examined through the use of modified time diaries. Individuals’ prior experiences, psychological characteristics, level of computer experience, and social system are all examined to determine how they influence the frustrations that users face with their computers. In addition, factors such as the importance of the task that was interrupted, the frequency of occurrence (both of same and different frustrations), and the amount of time or work lost as a result of the problem are also examined to determine how they affect the experience of frustration as well. The existing psychological literature on frustration provides a foundation for the examination of the frustration

process in computer use. Through the Computing Frustration Model presented in this paper, the factors correlated with frustration are examined. The goal is to help elucidate the nature of the frustration experience with computer use. Implications for numerous stakeholders, including users, managers, software designers, and policymakers, are discussed.

Frustration

A review of the psychological literature reveals diverse definitions of frustration. Sigmund Freud introduced frustration as a concept with external and internal aspects and related it to goal attainment. Frustration occurs when there is an inhibiting condition, which 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 also discussed 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. The emotional response, in this case, is the effect. The individual is aroused by this external cause, and a response is often directed towards the environment (such as yelling, hitting, or anger).

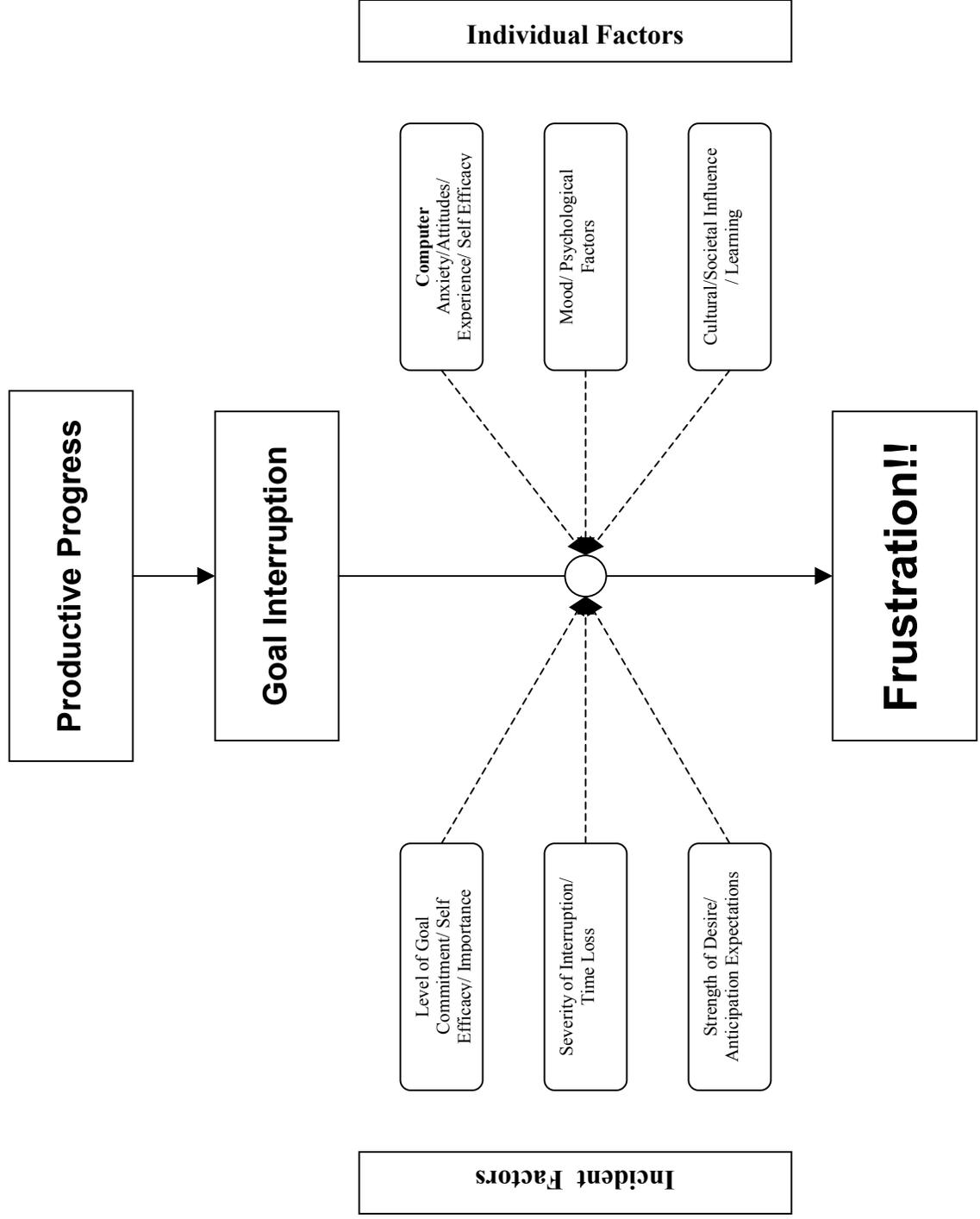
The level of frustration experienced by an individual clearly can differ, depending on the circumstances surrounding the frustrating experience, and on the individual involved. One major factor in goal formation and achievement is goal commitment, which refers to the determination to try for and persist 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 two factors: 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 to the individuals, in addition to the strength of the desire to obtain the goal (Dollard, Doob 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). The belief about how well a task can be performed (self-efficacy) when it involves setbacks, obstacles, or failures may also affect how committed individuals are to that goal (Bandura 1986).

