Analysis, Design and Implement of Database for Wheelchair Skills Program

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1. Introduction

The author was employed as a Health Informatics Analyst Intern to analyze, create, design, and implement a web-based interface to the database for the Wheelchair Skills Program (WSP).

The health informatics component of the WSP project was to identify the flow and use of information in Rehabilitation Center settings that would help the researchers to evaluate the health status and outcome measurement of their patients. This is a report of the work done by the author during his internship with Rehabilitation Center. This was done as part of a research project headed by Dr. Lee Kirby, Division of Physical Medicine and Rehabilitation, and Dr. McAllister, faculty of Computer Science and Wheelchair Research Team.

Background

Wheelchair users are one of the most visible members of the disability community because they are using of wheelchair. They are at a higher risk of injury than others member of community because of functional limitation and activity restrictions. There were approximately 1.6 million wheelchair user out of institutions [2] in the United States in 1994-95 and that number exceeded to two million by the year 2000. [3] According to the US national data, National Institute on Disability and Rehabilitation Research estimate that between 1.6 and 2.2 million Americans rely on wheelchairs to assist them with mobility impairments. [4]

The amount of the population who use wheelchairs increases sharply with age. The majority of the population using wheelchair are elderly for example because of increased precautions and compromised adaptability to external hazards, injury risk of disabled children is reduced.[5]

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The wheelchair is an invaluable device in rehabilitation to users for functional mobility. There are several problems to use wheelchair; such as the wheelchair-related injuries, according to the wheelchair related injuries treated in emergency departments in US have increased during the past decade (more than 100,000 in 2003 which is double the number reported in 1991) [4]; 50 deaths per year, 100,000 injuries to ER/year, 5% of community wheelchair users injured/year, 38% fell at least once in past year & 47% of fallers (18% overall) suffered an injury [6] or natural and build environments which disabled people's access needs and requirements are articulated in public policies and practices towards the development and regulation of the built environment.

2. ORGANIZATIONAL PROFILE

The Nova Scotia Rehabilitation Centre is part of QEII Health Science Centre and Capital Health District association for musculoskeletal and amputee rehabilitation, neuromuscular rehabilitation (including spinal cord injury and traumatic brain injury), and stroke rehabilitation. [7] It was opened in 1977 to provide quality service in the areas of physical rehabilitation. Staff works with people who have physical and associated disabilities to develop their potential through specialized rehabilitation programs and services. [8]

Figure 1 Carpet adopted from WSP website [19]

Figure 2 Grave adopted from WSP website [19]

The Nova Scotia Rehabilitation Centre focuses on each patient's needs, abilities and unique potential. It provides services such as the *Wheelchair Skills Program (WSP)* that uses methods based on the rehabilitation, wheelchair and motor skills literature to teach wheelchair skills. The process begins with an evaluation of each patient's medical and rehabilitation needs. [8] The WSP was developed by the wheelchair research team, and is based on over 20 years of Dalhousie research into wheelchair stability and performance. [9] It assesses an individual's performance in 18 groups of wheelchair skills through its *Wheelchair Skills Test*. The WST is an evaluation method, to test a specific person in specific wheelchair. [20] The skill groups are divided into three levels of difficulty: Indoor, Community, and Advanced. The WST and *Wheelchair Skills Training Program* (WSTP) divided into three levels of skills for simply testing, training and reporting. The Indoor skills are first learned, such as rolling forward or backward. The Community skills are needed in a community such as crossing a slope. Advanced skills are the level of training user has completed initial rehabilitation. These skills are more advanced such as for example wheelie on level terrain moving turns backward or forward. The WST may be used for clinical purposes as a diagnostic measure to address which skills need to be address during the rehabilitation process or can be used for program evaluation to answer research question to assist in wheelchair design. [20] The WST can be used as an outcome measurement by repeating the test on completion of rehabilitation phase. [20] The *WSTP* is the same skill set as for WST and training methodology based on the

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rehabilitation, wheelchair skills [20] to test and train wheelchair users and/or their caregivers and clinicians. The WSTP is a structured protocol that incorporates several principles of motor learning. [21] The WSTP used for in-depth analyses for specific skills and long term care setting. The WSTP helps and train the caregivers in practice to the wheelchair-handling skills of untrained caregivers.

