

iTherapy: A Recommender System for Learning Disability Therapy Plan

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Abstract

iTherapy is a web-based system for the head of therapist and therapist of Penawar Special Learning Centre (PSLC) to make therapy plan automatically. PSLC is a centre that assists children with learning disabilities in overcoming their problems by providing a set of therapy treatments. They have nine branches all over Malaysia. It is a stressful job for the therapists to key in all the information in a paper-based approach and using WhatsApp communication to get approval from the head of therapist since there are 3000 patients to be analysed. To develop the iTherapy system, an iterative development methodology is used. The development code for the website has been done by using Visual Code Studio and XAMPP as a localhost to deploy the project, Hyper Text Markup Language (HTML), Cascading Style Sheets (CSS) for frontend development while Structured Query Language (MYSQL) to construct the database framework and Hypertext Preprocessor (PHP) as backend development. This system allows the head of therapist and therapists to do patient diagnosis, view therapy plan, get approval and print the approved therapy plan. It is hoped, iTherapy will help the head of therapist and therapist in PSLC to solve their current issues with paper-based approach.

Keywords—*iTherapy, web-based application, learning disability, FMCDM, QFD*

1.0. Introduction

Refer to the WHO and the World Bank (2011), 15% of the world's population has any kind of disability. In certain countries, the term Learning Disabilities (LD) is referred to as Specific Learning Difficulties (SpLD) or dyslexia [1]. While in Malaysia, there are 197,519 disabled persons registered according

to the Department of Social Welfare's statistics [2]. In 2018, Department of Social Welfare list out statistics the total of registration of Person With Disabilities (PWD) increasing to 497,390 [3]. Penawar Special Learning Centre (PSLC) is a facility that assists children with learning disabilities in overcoming their difficulties by providing a series of treatments over a period of time. PSLC currently has about 9 branches in Malaysia. Usually, staff enter all patients' details and treatment by using paper based approach. This is time consuming that causes problems for the staff. The problem in setting approval form Head of therapist because they are using WhatsApp communication system. The approval should be done by one, head of therapist and troublesome for her to check one by one message since they have more than 3000 patients. iTherapy is suggested to solve these problems, which enable PSLC therapists to conveniently record their patients' records. Thus, this website also create interface that can provide treatment plan suggestions based on the analysis of a patient's condition. iTherapy would synchronise all medical information from all therapists to aid the approval from head of therapist in doing an examination.

Referring to Figure 1, this is a layout of paper based approach used by the head of therapist or therapist in PSLC which they have to insert manually details of patients and doing problem analysis towards patients. When above steps completed, they continue to state every objectives of problem analysis based on the short term or long term treatment plan duration and list out the best treatment plan regarding patient condition in Figure 2. Furthermore, the therapist will put some comments in comments section about patients condition thus input their details including their name and date as this complete document will send to the head therapist for checking and approval in Figure 3.

1. VISIPENAWAR SPECIAL CENTER ()

BRANCH : _____

NAME : _____

NRIC : _____

DIAGNOSIS : _____

DATE : _____

PROBLEM ANALYSIS	
1. SENSORY	1. Visual 2. Auditory 3. Olfactory 4. Gustatory 5. Vestibular 6. Proprioception 7. Touch/ texture
2. COGNITIVE	1. Attention 2. Concentration 3. Memory (Short-term, Long-term, Immediate) 4. Problem solving 5. Decision making 6. Orientation
	7. Basic concept (alphabet/ numbers/ shape/ colors/ opposition) 8. Left and right discrimination
3. BEHAVIOUR	1. Tantrum 2. Hyperactive 3. Inattention

Figure 1. Therapy plan – Problem Analysis

OBJECTIVE / GOALS	
SHORT TERM (1-3 months)	LONG TERM (ADL only)
If no improvement will review back the treatment plan Assessment and re-assessment	

TREATMENT PLANNING		
COMPONENT	ACTIVITY	DURATION
SENSORY	Writing	
	Reading	
	Counting	

COGNITIVE		

Figure 2. Therapy plan – Objective and Treatment Planning

Comments :	_____

Prepared By:	
Therapist's Name :	_____
Date :	_____

Figure 3. Therapy plan - Comment and Verification

2.0. Related works

2.1. Introduction to Learning Disability

Learning disability is a disorder that affects the learning skills of humans and it affects anyone either children or adults. Sometimes the impairment may go unnoticed throughout their life [4]. This problem can be detected based on their daily life activity, social skills, and academic performance. There are various definitions to define people who are categorized as a person with a learning disability. A child that has difficulty in communication, cannot read, write, and solve a mathematical problem that is for their age is considered as a child with a learning disability. In the U.S, a child with academic achievement below two or more years of their age and IQ level is considered as learning disabled. This disorder affects the ability of a person to store, process, and produce information [4]. Each person with a learning disability disorder is unique and has their own profile of learning abilities and disabilities. Several criteria that are commonly mentioned in definitions of learning disability are discrepancy, heterogeneity, exclusion, constitution factors, and special education [5].