User Frustration with Computers

There are many possible causes of user frustration with computer technology. For instance, a software application may crash, an error message may be unclear, or an interface can be confusing (Preece, Rogers, and Sharp, 2002). Users can lose work and waste time. In the context of the social psychological research literature, frustration occurs when users cannot attain their task goals. The causes of the problem could include poor interface design, computer hardware or software failure, or even the users' lack of knowledge regarding the computer, but the result is the same: users cannot complete their tasks, and may have an emotional response (frustration!) to the inability to attain their goal. This is especially true as the Internet changes the nature of the computer user population, to include many more non-technical people and people with little computer experience (Shneiderman, 2000; Cummings and Kraut, 2002).

The amount of frustration that users face can differ, depending on a number of factors, such as the time lost, the importance of the goal, the user's self-efficacy, and the user's computer experience. The Computing Frustration Model examines what specific aspects and qualities lead to user frustration, with the end goal being to determine ways of ameliorating the frustration. Based on the frustration literature, goal-attainment theory, and the literature on computer attitudes and anxiety (Bessiere, Ceaparu, Lazar, Robinson, and Shneiderman, 2003), we propose a Computing Frustration Model (Figure 1).

Figure 1: Computer Frustration Model



Frustration theory indicates that it is the interruption of a goal or task that causes individuals to become frustrated. There are various factors that can then subsequently affect the level of frustration experienced. These can fall into two categories: the incident and individual factors.

Incident Factors

The incident factors that affect the level of frustration experienced by end users include the level of goal commitment, the severity of the interruption, and the strength of the desire to obtain the goal. Goal theory tells us that experience, self-efficacy, and the importance of the goal all affect the commitment to the goal or task. When the goal interruption occurs, the level of goal commitment, measured in terms of the importance of the task to the user, will affect the amount of frustration experienced by individuals directly. Severity of interruption is measured as the amount of time it took to fix the problem combined with the amount of time lost due to the problem. The strength of desire for the goal is also affiliated with how important the goal was, so importance is also used here as a proxy for strength of desire.

Individual Factors

Individual factors affecting the strength of the frustration include computer experience variables, mood and other psychological factors, and the cultural and societal influences upon the individual. Measures of mood include satisfaction with life, how often subjects get upset over things, and general mood. Also of interest are how the frustrating incident affected the users' day, and how frustrated users were, overall, after the session. Computer variables are separated into computer experience/self-efficacy and computer anxiety/attitudes. Computer experience can be measured as years of computer use, hours of computer use per week, and a subjective measure of experience – also effective as a measure of computer self-efficacy. Additional measures of computer self-efficacy include confidence about their ability to fix problems, how much users persevere when encountering a problem on the computer, and how much users thought about unresolved computer problems after being unable to fix them. Computer anxiety is measured with two questions, one on level of comfort with the computer and one on how subjects react to a problem with a computer. Cultural and societal influences are not measured, as they are expected to be a constant. Our sample is taken from an American university setting in which it is expected that most respondents will be American. While user frustration as occurs in different cultures is certainly an interesting question to pursue, it lies outside the scope of the current study.

Research Methodology

An attractive way to study the incidence of frustration is a modified time diary, rather than a survey. Survey questions often ask respondents to estimate the answer to the question from memory, which can often lead to inflated or incorrect answers. Because it is important to ascertain *exactly* what it is that users encounter as they work on their everyday tasks, in addition to the time lost due to these experiences, a modified time diary was chosen as the best way to obtain the data. Time diaries minimize the reporting burden on the respondents by allowing them to record their time use immediately after it occurs, instead of attempting to remember an aggregate amount of information at a later date. In addition, it is possible to capture the session length and the exact amount of time lost due to frustrating experiences by using this modified version of the time diaries, information that may be lost or incorrect if it were asked in a survey format.