3. DESCRIPTION OF THE WORK PERFORMED

This project is web bases delivered to collect the data which is the test examination of the patients by tester who is clinicians or therapist and push information and tailgated this way for the Wheelchair Skills Program and try to quick information online and increase the service level try to help examinations.

The Wheelchair Skills Program (WSP) has two components: the Wheelchair Skills Test (WST) and the Wheelchair Skills Training Program (WSTP). WST assesses how well a patient operates a wheelchair. It is a set of 57 skills test that target quality of life assessments. The WSTP is an assessment that identifies which skill is acquired or which one is efficient. What we can do to improve to quality of life and also used of the disseminate skills as the way of the new assessing to new technology as the base wheelchairs. Part of this project is to create the form connected to the database to collect the information from wheelchair users' examination by tester who is clinicians or therapist.

This is help how to get the correct information through the internet to do more question and automatically calculate and do comparison the result and also help with insure integrity verification to make sure all the answer of the question check out correctly as to go to provide advise to some patients and also can be helpful to locate similar results from other patients and provide advice on what progress to expect and to help the researchers in their analyses.

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The basic WST skills are simple uses of wheelchairs like how to pick up objects from the floor, how to close a door, how to turn around obstacles like steps, or move backward. The WST is also about quality of life which help the wheelchair users to be more involved in the community such as steep incline descent: wheelie or ascent: lifting instead of rolling.

Figure 3 Wheelchair user and caregiver [19]

Another important element in the rehabilitation process is training the caregiver because wheelchair users sometimes need someone to assist them. Caregivers usually are females like mother, wife which help and care younger persons, people with decreased mental health, spouses, and children. [22]

We can divide the project in two steps. At the first step, clinician, technicians and researcher can use the form locally. This will help the clinicians and the research team to work with the form as a tool for WSP. When the team is satisfied with the process of data collection through the web then the next step will be to increase the scope of users and allow the other clinicians and researcher to use of the information for their analyses. This information also might be useful for improvement of wheelchair technology.

OVERVIEW OF WEBPAGE DEVELOPMENT

Figure 3 depicts the architecture of the project with database and web technologies. This architecture is divided into two parts: inside (local) or outside the firewall. The

