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Conceptual framework for assessing human anxiety on the Internet

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Abstract

The Internet has become a conduit for services, applications, information, content and opportunities. There is no common understanding for assessing human anxiety on the Internet. This paper aims to identify dimensions of anxieties and proposes a conceptual framework. The framework consists of three elements; i.e., the service front-end, FeelCalc and psycho-physiological elements. A simple interface tool named “MyAnxiety,” aimed to service front-end element of the framework is presented which permits identification of seven types of Internet anxiety. Initial tests with twelve and final tests with 140 university participants indicate the viability of the high-level view of the framework since the anxiety types are identified, and the framework-based assessment provides a measurement of anxiety.

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Open access under [CC BY-NC-ND license](http://creativecommons.org/licenses/by-nc-nd/4.0/).*Keywords:* Conceptual framework, Internet, Anxiety, Measurement;

1. Introduction

“Neither comprehension nor learning can take place in an atmosphere of anxiety.” - Rose F. Kennedy

The words of Rose F. Kennedy express what has long been known by educational psychologists; namely, the consequential effects of anxiety on behavior and performance; anxiety and behavior are interdependent variables. In nonprofessionals’ terms, behavior is an action or reaction in response to external stimuli, and anxiety is fear, anger, worry, or frustration caused by unusual circumstances. In general and within the context of the Internet, anxiety is an emotion imposed on a user and the user can show different types of behavior driven by this emotion. Over recent years, use of Internet-based services (e-ticketing, online gaming, and banking) and applications (YouTube, Facebook, MySpace, Newsgroup, Blog and Wikis) have very rapidly become commonplace and such a change in the status quo may be presumed to give rise to user anxiety. In addition, a key problem is that interactions at the human-Internet interface are very hard to predict. Furthermore, it is very difficult to determine types of behavior based on a single occasion. For example, some users regularly update a blog, whereas others are nonactive (Feldman, 2006). Many studies have been conducted in designing user behavior models and tasks (Agichtein, Brill, & Dumais, 2006; Agichtein, Castillo, Donato, Gionis, & Mishne, 2008; Backstrom, Kumar, Marlow, & Novak, 2008; Fisher & Smith, 2006; Menascé, Almeida, & Fonseca, 2000). Studies have indicated that humans could

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express anxiety, social isolation, and personality disorder behaviors on the Internet (Amichai-Hamburger, 2002; 2004; Stoll, 1996; Turkle, 1996). The work by (Thatcher, 2002; Thatcher, Loughry, & Lim, 2007) suggests that Internet anxiety is influenced by personality traits, individual beliefs, and social support. Their paper claims that “by providing suitable resources and fostering a supportive environment, leaders can reduce Internet anxiety and may consequently influence technology use in their organizations” (Thatcher et al., 2007). Furthermore (Joiner, Brosnan, Duffield, & Gavin, 2007) have suggested that almost one in ten students suffers from Internet anxiety. Although (Joiner et al., 2007; Joiner, Gavin, & Duffield, 2005) demonstrated that increased Internet use was correlated with reduced anxiety, one can argue whether, with online applications and services spawning daily, this claim still holds true. Moreover, problems in the network, delays in loading web pages, eye-catching pop-ups and unnecessary advertisements may likely cause anxieties.

Despite possible feelings of general malaise, users on the Internet are, nevertheless, not generally intuitively aware of health problems caused by Internet anxieties. For instance, at any given moment, a user might be suffering from Internet anxiety for a whole host of reasons. An extremely useful Internet application that a user regularly uses to perform daily tasks might have been removed, deleted or lost, and consequently, the user feels frustrated. Or else, a user may use an app, but it is at home, and not installed on the workplace computer; or has been updated such that it is too complicated for the user’s purposes, unlike the original app, which might have been a very much stripped down version. To assess and ease the burden of worries, anxieties, and stress, there is a need to devise a future-proof conceptual framework to assess human anxiety on the Internet. Therefore, the following research question and hypotheses are posited:

How can we create the conceptual framework for assessing human anxiety on the Internet?

A user’s usage of the Internet will be, H1 (a): inversely related to types of Internet anxiety or H1 (b) positively related to types of Internet anxiety.