In order to obtain data reflecting typical computer usage, we asked subjects to work on the computer for a minimum of one hour, on tasks of their own choosing. Because self-set goals are more meaningful to individuals, they may be better than assigned goals that may be unclear or be rejected (Locke, Shaw, Saari, & Latham, 1981). Subjects worked on tasks of their own choosing as opposed to assigned tasks. In order to be able to collect data on tasks that are important to the individuals, it was important that the tasks were not pre-assigned. Prior to the session, subjects filled out a short online pre-session questionnaire assessing demographic information, computer experience and attitudes, and mood.

After completing the one-hour long data collection period, subjects then returned to the website and filled out a 5 question post-session survey. A typical user in this study would:

- 1) Go to the website and fill out the pre-session questionnaire
- 2) Begin the work session and work for a minimum of an hour, filling out paper frustration reports when encountering anything frustrating (the modified time diary)
- 3) Immediately following the one-hour session, the user would return to the website to fill out the post-session survey
- 4) After filling out the post-session survey, the user would enter the paper frustration reports into an online database.

The pre-session survey [Appendix A] asked respondents about demographic information, computer experience and attitudes, level of computer anxiety, and mood. Previous research indicates that level of computer experience or perception of computer self-efficacy can affect subsequent user behavior (Murphy, Coover et al. 1989; Brosnan 1998). Questions were chosen after a careful review of previous research on the Computer Aptitude Scale, assessing computer attitudes, computer anxiety/confidence, and computer liking (Loyd & Gressard 1984; Nash & Moroz 1997). Stemming from this, it was hypothesized that prior experience and level of perceived knowledge will affect individuals' level of frustration as well. To assess the overall state of the individuals, we included three questions dealing with overall life satisfaction, general mood, and how often they get upset over things. The post session survey [Appendix B] consisted of five questions to assess mood after the session, how frustrated overall the individuals were after the session, how these frustrations affect the rest of the day, and the frequency and typical nature of the frustrating experiences during the session.

To minimize the amount of additional time to fill out the forms, subjects filled out a one-page time diary for each incident that occurred in the one-hour long data collection period. By filling out a paper time diary form, rather than an online version, the amount of added frustration with the computer was minimized, and was therefore only based on the user's work on the computer. When the hour was completed, subjects returned to the website, filled out the post session form, and then entered their frustration reports into the database via a form on the website. There were two stages of data collection: subjects performing self-reported diaries, and subjects observing other users. Subjects were enlisted from students at both the University of Maryland and Towson University. For the self-reported diaries, students completed a minimum of one hour of data collection and filled out incident reports for their daily computer use. For the observations, students were also asked to observe another person not in the class and gather data on this individual. Subjects for the observations were enlisted by the students and followed the same methodology as the self reports. Instead of filling out the frustration experience report forms themselves, however, the observers filled them out, asking the subjects to talk out loud and share their experience with the observer.

Our first analysis of the data (Ceaparu, Lazar, Bessiere, Robinson, and Shneiderman, 2002) examined the frequency, cause and the level of severity of frustrating experiences. The three task applications that were the cause of the most frustrating experiences (N=373) were web browsing (122 frustrating experiences), email (49 frustrating experiences), and word processing (44 frustrating experiences). The specific causes of frustration most often cited were error messages (35), timed out/dropped/refused connections (32), freezes (24), long download time (23), and missing/hard-to-find features (23). Most subjects indicated that the frustration experience had happened before (277), as frequently as several times a month (40), week (54), or even several times a day (60).

The most disturbing result in our previous analysis was with the amount of time lost due to frustrating experiences. One third to one half of the time spent in front of the computer was lost due to frustrating experiences when looking at both the time it took to fix the problem and any additional time that was lost due to the problem. When only looking at the time actually lost spent fixing the problem, we found that between one quarter and one third of the time in front of the computer was spent fixing the

problem. This is clearly a large amount of time lost due to problems on the computer, and this time lost has a value both in productivity and in monetary terms.

Results

We analyzed both incident level frustration, measured as level of frustration per incident, and session frustration, measured as overall frustration after the session, in an effort to determine the factors that are indeed correlated with level of frustration. Individual level frustration factors examined are demographic factors, computer experience, computer anxiety, computer self-efficacy, and mood. In addition, measures of overall frustration after the session, mood after the session, and the effect of the session on the individuals' day were analyzed.