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clinicians, technicians, caregivers and patients can access the website through internet to the Windows Server and use the website which created by PHP and connected to the database to collect the data and/or report. The next step will be involved other researcher and clinician to use of these data and information.
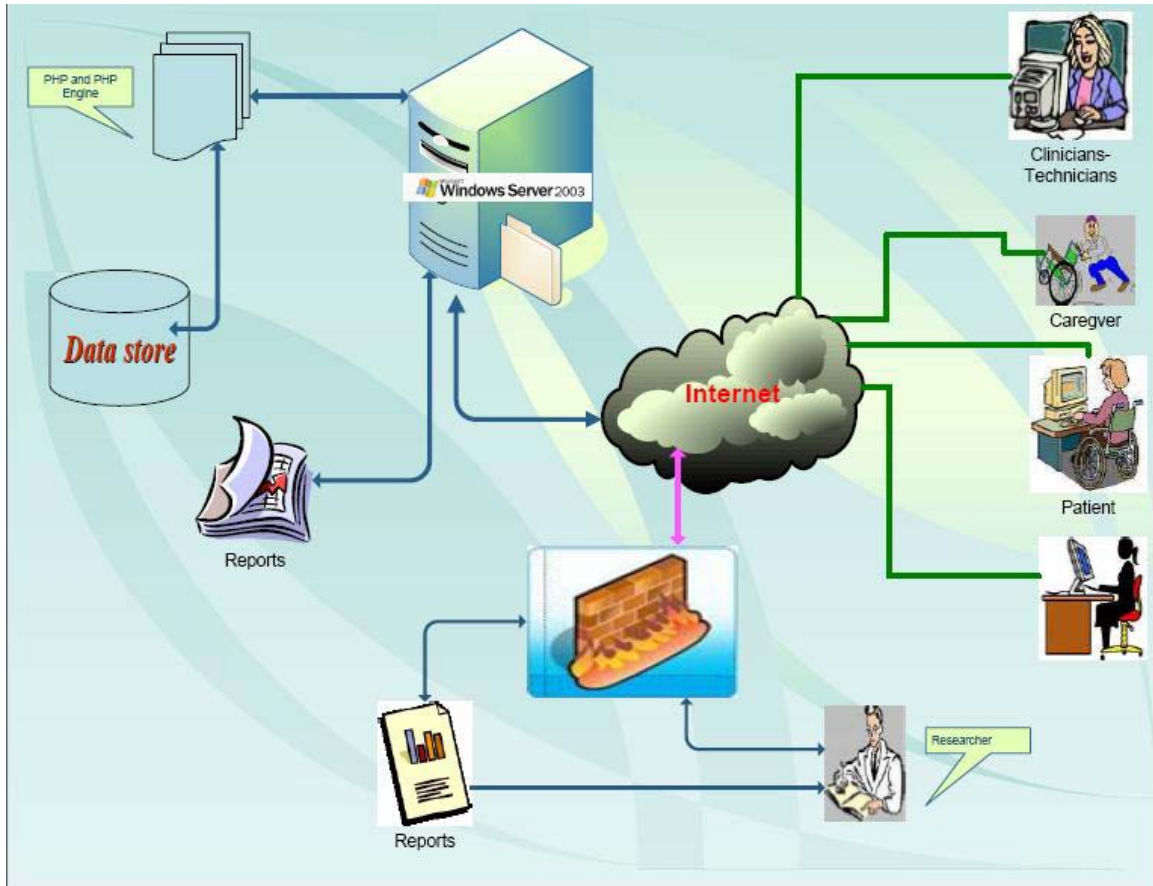

Figure 4 Overview of WSP Architecture

WEB INTERFACE AND DESIGN

The web interface is shown in Figure 5. Base on WST version 3.2 manual [20] we create the form. The form is divided to two parts: the main page and the summary of the form in the left hand side. The summary gives users the opportunity to quickly view how much of the form is completed before submitting the form.

The summary side starts with the help link to give the user information about how to use the form. It also shows the summary of the skills in the each category the background

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color of each skill on the form will change depending upon of the value of the corresponding skills in the main page. The underline under each skill's number represents a skill that was failed due to unsafe conditions. There are five options to display and customized the main page such as demographic, indoor, community, advanced and safety column. Appendix A shows a complete list of the possible interfaces of the form.

Figure 5 Main user interface

The main part of the form is divided into four parts: 'demographic information' that contained of the patient's personal information, caregiver, tester and the date and time of examination and form number. At this part we can see the list of the names of 'first name', 'last name', 'caregiver', and 'tester' that already exist in the database. This is not to only make easy to enter the data to the database also the person can see the complete list of the patient and tester and caregiver from the database.

The other parts of the page such as indoor contained the basic skills questions, community with 13 skills questions and advanced with 14 skills questions and for each question there is the select option of Fail/Pass/Not tested (NT) and for the first 12

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questions Not Part (NP). By select any of Fail (red)/Pass (green)/NT (blue)/NP (yellow) the color of the select part and summary in side of the page will change.

There are the lists of skills that have pre-requisites as well as those that can be achieved through combining skills. If the pre-requisites skills fail the related skill(s) will fail. In other way, if the combining skills pass then the related skill(s) will pass automatically.

The first step of data collection through the form is to select the skills questions. The form can not be submitted if any of the skills questions stay unselected and require to select all the questions with pass, fail, not part; if any skill question remain uncheck will be listed and the list of unselected skills will be shown as an error and gives the options to go back and select the skill or select all as pass or fail or NP. There is another option to check the uncheck skill(s) question(s) as Not Tested if the examination was not finished in the time.