Since the aim of this paper was also to make a simple user interface to conceptualize Internet anxiety, the following further hypotheses are also posited:

An automated tool H2 (a): cannot detect and measure a user’s Internet anxiety problems or H2 (b): can detect and measure a user’s Internet anxiety problems during interaction with the Internet.

In this paper, the concept of a service front-end is used in the measuring and analysis of dimensions of anxiety. Thus, just as; for example, a search engine uses the history of searched keywords in determining a user’s areas of interest; a similar approach could be used to detect user behavior and anxieties. Many Internet services do not primarily focus on the human and machine interface; they rely merely on a technical layer for communication between services. The lack of an effective front-end— one that does not cause anxiety— prevents better use of online services. The paper begins by briefly presenting a high-level view of the framework (Chapter 2). Then, key elements of the framework are introduced; the service front-end (Chapter 2.1), FeelCalc (Chapter 2.2), psycho-physiological elements (Chapter 2.3), system designs and implementation (Chapter 3), and the evaluation results (Chapter 3.1). Finally, the conclusions (Chapter 4) of this work are presented.

2. High-Level View

A high-level view of the conceptual framework was devised at the outset of the work. There are three key elements in this view; 1) the service front-end, 2) FeelCalc, and 3) psycho-physiological elements (Figure 1).

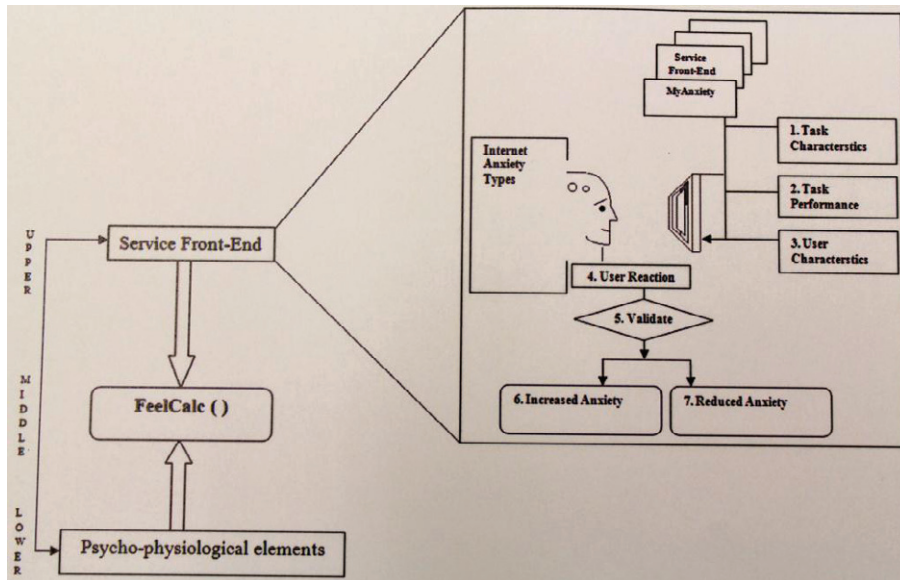


Figure 1: High-level view of the Conceptual Framework

The upper part of the high-level view represents user experience and HCI, whereas the lower part (psychological, BCI, psycho-physiological, neuron-imaging, heart rate, blood pressure, and fMRI) is conceptualized from medical science and encompassed areas where medical treatment for reducing anxiety and Internet anxiety could be used. The middle part of the high-level view is an anxiety feeling calculation element (FeelCalc). The FeelCalc element is a significant module in determining the feelings of individual users. The lower-middle part provides filter data for FeelCalc. The three characteristics that are shown on the right of the diagram are task characteristics, task performance and user characteristics. These functions are necessary to gather information about the user's behavior and feelings of anxiety. The aim is that user reaction is deduced based on evaluation of each of these metrics. Once the reaction has been formulated, validation of the reaction is necessary. The Internet anxiety types (S. Kalwar, 2010; S. K. Kalwar & Heikkinen, 2009) also need to be taken into account. Each anxiety type could be evaluated as a whole or separately. The user could possess increased anxiety or reduced anxiety. Based on the information gained, the feeling calculation element is run in order to identify the user's reactions while using the Internet.