Demographic Information

Out of 112 total subjects, 4 were discarded due to technical problems with the database. There were a total of 372 frustrating experiences reported. The remaining 108 subjects in the study were approximately equal male/female, and were composed mainly of college undergraduates (75.9%). As a result, exactly half of the subjects were under the age of 22. The remaining half ranged from age 22 to 80. Respondents also reported a high level of self-reported perceived computer experience, and 40% of the respondents reported either being a computer professional or student (see Table 1.1).

Table 1.1 Perceived Computer Experience

Experience Level: N=108, mean = 6.88, sd = 1.88		
	Frequency	Percentage
1	1	0.9
2	2	1.9
3	4	3.7
4	8	7.4
5	6	5.6
6	15	13.9
7	26	24.1
8	22	20.4
9	24	22.2
Total:	108	100

Age is negatively correlated with experience in our study ($r = -.278, p < .001$) indicating that younger users seem to have more experience with computers, an expected result.

Incident Frustration Level

Incident frustration level is measured on a scale of 1 (not very frustrating) to 9 (very frustrating) for each incident occurring in the study. The frequency table shows that two-thirds of the incidents resulted in high levels of frustration, 7-9 (see Table 1.2).

Table 1.2 Incident Frustration Level

Frustration Level: N=372, mean = 6.74, sd = 2.13		
	Frequency	Percentage
1	6	1.6
2	16	4.3
3	19	5.1
4	22	5.9
5	27	7.3
6	45	12.1
7	67	18
8	81	21.8
9	89	23.9
Total:	372	100

Incident frustration level is quite significantly skewed towards the high end, indicating that users are often very frustrated by problems that they encounter with their computer. 75.8% of the incidents reported in the sessions resulted in higher than neutral frustration. In addition, almost 50% of the incidents (45.7%) resulted in a frustration score of 8 or 9, the highest levels of frustration possible.

In addition to frustration level, we asked subjects to record their feelings after the incident, in an effort to determine what kind of reaction was elicited from them after a problem with the computer (see Table 1.3).

Table 1.3 Post-Experience Feeling

Feeling: N=370		
	Frequency	Percentage
Angry at the Computer	155	41.9
Angry at Yourself	15	4.0
Determined to Fix it	84	22.7
Helpless/Resigned	45	12.2
Other	71	19.2
Total:	370	100

Here we see that 42% of the users in the study have a resultant feeling of being mad at the computer after a frustrating experience. Only 4% of the users reported being angry at themselves, but 12% of them reported feeling helpless or resigned, indicating that some users do in fact experience a sense of loss of control when faced with computer problems. On the other hand, 23% of the users were determined to fix the problem, which may be mediated by the high level of experience reported by the subjects.

Session Frustration Level

After the session was completed, subjects answered a few questions designed to measure how the frustrations that they experienced affected them overall. Overall frustration about the session, how it affected their day, their mood after the session were all measured, as well as a question on whether they experienced more or less frustrating incidents in the study, as compared to a typical day (see Table 1.4).

Table 1.4 Post-Session Variables

	Overall Frustration (N=108)	Affected Day (N=108)	Pre Mood (N=108)	Post Mood (N=108)	More or Less Frustrations (N=108)
Mean	5.87	3.87	6.1	5.66	4.54
Standard Deviation	1.89	1.95	1.45	1.59	1.84

Overall, it does not appear that the session as a whole produced much of an overall affect on the individuals. It would appear that the frustrating incidents encountered were about average for these subjects. The score for whether they encountered more or less frustrating experiences in an average day was just about 5. The mean for overall frustration was much lower than the mean for incident frustration, indicating that the individual incidents as a whole did not produce a feeling of high overall frustration. Subjects reported a low mean score for whether or not the incidents taken together affected the rest of their day, as well. Mood scores went down slightly on average after the session, from 6.1 to 5.7.

Correlations

To determine the factors that influence both incident specific frustration and the overall effects of frustration in computer use, we ran correlations with time, computer anxiety, computer self-efficacy, mood, and importance variables (See Table 1.5).