The next step after submitting the form will not only show the preview of the form also it shows the table of the results of Pass/Fail … in total and individual for each category (Figure 4). At this point the form can be entered into the database or printed as a hard copy for any purpose. The preview shows the result using images for each of pass, fail, not part and not test to be easy to realize which skills were passed, failed, not part or not tested one of the advantages of adding different images is to compare the form to make sure there is no error to enter the data. Another advantage is easy to conclude from the form to see which skill was passed, failed, not part or not tested.

42	Inclines	7.5 Wheelie Fwd Descent	N/T ☐		Safe ■
45		15cm Ascent	N/T ☐		Safe ■
46	Level Changes	15cm Descent	N/T ☐		Safe ■
47		15cm Wheelie Fwd Descent	N/T ☐		Safe ■
48		No-Hands Rest	Fail ✉	Because of Prerequisite 2	Safe ■
49		Stationary	Fail ✉		Safe ■
50		Rolling Forward	N/T ☐		Safe ■
51	Wheelie on Level Terrain	Rolling Backward	Fail ✉		Safe ■
52 & 53		Turns in Place	L N/T ☐ R N/T ☐		L Safe ■ R Safe ■
54 & 55		Moving Turns Forward	L Pass ■ R Pass ■		L Safe ■ R Safe ■
56 & 57		Moving Turns Backward	L Pass ■ R Pass ■		L Safe ■ R Safe ■

Your over all comment(s):
This is a general comment that will be added for mor inormation rom test examination

Form results:

Indoor:	Pass: 5	Fail: 9	Not Part: 3	Not Tested: 13	Safe: 28	UnSafe: 2
Community:	Pass: 1	Fail: 0	Not Part: 0	Not Tested: 12	Safe: 13	UnSafe: 0
Advanced:	Pass: 4	Fail: 2	Not Part: 0	Not Tested: 8	Safe: 14	UnSafe: 0
Total Number of:	Pass: 10	Fail: 11	N/P: 3	N/T: 33	Safe: 55	Unsafe: 2
Total Percentage of:	Indoor Pass: 18.5%	Community Pass: 7.7 %	Advanced Pass: 28.6%	all Passes is: 47.6%		

See Wheelchair Skills Program for explanations. Available at www.wheelchairskillsprogram.ca.

[Submit Form] [Print Results] [New Form]

Figure 6 Submit page with the results

DATABASE DESIGN

The research team used MS Access as a database in the past; we also used MS Access as a database to be integrated with the past database used in WSP. MS Access needs to be run in Windows environment; therefore, we use Windows Server 2003 and ODBC (**O**pen **D**ata **B**ase **C**onnectivity) which is standard database access method to connect the form to the MS Access as a database. The goal of ODBC is to make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data. ODBC manages this by inserting a middle layer, called a database *driver*, between an application and the DBMS. The purpose of this layer is to translate the application's data queries into commands that the DBMS understands. [14]

We create five tables for Patient information, Caregiver name, Tester name, Session information and Skills value, comments and safety. Appendix B shows a complete list of tables and relationships.

4. HEALTH INFORMATICS RELEVANCE

The health informatics component of the WSP project was to identify the flow and use of information in rehabilitation. At this point the local researcher and the future the researcher can use of the information provided by the WSP for their analyses. It is important to make sure who, where, why and when can access to the patient information. The WSP assists the patient and trains them how to use the wheelchair and in each examination the technicians or clinicians record the test and enter it to the database to be used for research purpose.

This is reminiscent the Clinical Decision Support Systems (CDSS) which is interactive computer programs. It assists physicians and other health professionals with decision making tasks. [15] Computerized decision support is assisting healthcare providers and administrators with such decision tasks as information retrieval, data analysis, diagnosis and test, procedure and case management recommendation has been one of the critical information technologies heavily deplored to transform healthcare. [16] This project will help by using of the different queries depend upon on the research question to help clinicians, technicians and researcher.