2.1. Service front-end

The service front-end permits various user characteristics, task characteristics, and task performances to get applicable user reactions. User reactions are assessed based on usage of Internet services. It is important to determine what type of action or reaction a user shows while using a service. Qualitative and quantitative research methodology can be used to determine a user's action. For simplicity, it can be presumed that if a user reacts positively then this might lead to an improvement in the user's productivity. However, if the user reaction is negative, then possible measures to assess and enhance the user interaction with the service are required.

2.1.1. User Characteristics

When a user interacts at the Internet interface, it is important to determine user characteristics. The users and their service preferences should be collected and profiled. The background of users (education, knowledge, expertise, skills, training, motivation, attitude, and behavior) also needs to be taken into account. All these variables are key factors. The relationship between these variables and Internet anxiety can be obtained from the profile information.

2.1.2. Task Characteristics

In 1988, Eason recognized the significance of task analysis in usability measurement (Eason, 2001). Draper, in 1993, proposed a notion for a task “as a way of finding out how to do something; as a way of finding out what a system function does; and as an insurance in case of disaster.” A task could be a set of smaller tasks. In the conceptual model in this study, the task characteristics are determined by the number of tasks completed, the number of tasks gave, and the time took to complete each task. Furthermore, task characteristics should be measured based on how effective the task is, how feasible the task is, and how rewarding the task is. This information is necessary for enhancement of the task with the aim of measuring and thus, reducing Internet anxiety.

2.1.3. Task Performance

The data collected from users need to be measured in order to determine the performance level. For example, the adjusted Wald confidence interval (Sauro, 2005) can be calculated for binary task completion data. The conceptualization of a task and the way in which users perform simple tasks on the Internet are important steps in the conceptual framework utilized in this study. The way anxiety affects working memory (Eysenck & Payne, 2006; Eysenck, Derakshan, & Santos, 2007) can result in better or worse task performance (Teigen, 1994; Yerkes, 1908). It is known that at times increased anxiety relates to increased performance (i.e. Yerkes-Dodson Law). However, the causation of the correlation has not yet been successfully established (Anderson & Revelle, 1989; Teigen, 1994).

Task performance can be measured in a variety of ways; ANOVA –for statistical analysis of variance, heuristic evaluation, think-aloud protocols, interviews, surveys, and questionnaires. Task performance analysis should consider the effectiveness, satisfaction, and efficiency of the task being performed. Performance measured of speed, and errors committed by users may provide indicators valuable in the assessment of anxiety.

2.1.4. User Reaction

User reaction is a result of a combination of user characteristics, task characteristics, and task performance. In other words, reaction to effectiveness— how successfully the goal set by the user has been achieved. For simplicity, the reaction of users has been divided into two types: increased anxiety and reduced anxiety.

Increased/Reduced Anxiety

If user reactions were measured, they would indicate satisfaction or dissatisfaction. However, the relationship between effectiveness, efficiency, and satisfaction and how they relate to user emotion and experience is based on what the user goals are. That is, sometimes task effectiveness (ability to complete a task) does not always lead to satisfaction. Presumably, if the user is dissatisfied, this might lead to an increase in anxiety. On the other hand, if the user is satisfied with the system or product, this would presumably lead to reduced anxiety.

2.2. FeelCalc engine

The *FeelCalc* module is an intelligent module that takes input from the psycho-physiological elements and the upper part of the high-level view of the conceptual framework. The psycho-physiological elements, shows that the high-level view, consist of four phases: diagnosis, evaluation, treatment, and assessment, and reevaluation. The output of the *FeelCalc* element can be used to provide input to the psycho-physiological elements and vice versa. The input from the psycho-physiological element could be used to determine and interpret effective measures mitigating Internet anxiety. *FeelCalc* interprets the data provided and analyzes results based on a presumed threshold for the Internet anxiety level of users. Without a threshold or an algorithm it would be extremely difficult to determine the level of anxiousness among Internet users of a service and the effects of mitigating actions. An algorithm to measure Internet Anxiety is thus required for this element (See Table 1).