Table 1.5 Frustration Scores and Correlates

	Incident Variable	Session Variables		
	Frustration (N=372)	Overall Frustration (N=108)	Post-Mood (N=108)	Affect Day (N=108)
	r	r	r	r
Time Variables				
Time Lost (Incident)	.316***			
Time Fix (Incident)	.231***			
Computer Years	-.059	-2.00*		-.261**
Hours per Week	-.122*	-1.75		-.091
Time to Fix (Total)		.124	.007	.250**
Time Lost (Total)		.062	-.014	.146

Computer Anxiety Variables				
Anxiety	.029	-.106	.344***	-.171
Comfort	.100 [†]	.012	.274**	-.164
Computer Self-Efficacy Variables				
Experience	-.020	-.151	.315***	-.239*
Ability to Fix	-.019	-.157	.286**	-.282**
Unresolved	-.058	-.008	.122	.047
Stick with it	-.139**	-.327***	.437***	-.245**
Mood Variables				
Life Satisfaction	-.095	-.178	.185	-.166
PreMood	.116*	.005	.336***	-.009
Upset Often	-.027	.150	.362***	.155
Mood Swing	-.085	-.321***		-.241*
Importance				
Importance	.237***			
Avg. Importance		.085	.110	.136

* = p<.05 ** = p<.01 *** = p<.001 † = p=.055

Incident Frustration Factors

Incident frustration in our subjects has a high positive correlation with the amount of time it took to fix the problem, the amount of time or work lost due to the problem, and the importance of the task. Computer experience does not seem to be a factor in the amount of frustration experienced, although there is a slight significant negative correlation between the number of hours worked per week and the frustration level, indicating that the number of hours worked per week could lessen the amount of frustration experienced. Level of comfort with the computer, while not significant, has a p value of .055. In addition, whether or not the subjects would stick with a problem encountered on the computer is negatively correlated with the level of frustration experienced, with a p value of <.01. Mood before the session, on the other hand, is significant at p=.05, and has a positive relationship with frustration level.

Session Frustration Factors

Overall frustration level after the session on the computer is highly correlated (p<.001) with whether users experienced more or less frustrations on an average day, whether they would stick with a problem until it was fixed, and also with the difference in pre and post session mood. A strong positive correlation exists between the average amounts of frustrations as compared to the current session. Negative relationships are seen between overall frustration and the stick with it and mood swing variables. A small but significant negative relationship is also found between the number of years the individual has been using a computer and level of overall frustration.

How the frustrations experienced were expected to affect the day of the individual is positively correlated with the total amount of time it took to fix all the problems experienced, and whether they experienced more or less frustrations on average. There is a negative correlation between the effect on the day and number of years of computer use, level of perceived experience, perceived ability to fix problems on a computer, willingness to stick with the problem until it is solved, and the mood swing between the start and end of the session.

The individuals mood after the session has a high positive correlation (p<.001) with level of computer anxiety, perceived level of experience, mood before the session, and whether the individual gets upset often. Smaller positive relationships (p<.01) exist with level of comfort with the computer and perceived ability to fix problems on the computer.

Discussion

The Computing Frustration Model hypothesizes that frustration is affected by importance of the task, previous experience, the severity of the interruption, level of computer anxiety, computer self-efficacy, and psychological or mood factors.

Importance of Goal (I1)

The importance of the task has a high positive correlation with incident specific frustration levels, indicating that the importance of each individual task has a strong effect on the level of frustration experienced because of that incident. However, the average importance level of all the tasks combined was not correlated with any of the post-session outcome variables. Overall frustration, post-session mood, and the affect of the day do not appear to be correlated with the average importance of the tasks performed. This indicates that task importance affects the immediate reaction to the interruption but does not linger on as time goes on.

Severity of Interruption (I2)

The severity of the interruption, measured as the amount of time it took to fix the problem and the amount of time or work lost as a result of the problem, is highly correlated with the incident frustration level, but not with the post-session outcome measures. Both of these measures are positively correlated with frustration level, indicating that as the amount of time lost increases, so does the level of frustration. It is also possible that as frustration increases due to time loss, the increase in frustration causes the individual to become less able to fix the problem, which would then lead to an increase in time lost. This cascade effect could obviously become quite problematic as the individual encounters more frustrating experiences and loses more and more time.

Total time lost only appears to be significantly related to whether or not the frustrations affect the subject's day. Here as well there is a positive association, indicating that as the amount of time to fix the problem goes up, the person's day is affected more and more. However, the amount of time lost as a result of the problem is not significant here for any of the post-session variables.

Strength of Desire/Importance(I3)

As mentioned above, the importance of the task has a high positive correlation with incident level frustration level. This is what we expected to find, given that goal theory indicates that the importance of the task is vital to goal commitment, and that frustration theory indicates that it is an interruption on the path to a goal that causes frustration. It makes sense, then, that the more important the task or goal, the more frustrated a person would get on an individual task basis when they could not complete the task.