5. DISCUSSION OF A HEALTH INFORMATICS PROBLEM

There is no standard of using wheelchair because the wheelchair users own wheelchairs in the own environment and learn by experience in the daily life and these experiences are not based on the research evidence. [18] Sometimes the wheelchair users are injured from caregiver if they do not know how to help the wheelchair users for example when caregivers push their knee in the wheelchair user back when they try to help the wheelchair user to pass the steep or slope or sometimes caregiver get back injured when try to help wheelchair user to pass from for example the high threshold. The goal of the WSP is to standardize of the training and examination of wheelchair users and caregivers and this project used to support the WSP. However, because of some of privacy and security issue there will be some restriction for researcher and other

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clinicians to use this tool. We are hoping to fix this problem in the next step of the project.

6. LESSONS LEARNED

I did not have any experience and knowledge about the WSP. During this project, I learned many things about the WSP; part of the lessons was related to the wheelchair program itself and the other part was a technical side. This was the first time for me as experience and working so close in the rehabilitation center. I did not have prior experience with wheelchair skills and rehabilitation.

At the beginning, it was important for me to learn quickly about not only the project but also about the wheelchair training and the process of data collection by the technicians and clinicians. I joined several training sessions to follow the process from the beginning directly. I also followed a research study in this area to understand what exactly was important in this field and why this tool can improve the WSP before I started to implement.

Another lesson I learned from this project was from the IT side during implementation. In this part I should find out what exactly the client wants based on technical details and make sure that they are happy of the performance and functionality. Meeting with clients after each step helped me to make sure the tools fit their needs.

7. CONCLUSIONS

The WSP is practical, safe, well tolerated, and useful. It is an assessment to identify which skills are efficient for any single individual. What can be done to improve the quality of life, it also use of the disseminate skills as the way of the new assessing to new technology as the base wheelchairs.

The main target is not necessarily the people in the wheelchair, is the clinicians, the technicians who are helping integrate wheelchair users back to their community, giving

them the assessment and the training. The clinicians themselves could find out, where they should direct or focus with the therapists for the individuals and try increased the web support to provide more informed context for clinicians to invest tailor their approach.

8. RECOMMENDATIONS

In the future access to the data can be more protected by using of authentication and then the information gather can be trusted, because the individual can be identified. Using of three key principle of secure system such as confidentiality to help to protect patient privacy to be assurance that sensitive data is being accepted and viewed only by those who are authorized to see it; integrity to prevent modification of information by unauthorized, by authorized users, and to preserve the internal and external consistency of databases; and availability to make sure the information accessible to authorized viewer at all the time special for people who are not part of Capital Health that can access to the data easily (of course with some conditions and/or restrictions) because they are behind the firewall.

Another recommendation is switch from MS Access to the SQL server. The problem with MS Access is for example limitation of size of the table (maximum1 GB), size of the database (maximum 2 GB), and limit of the number of the tables, limit of number of columns and etc. Another advantage of using SQL is PHP, SQL and UNIX work together as family. Therefore, the systems will be more secure and reliable.

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APPENDIX A:

Screenshots of the WSP Web Tool

Figure 7 Enter the data

Figure 8 Unselect the Safety column

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Figure 9 Warning of the test time incorrect