Table 1 A simple procedure for implementation of the *FeelCalc* module

1. Initialize user(s) with Initial Values of their feelings.
2. Use user Psycho-physiological elements
3. Measure the User's Reaction
 - a. Through bodily gestures recognition (skin, haptic, multi-touch)
 - b. Record the data
 - c. Validate the data with predetermined values
4. Evaluate if the user's reaction is greater/less than initial values.
5. Implement tools/methods/concepts (e.g. MyAnxiety)
6. Perform user study with the implemented system.
7. If user's feelings could not be determined, Go to Step 2
8. Re-evaluate user's data with self-assessment tool
9. Add successful feelings and omit unsuccessful feelings.

2.3. Psycho-physiological elements

The effects of post-traumatic stress of the Internet have been studied (Lange & JPQR van de Ven, 2000; Lange & JP van de Ven, 2003; Lange, Rietdijk, & Hudcovicova, 2003; Lange, JP van de Ven, & Schrieken, 2001) in the literature. Diagnosis of anxiety caused to users is a key aspect of the conceptual framework. Possible diagnostic approaches to anxiety include self-assessment psychological tools, psychological counseling, and psycho-physiological assessment. However, the former tools are mainly used to treat forms of anxiety that is not related to Internet use and they may not be suitable for diagnosis of Internet anxiety. Internet anxiety is a psychological problem caused by excessive usage of contents on the Internet. Literature shows anxiety can be diagnosed by psycho-physiological or psychological approaches. When measuring anxiety through a psycho-physiological process, it is vital to determine the types of anxieties caused to the users. In the framework, use of psycho physiological tools has been extended to the diagnosis of Internet anxiety. Possible psychological treatments may include therapy and counseling.

3. System Design and Implementation

The requirements for the “MyAnxiety” system were defined by working closely with selected users that had shown some anxieties while on the Internet using semi-structured interview. The main aim of the system is to enhance users' ability to manage their personal lifestyle on reducing their anxiety. During implementation, a preliminary prototype of the system should first be introduced to the users. Based on their feedback, the prototype should be changed, if needed. It is very important to take into consideration design cost, working hours and simplicity while designing preliminary prototypes. To accomplish this objective, the following requirements (R1-R4) were elicited.

R1: MyAnxiety system must enable techniques to measure and monitor the user's anxiety level and severity-degree of online usage. Since there are behavioral changes, users need to understand how their online usage affects their behavior and vice-versa.

R2: The system needs a log monitor, measuring catalog, printing service, sensing device, and some animation for effective usability scenarios.

R3: Since the time spent on the Internet is real, it is acceptable to allow users to change some data in the system manually.

R4: A reference implementation or the characteristics of available software/services such as pop-up blocker, parental control software; ad plug-ins should be checked to code the system.

In the light of the above requirements, a simple front-end prototype named, “MyAnxiety” was designed. The “MyAnxiety” system consists of two tier architecture (See Figure 2). The first tier consists of e.g. on-body sensor interface that is responsible for collecting data from psychological elements. The second tier consists of a mobile

interface and desktop interface for logging, measuring, reporting, and communicating between these devices. The second tier is, effectively, a simple front-end interface that is responsible for storing, searching, and identifying elements of the anxiety of users.