Experience(I4)

We measured level of computer experience in two different ways, both an objective measure of experience and a subjective measure of experience. In terms of incident level frustrations, it does not appear that either measure of experience has a significant effect on the level of frustration experienced. There is a slight negative relationship observed due to the number of hours worked per week, indicating that possibly the more a person works on a computer during the week the less frustrated they are when they encounter problems. It is possible that this is due to a habit effect, where frustrations are so common that the subjects fail to register them as very frustrating when they occur. It is also possible that the skewed distribution of experience in our subjects could be affecting the relationship here.

The number of years of computer use also has an expected significant negative relationship with the session variables of overall frustration and the effect on the day. Apparently here as well, years of experience is related to a decrease in the effects of frustrating experiences on the individual. For the session level variables, level of perceived experience is also correlated with mood after the session and

the effect on the day. As expected, there is a negative relationship with the effect on the day and a positive correlation between perceived level of experience and mood. As the perceived level of experience goes up, so does the mood after the session. This would make sense given the previous findings that the more experience you have the less it might affect your day and the less overall frustration you experience. Our subjects were for the most part highly experienced, and we might anticipate more severe negative effects on users with less experience.

Computer Anxiety/Attitudes (I4)

Surprisingly, only mood after the session was correlated with either anxiety or level of comfort with the computer. However, we suspect that this is due to the relationship between experience and computer self-efficacy with these variables. Both of these variables do correlate with the mood after the session, however. The more comfortable people are with the computer and the less anxious they are, the better their mood after the session.

Computer Self-Efficacy (I4)

As expected, computer self-efficacy does correlate with frustration levels. The most interesting of these variables is the “stick with it” variable, which asked respondents how likely they would be to stick with a problem on the computer until it was solved. As the likelihood increases that they would stick with the problem until a solution is found, level of frustration (both incident and session based) decreases, there is less of an effect on the day, and the mood after the session increases. This suggests that people who enjoy solving problems or are more stubborn are less likely to become frustrated by problems on the computer. Perceived level of experience and perceived ability to fix a problem on the computer are positively related to post-session mood, and negatively related to the effect on the day. In other words, as computer self-efficacy increases, the frustration levels go down and the mood afterwards is better.

Mood Variables (I5)

Mood does not appear to have a strong affect on either the incident or session frustration level. Mood prior to the session appears to affect individual level frustration levels, but not overall frustration. When looking at the mood swing that occurs before and after the session, however, we find that there is a strong negative correlation between this difference and overall frustration. This could indicate that as overall frustration level goes up, the difference in mood goes from positive (post mood being higher than pre mood) to negative. This holds true for the effect of the frustrations on the day as well. This is what we would expect to find with regard to frustration and the change in mood.

Cultural/Societal Influence (I6)

Cultural factors were not measured in this experience, due to the nature of our sample. While the question of whether international and cultural differences affect the experience of frustration is an interesting one, our sample was drawn from an American university and was expected to be fairly homogenous in terms of cultural differences. Because the sample was relatively small, we felt that not enough cultural diversity would be found and as such did not measure cultural differences in this study. However, we do believe that this is an important variable, and when extrapolating beyond Americans as a population should be examined in greater detail.

Conclusion

From this data, the severity of the interruption and the importance of the task combine to form the greatest influence on incident frustration levels. On the other hand, computer self-efficacy has the greatest effect on overall frustration levels. Experience, computer anxiety, and mood also all combine to influence the level of overall frustration, mood, and affect the day of the individual as well. It appears that incident level factors correlate more with incident level frustration, and that individual level factors correlate more with the overall outcome variables. In other words, the circumstances surrounding the actual frustrating incident have a greater effect on the resultant frustration due to that one incident, and other factors such as mood, experience, computer anxiety, or computer self-efficacy do not have as much of an effect. However, when we look at the overall experience of frustration, and how it affects the mood and day of the individual, we see that these variables become very significant to the outcome of the frustrating experiences. In addition, incident specific variables lose their importance. Even a variable such as total time lost, which we would expect to be correlated with the post-session outcome variables, is not significant. Perhaps incidents in and of themselves cause a fleeting but very strong annoyance, but overall frustration with the events in the session stays more constant. Because it is more constant, it is correlated with other global variables on an individual basis. Each incident by itself causes a brief flare-up in frustration, but adds to the users experience and levels of self-efficacy, which in turn affect global frustration levels.