Figure 10 Show the list of the data
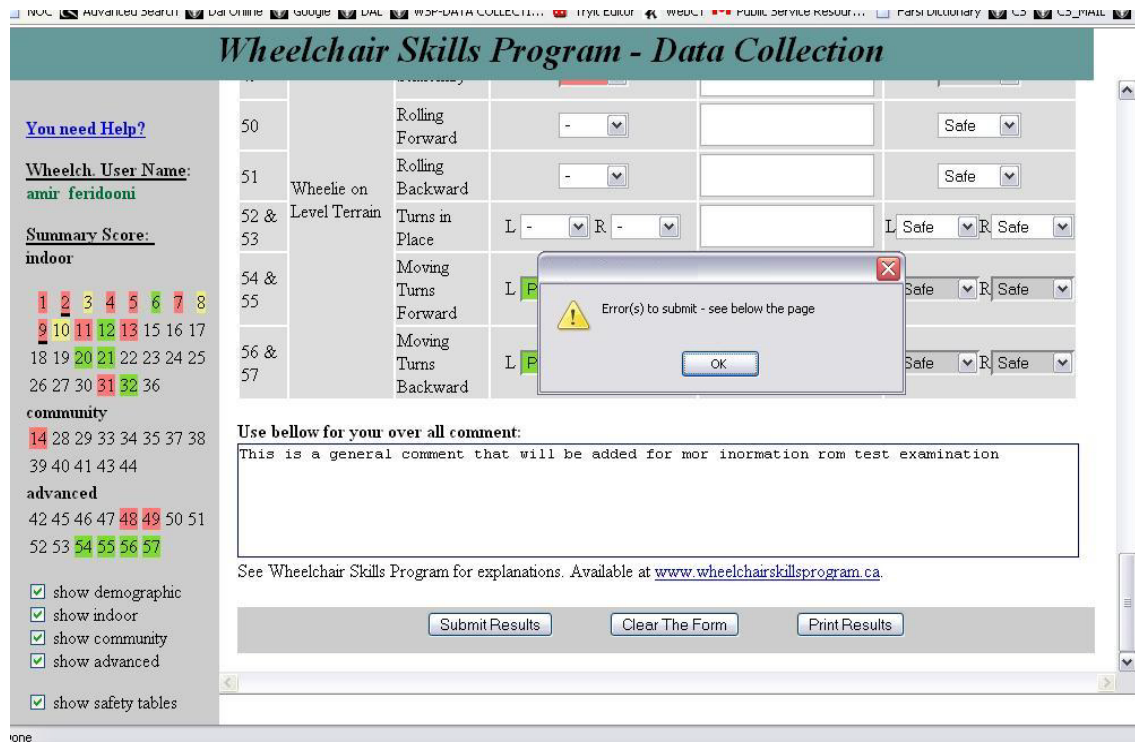
Figure 11 Detected upon submission