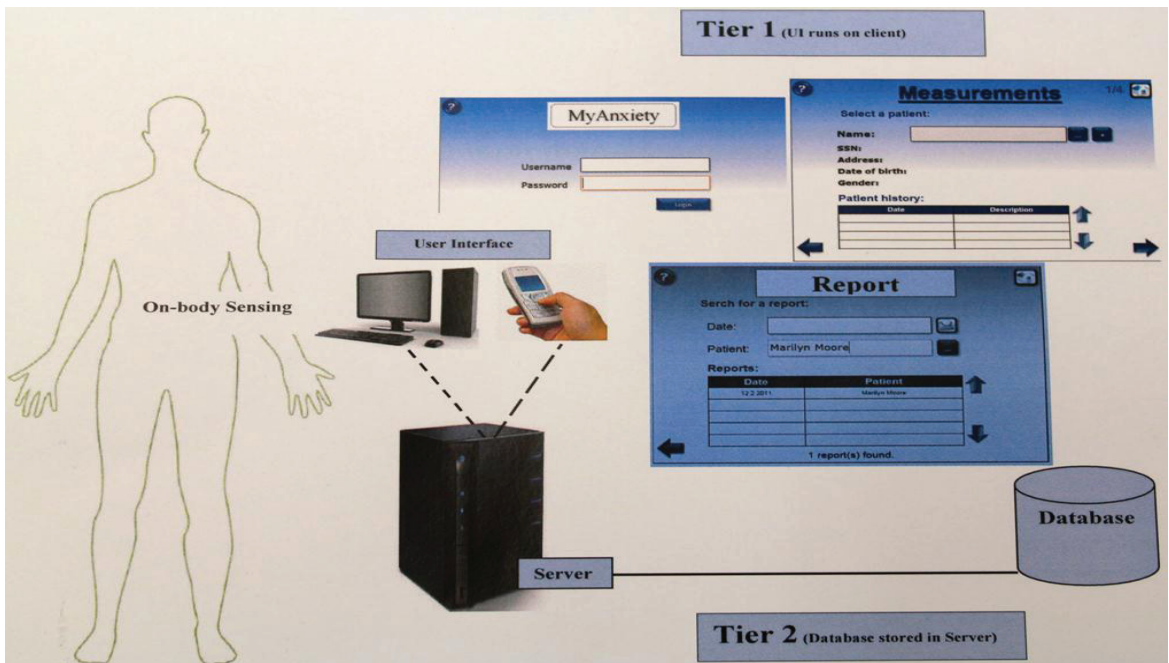


Figure 2: “MyAnxiety” — a two tier system to test the severity of a user’s anxiety

The MyAnxiety system follows a two tier system implementation. Firstly, a user signs up. The user inserts the information required (See Figure 3). Now, MyAnxiety is running and collects user behavior on the Internet; it contains logs that have the information related to various pages user visits, has visited. Secondly, the system has a provision for setting up measurements automatically. Since on-body sensors were unavailable, MyAnxiety system is coded so user had to select various body part for which they might have felt anxiety. A user could select types of Internet anxiety and rate these types using rating scale (1=never, 2=rarely, 3=sometimes, 4=often, and 5=very often). MyAnxiety does not allow browsing before setting up measurements. Thirdly, the system provides functionality for adding new user, generating reports and displaying results (e.g. in Figure 4 on right, one user has one type of anxiety). Fourthly, log out screen is presented.



Figure 3: User sign-up page (left). A user can input values for measuring various types of Internet anxieties (right).

A new user can be easily added in the System with Name, SSN, Address, DOB and Gender. These data are simply input for any new users. The figure 4 below shows the output screen of one user showing one type of anxiety found (right) and the output for adding a new user (left) (See Figure 4).

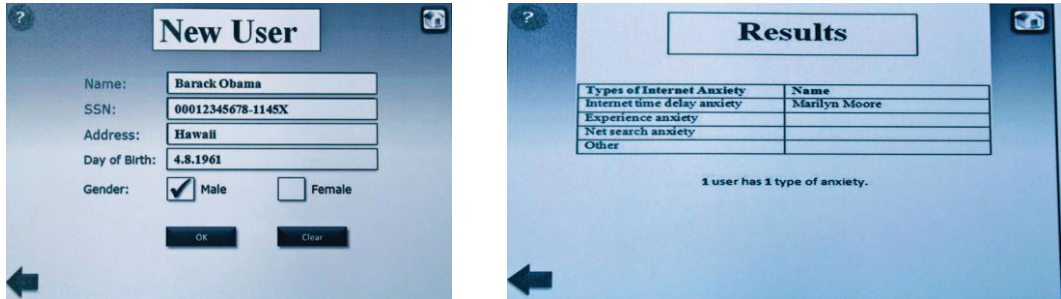


Figure 4: Adding a new user (left) and results (right).

3.1. Evaluation results

The “MyAnxiety” system was evaluated with twelve Master degree students. In initial evaluation study, all the users were male and between 25-34 age range, mostly Asians (83.3%) and Westerns (16.7%). Note that the main aim of the evaluation was to establish the viability of the “My Anxiety” system concept. Test users were asked to rate the types of anxieties based on a five point-linkert scale such as (1=never, 2=rarely, 3=sometimes, 4=often, and 5=extreme). They were instructed to do following: use the system throughout the day after having browsed the Internet, record their feelings about the system, refer to the provided help menu and troubleshooting instructions, and e-mail the developers on encountering difficulty using the system or when wishing to provide feedback about the system.