Implications of this Study

For Users: While individual frustrating experiences are annoying and cause a brief flare-up in frustration, it is rather the individual factors that are of the most concern. Previous experience, attitudes toward the computer, and computer self-efficacy all have an effect on the experience of users with the computer. In order to have the best experience, it appears that a positive attitude towards the computer and development of skills is essential. Users should make an effort to receive training on their computer systems and software. In addition, the type of training received should best match the task needs, e.g., training related to web browsing, an exploratory environment, should receive training using the exploratory model (Lazar and Norcio, 2003). An increase in knowledge and experience can only serve to enhance the computer attitudes of the individuals. Since computers are increasingly being used for personal and entertainment-related tasks, rather than workplace-related tasks, the users become more responsible for ensuring the success of their tasks (Cummings and Kraut, 2002). While individual frustrations may continue to occur, the increase in experience and computer self-efficacy and the positive tilt in their attitudes towards the computer will minimize the effect of these frustrating experiences as a whole.

For Software Developers: Software developers should emphasize strategies for reducing the frequency of user frustration. More reliable software, better user interfaces, clearer instructions, and improved tutorials could reduce and prevent problems. For instance, subjects cited error messages as major sources of frustration. Although the problems of poorly-worded error messages are well-established, unfortunately, error messages are still negative, unclear, and do not actually help users respond to errors (Shneiderman, 1998; Lazar and Huang, 2003). Some error messages are well-known, such as the “fatal exception,” also known as the “Blue Screen of Death.” A recent e-mail sent by one of the authors of this paper was

returned, with the resulting error message stating that “[servername] does not like recipient.” Such an error message cannot actually assist users in responding to errors. Another issue is that many developers design technology for the future, thinking that “this application will be great when users get faster download speeds and larger monitors and storage devices” While the field of information technology is inherently “future-oriented” (Kling, 1999), the effort should be made to develop computer systems that users can use effectively now, given the technology that users currently have.

For Managers: While it is hard to extrapolate from our sample to the business population, there are some clear possible effects. First, each frustrating experience will cost the company in minutes and work lost. Second, the aggregate effect on the individual is to lower the mood and increase the likelihood of having a bad day, which can adversely affect work performance as well. Clearly, it is a good idea for businesses to invest in both the technology and the training of their staff, in the technology in order to improve productivity. Future study on workers should help to bring forward these issues with a more appropriate sample.

For Policy: If previous experience shapes attitudes towards the computer, then the development of technological skills is essential to the elimination of user frustration. Purchasing hardware and software simply is not sufficient to enable effective use of computer technology. Policy makers should not pronounce the digital divide “solved” simply because people have access to computers, but rather, should promote programs that provide training to underserved populations. If frustration is such a large part of the user experience, and experience and perceived efficacy can help eliminate this frustration, then it is vitally important that the low-income and disadvantaged communities receive as much help in this arena as possible. Unfortunately, support and training have never been a priority for government funding in the United States. The Universal Service Program, sponsored by the U.S. Federal Government (also known as the E-Rate), helps to provide funding to connect schools and libraries to the Internet (U.S. Congress, 1996). However, the law specifically excludes expenses for training users (Lazar and Norcio, 2001). Many government programs also prohibit the use of funds for training or any non-equipment related expenses (General Accounting Office, 1998). Training and exposure are clearly vitally important to the user experience. It is quite possible that new users, who lack knowledge, training, and access to helpdesks will simply never advance their skills.

Future Research

The data tells an intriguing story, indicating that frustrating experiences each have a strong but fleeting instantaneous effect. However, the total effect of frustrating experiences has the strongest implications for users. This theory should be validated with further data collections, which we are pursuing. In addition, different pools of subjects should be examined in order to verify whether this pattern continues beyond the student population. Examining incident and individual factors, to determine its relationship to frustration levels will also further the knowledge of what factors can be altered in order to ameliorate the user experience. While it is clear that experience is an extremely important factor, further examination of other variables will elucidate how to decrease user frustration without having to wait until the users become experts.

Cultural and societal variables were not examined here, but an examination of various cultures and their responses to and experience of frustration would also be extremely interesting. Data from this line of study could serve to show how different coping strategies are employed by users to deal with frustration.

Information technology is continuously advancing and that user frustration is unlikely to be eliminated completely. However, examining the factors behind frustration could influence documentation, training, design of systems and software, helpdesk services, and personal strategies for coping.