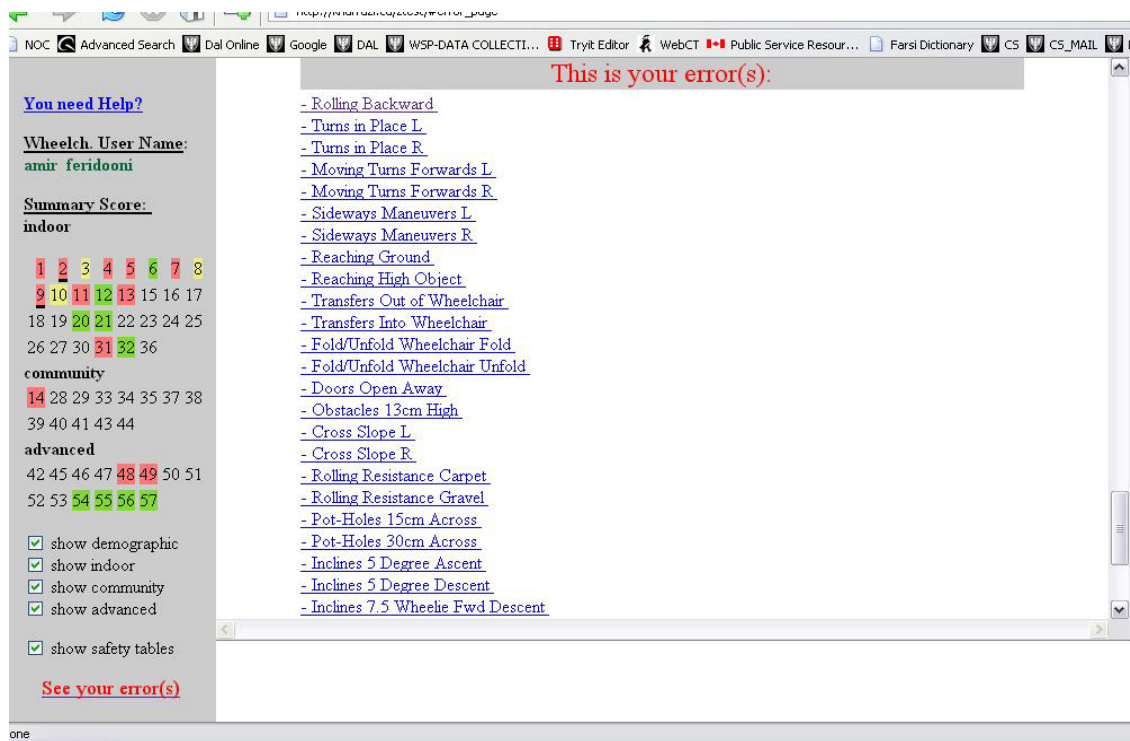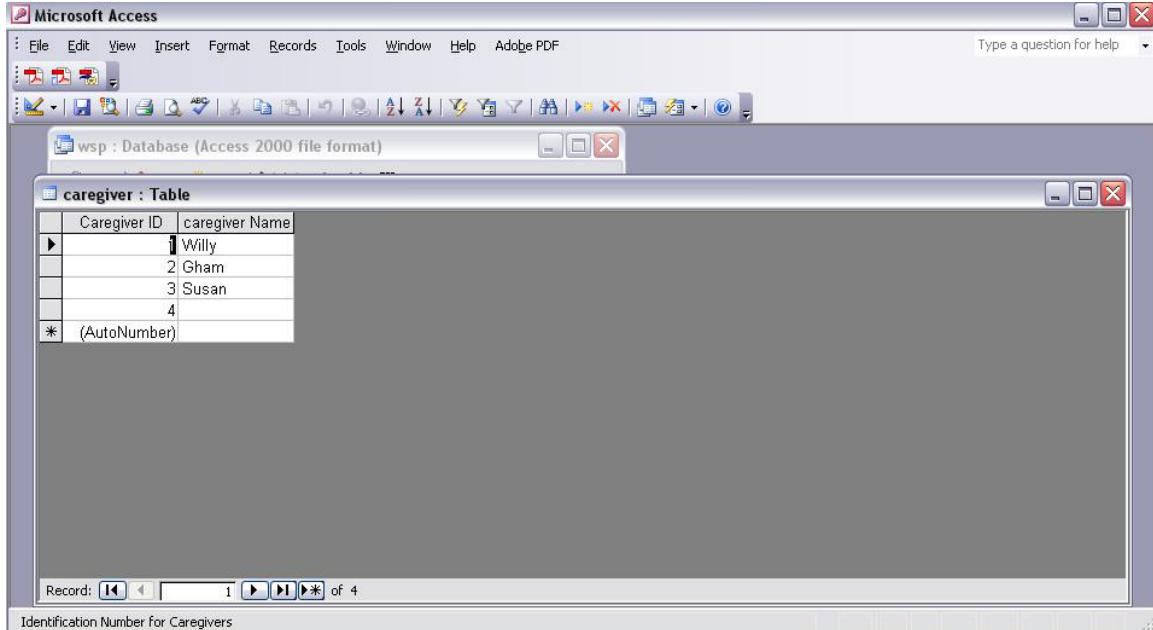
Figure 12 List of Errors