3.1.1. Initial results

Overall, the initial results were convincing evidence that the system is viable. Few test user feedback showed that most of test persons liked the system and reported it was very easy to use. Most users reported on identified types of Internet anxiety; Internet terminology anxiety, Internet time delay anxiety, General Internet failure anxiety, Usage anxiety, Experience anxiety, Environment and attraction anxiety, and Net Search anxiety. Data collected with measure scale among twelve university participants is shown in Table 2:

Table 2 Data collected to measure types of Internet anxiety among twelve users (n=12)

Types of Internet anxiety	never	rarely	sometimes	often	very often
Internet terminology anxiety	4	4	2	1	1
Internet time-delay anxiety	2	2	2	3	3
General Internet failure	2	3	2	3	2
Usage anxiety	2	4	4	2	0
Experience anxiety	0	2	7	2	1
Environment and attraction anxiety	2	2	3	4	1
Net search anxiety	0	3	6	1	2
Average	1.714285714	2.857142857	3.714285714 (max)	2.285714286	1.428571429 (min)
Standard deviation	1.380131119	0.899735411	2.058663459	1.112697281	0.975900073

In initial tests, most users reported that they “sometimes” (3,714) experienced these types of Internet anxieties with an average standard deviation (1.285). Furthermore, users also reported that they “very often” (1.428) experience these types of Internet anxiety. In initial results, 95% Confidence Interval (CI) for each measure was calculated. For “never” (-0, 33, 5, 07), “rarely” (0,806, 4, 33), “sometimes” (3, 59, 11, 63), “often” (0,364, 4, 72) and “very often” (-0, 51, 3, 2). Overall, sample mean was (2, 4), standard deviation (1, 28), and CI was (0, 56, 5, 58). Since a correlation coefficient ranges from -1.0 (i.e. negative correlation) through 0 (i.e. no correlation) to

+1.0 (positive correlation), the diagonal value is 1.0, as variable always correlates with itself. Table 3 shows values of the correlation coefficient between the pairs of variables with sample size (n=12). In initial results, we find negative correlation (-0.842) among “Internet time delay anxiety” and “Internet terminology anxiety” also negative correlation (-0.7637) among “Usage anxiety” and “Internet terminology anxiety.”

Table 3 Shows values of the correlation coefficient between the pairs of seven variables (n=12)

	Internet terminology anxiety	Internet time-delay anxiety	General Internet failure	Usage anxiety	Experience anxiety	Environment and attraction anxiety	Net search anxiety
Internet terminology anxiety	1						
Internet time-delay anxiety	-0.842700972	1					
General Internet failure	0.060192927	0.166666667	1				
Usage anxiety	0.512271764	-0.763762616	0.327326835	1			
Experience anxiety	-0.231845279	-0.30408182	-0.135147476	0.619323537	1		
Environment and attraction anxiety	-0.260241719	0.080064077	0.480384461	0.419313935	0.421997858	1	
Net search anxiety	-0.128887459	-0.356873214	-0.158610317	0.597050251	0.932456603	0.114290898	1

3.1.2. Later results

The initial test was limited with only few participants; therefore; more university participants were recruited for assessing human anxiety on the Internet. One hundred forty university respondents to questions on types of Internet anxieties identified. In later evaluation study, male (59.3%) and female (40.7%) with age range between 25-34, mostly Westerners (85.2%) and Asians (7%) participated. The table 4 shows data collected among 140 university participants with an average standard deviation (9.307).

Table 4 Data collected with 140 university participants (n=140)

Types of Internet anxiety	Frequency				
	never	rarely	sometimes	often	very often
Internet terminology anxiety	53	47	37	3	0
Internet time-delay anxiety	21	36	52	28	3
General Internet failure	19	35	54	28	4
Usage anxiety	49	52	32	7	0
Experience anxiety	40	60	35	5	0
Environment and attraction anxiety	52	44	30	9	2
Net search anxiety	25	56	45	11	3
Average	37	47.14285714 (max)	40.71428571	13	1.714285714 (min)
Standard deviation	15.0443788	9.56431861	9.655987533	10.56724499	1.704336206