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Name: _____ Email: _____ Class: _____

Section I: Demographic Information

1. Age: _____
2. Gender: F M
3. Education: _____
 _____ High School Graduate _____ Fresh/Soph in College _____ Jr./Sr. in College
 _____ College Graduate _____ Advanced Degree
4. Employment: (Please choose ONE)
 _____ K-12 Student _____ Professional _____ Service/Customer Support _____ Homemaker
 (Doctor/Lawyer/etc) _____ Academic/Educator _____ Clerical/Administrative _____ Self-Employed
 _____ Student - Computer _____ Science _____ Computer _____ Unemployed,
 _____ Student - Other _____ Technical/Engineering _____ Sales/Marketing _____ looking for work
 _____ Executive/ _____ Other Technical/Engineering _____ Tradesman/Craftsman _____ Retired
 Managerial
 Other _____

Section II: Computer Experience and Attitudes

1. How many years have you been using a desktop or laptop computer for home or work use? _____
2. How many hours per week do you use a desktop or laptop computer? _____
3. What type of Operating System is installed on the computer that you are currently using?
 _____ DOS _____ MacOS 10 _____ MacOS Prior _____ Windows 95 _____ Windows XP
 _____ Windows NT _____ Windows 98 _____ Windows ME _____ Windows 2000 _____ Unix/Linux
4. What type of applications and programs do you typically use? (check all that apply)
 _____ Email _____ Other Internet Use _____ Graphic Design Programs
 _____ Chat/Instant Messaging _____ Word Processing _____ Programming Tools
 _____ Web Browsing _____ Spreadsheet Program (Excel) _____ Database Tools
 _____ Presentation Tools _____ Other (please explain) _____
 (powerpoint) _____
5. How many years have you been using the world wide web? _____
6. How many hours per week do you spend online? Please indicate the amount of time that you are actually using the computer while online, not simply the amount of time you are connected to the internet. _____
7. Do you currently _____ Have a permanent connection to the internet **OR** _____ dial in through a modem

8. Where is the computer you are using now? ___ Home ___ Work ___ Library ___ Computer Lab ___ Other
9. Which of the following do you do when encountering a problem on the computer or application that you are using?
 ___ try to fix it on my own ___ consult a manual/help ___ Ask help desk/consultant
 tutorial ___ for help
- ___ Ask a friend/relative ___ Give up or leave it
 for help ___ unsolved

Section III: For the following questions, please choose the number that best corresponds to your feelings

1. Computers make me feel: *Very Uncomfortable* 1 2 3 4 5 6 7 8 9 *Very Comfortable*
2. When you run into a problem on the computer or an application you are using, do you feel:
Anxious 1 2 3 4 5 6 7 8 9 *Relaxed/Indifferent*
3. When you encounter a problem on the computer or an application you are using, how do you feel about your ability to fix it?
Helpless 1 2 3 4 5 6 7 8 9 *Confident I can fix it*
4. How experienced do you think you are when it comes to using a computer?
Very Inexperienced 1 2 3 4 5 6 7 8 9 *Very Experienced*
5. When there is a problem with a computer that I can't immediately solve, I would stick with it until I have the answer.
Strongly Disagree 1 2 3 4 5 6 7 8 9 *Strongly Agree*
6. If a problem is left unresolved on a computer, I would continue to think about it afterward.
Strongly Disagree 1 2 3 4 5 6 7 8 9 *Strongly Agree*
7. Right now, how satisfied with your life are you?
Very Unsatisfied 1 2 3 4 5 6 7 8 9 *Very Satisfied*
8. How often do you get upset over things?
Not Very Often 1 2 3 4 5 6 7 8 9 *Very Often*
9. Right now, my mood is: *Very Unhappy* 1 2 3 4 5 6 7 8 9 *Very Happy*

Name: _____ Email: _____ Class: _____

Please circle the number that best corresponds to your feelings.

1. Right now, my mood is:
Very Unhappy 1 2 3 4 5 6 7 8 9 *Very Happy*
2. We asked you to record your frustrating experiences. Overall, how frustrated are you after these experiences?
Not Frustrated at All 1 2 3 4 5 6 7 8 9 *Very Frustrated*
3. How will the frustrations that you experienced affect the rest of your day?
Not at All 1 2 3 4 5 6 7 8 9 *Very Much*
4. Are the incidents that occurred while you were recording your experiences typical of your everyday computer experience?
_____ Yes _____ No
5. In general, do you experience more or less frustrating incidents while using a computer on an average day?
Less 1 2 3 4 5 6 7 8 9 *More*