APPENDIX B:

Screenshots of the WSP Database

Figure 13 Caregiver Table
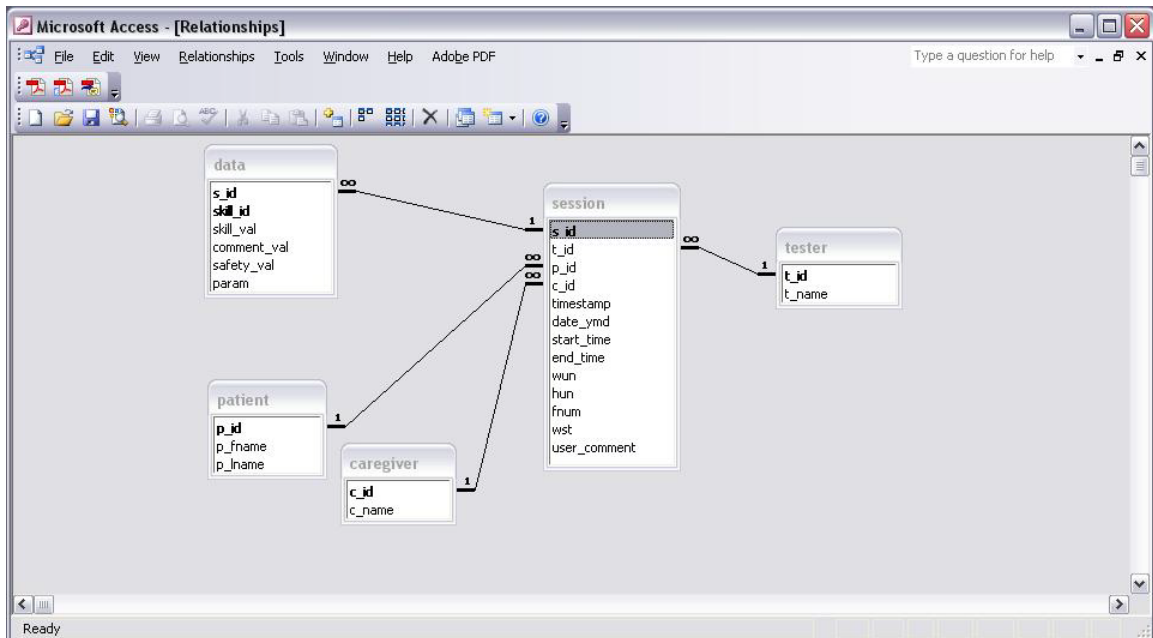
Figure 14 Tables Relationships

Session ID	Skill ID	Skill Value	Comment Value	Safety Value	Additional Parameters
16	10	2		1	
16	11	2	Because of Prerequisite 10	1	
16	12	2		1	
16	13	2		1	
16	14	2	Because of Prerequisite 13	1	0
16	15	5		1	
16	16	5		1	
16	17	5		1	
16	18	5		1	
16	19	5		1	
16	20	5		1	
16	21	5		1	
16	22	5		1	
16	23	5		1	
16	24	5		1	
16	25	5		1	
16	26	5		1	
16	27	5		1	
16	28	5		1	
16	29	5		1	
16	30	5		1	
16	31	5		1	
16	32	2	Because of Prerequisite 13	1	
16	33	2	Because of Prerequisite 32	1	
16	34	2	Because of Prerequisite 13	1	
16	35	2		1	
16	36	2	Because of Prerequisite 13	1	
16	37	2	Because of Prerequisite 36	1	
16	38	2	Because of Prerequisite 13	1	
16	39	2	Because of Prerequisite 38	1	
16	40	2	Because of Prerequisite 13	1	
16	41	2	Because of Prerequisite 13	1	
16	42	5		1	
16	43	5		1	

Record: |◄| ◄ | 1 | ► |►|| ►* | of 1254

Session id

Figure 15 Session Table

Skill Value is the value for each skill such as 1 for '–', 2 for Fail, 3 for Not Part, 4 for Pass and 5 for Not Tested. The value for Safety defined as 1 for safety and 2 for unsafely.

Figure 16 Patient Table

Figure 17 Session Table

APPENDIX C:

ENDORSEMENT

This report has been written by Amir Feridooni in partial fulfillment of the requirements of the Master of Health Informatics Program, Dalhousie University and has not received any previous academic credit at this or any other institution.

Amir Feridooni

_____   _____
Amir Feridooni   Date