In later tests, it was found that student participants “rarely” (47, 14) experienced types of Internet anxieties. Some of these participants did experienced Internet anxieties “very often” (1,714). In later result, 95% CI for “never” (527, 14, 586, 11), “rarely” (431, 92, 469, 39), “sometimes” (373, 93, 411, 76), “often” (116, 58, 157, 97), and “very often” (-0,418, 6,245) were calculated. Overall, sample mean (27, 91), standard deviation (9, 30), and CI (241, 33, 277, 79) were also calculated. The table 5 shows a positive correlation among “Net search anxiety” and “Experience anxiety” (0.9324). In later results, we could not find negative correlation among variables (or, types of

Internet anxiety) tested. All the variables were positively correlated, such as, “Net search anxiety” was positively correlated with “Internet terminology anxiety,” “Internet time-delay anxiety” was positively correlated with “General Internet failure,” “Usage anxiety” was positively correlated with “Experience and attraction anxiety,” and “Experience anxiety” was positively correlated with “Environment and attraction anxiety.” These positive correlations among types of Internet anxieties do not necessarily mean “causation”. However, in general and broader perspective one could argue the significance of results in line with findings of (Amichai-Hamburger & Hayat, 2011) that showed “Internet usage does not have a negative impact on the social lives of users and, in some aspects, it may even have positive effects.”

Table 5 correlation coefficient between the pairs of seven variables (n=140)

	Internet terminology anxiety	Internet time-delay anxiety	General Internet failure	Usage anxiety	Experience anxiety	Environment and attraction anxiety	Net search anxiety
Internet terminology anxiety	1						
Internet time-delay anxiety	0.762995736	1					
General Internet failure	0.74340976	0.998087403	1				
Usage anxiety	0.981778857	0.700810767	0.670449486	1			
Experience anxiety	0.979625337	0.667328004	0.63693654	0.998644947	1		
Environment and attraction anxiety	0.986729675	0.738954415	0.710327886	0.998479344	0.994725393	1	
Net search anxiety	0.997122721	0.793839106	0.772255759	0.984917951	0.979317545	0.991799711	1

The aim of the study was to create conceptual framework for assessing human anxiety on the Internet. Based on our data, we found that there is a positive relationship between user’s usage of the Internet and types of Internet anxieties (H1b). However, the findings might seem inconsistent with (Joiner et al., 2005; 2007) work that demonstrated increased Internet use was correlated with less anxiety. One reason could be Joiner et al., studied “relationship between Internet identification, Internet anxiety, and Internet use” and not types of Internet anxieties. Another reason could be human behavior on the Internet especially; the Internet usage is dramatically increasing over time. These findings also contrast with those of (Presno, 1998; Umeda, Kurashiro, Ejima, & Nozaki, 2005) that demonstrated various factors of Internet anxieties. One reason could be researchers have tested Internet anxiety in the classroom settings, whereas we have used a broad survey with the university participants. Hence, we extended this research by looking at types of Internet anxiety (S. Kalwar, 2010; S. K. Kalwar & Heikkinen, 2009), and by providing empirical evidence that most university participants “rarely” and “sometimes” do experience various types of Internet anxieties. Thus, hypothesis H2b is supported and positive because we could create and test a simple automated tool; i.e. “MyAnxiety,” as part of our service front-end that was also helpful for identifying user’s types of Internet anxiety.

4. Conclusions and Future Work

In this work, literature study formed the basis for the development of a conceptual framework for assessing human anxiety on the Internet. The framework can be of value to develop services that cause minimal anxiety. The preliminary evaluation was carried out using a qualitative research methodology (e.g. semi-structured themed interview, questionnaires, observation). The framework also assesses Internet anxiety types; a task which was done via the developed FeelCalc element utilizing MyAnxiety system implementation. The framework has potential for use with real users as a methodology for diagnosing Internet anxiety and may permit realistic assessments of

Internet anxiety. In this initial design and implementation phase, no on-body sensing sensors and costly medical facilities were used in assessment of the viability of the approach; only a simple prototype was created. The system cannot reduce anxiety, per se. It did, however, identify and report seven different types of Internet anxiety, providing the basis for anxiety abatement interventions. Future work will include further refinement of the algorithm for the FeelCalc element and the construction of various scenarios to validate the framework.

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