The signs of children having learning difficulties can be seen as early as in kindergarten. The identification process of children with learning difficulties is important in order to give them the treatment and support their need. There are several ways to help and support students with learning disabilities. Creating a small and interactive group as their teaching approach. The reason is to allow more interaction between the teacher and students and it is easier for the teacher to monitor the progress of each student [5]. In 1999, Elbaum & co. found that students

that were taught in a small group have greater effects compared to students that are learning within the whole class. Next, research shows that giving additional individual instruction to the students is effective in improving their results. Vellutino & co. make research by conducting 20 minutes of mentoring sessions for two-semester for first graders that having reading difficulties. The result shows that the individual mentoring did help students to improve their GPA in reading. Other than that, duration and intensity also influenced the effectiveness of the teaching process. One of the ways to increase the intensity is by adding one more session per day. Torgesen & co. conducted intensive and individual instruction to students by making two learning sessions per day which are 50 minutes each session. The results show the students' improvement and some of them able to return to regular classes without the help of additional instruction[5].

2.2. Available Techniques for Decision-Making

There are many expert systems out there that were created with a purpose to help doctors and therapists in doing assessment or diagnosis on patients to identify their patients' problem. There are many ways that can be implement to the system such as the use of Artificial Intelligence (AI), Expert Systems, collaborative decision making and Case-Based Reasoning (CBR)[6].

CBR is a process of solving current problems based on the solutions from similar past experience[7]. It is an intense strategy for PC thinking and unavoidable conduct in regular human critical thinking as what we think depends on past cases or experiences. There are four stages for CBR process which is Recover, Reuse, Reconsider and Hold. First stage is Recover. In this stage, recover similar past cases or experience in order to solve the current issue. The past case includes the issue, solution and how the arrangement was inferred. Next, the Reuse stage. Map the arrangement of past case to the current issue which include adjusting the arrangement so that it fits current circumstances. Third stage is Reconsider. Test the new arrangement to the current issue if it fits. If it does not fit, make changes to suit with the current issue. Lastly, Hold stage. After the arrangement has been made fit to the current issue, store current experience as another case in memory[6]. There are several reasons the application of CBR is done in solving problems and decision support in health science which are case histories are essential in training the health care professionals, many diseases are not well understood

and a biological system such as the human body is difficult to describe[7].

Other ways that can be used to solve decision-making problems is by implementing Multi-Criteria Decision Making (MCDM) methods. To solve problems related to uncertainty, fuzzy set theory is applied to MCDM. The Fuzzy Multi-Criteria Decision Making (FMCDM) technique is decision analysis integrated with fuzzy techniques which are to deal with problems on uncertainty and increase the accuracy of decision making [8]. Fuzzy set theory was first developed by Zadeh to solve problems related to uncertainty. It is useful in representation and information processing in a fuzzy environment. There are several steps to consider in implementing the FMCDM method. First is criteria selection which is considering the specific requirements of the system. It can be divided into two categories which is objective criteria and subjective criteria which is using the linguistic assessment. Next, choose preference rating system either to use fuzzy numbers or linguistic values or use both. After that, aggregate the decision-makers' fuzzy assessments and calculate the final rating. Some methods that can be used to aggregate the decision-makers' assessment is median and mean. In this step, calculation of fuzzy suitability index is needed in order to proceed to the next step. Then, rank the final ratings. Fifth step is to categorize the maximizing set and the minimizing set. Lastly, rank fuzzy suitability indices using the maximizing set and minimizing set so that decision-makers' can choose the best option[9].

Lastly, decision-making process can also be done by implementing Quality Function Deployment (QFD). The process of QFD is done by collecting the requirement from customers and analyse the requirement to develop a higher quality product[10]. There are several things that need to be focus on which is the product or the characteristics of the product, the customers, the competing product that will be used as reference and how the QFD approach fits into the product and process planning[11]. There are two model of QFD which is the Four-Phase model and Akao's Matrix of Matrices model. The Four-Phase model covers the basic product development steps, meanwhile the Matrix of Matrices model is designed for Total Quality Management (TQM) and covers the optional activities in Four-Phase Model such as reliability planning, value engineering, cost analysis and manufacturing quality control. The Four-Phase model are widely used compared to Akao's Matrix of Matrices model especially in US[12].

There are 4 phases or steps in the Four-Phase model. First phase which is called the Product Planning or Customer Requirement Planning is process of collecting customer needs or requirements (WHATs) for the product and transform (HOWs) them into technical measures. The corresponding QFD matrix created in this phase is called House of Quality (HOQ). Next phase is called Part Deployment. This phase is to transform the prioritized technical measures into part characteristics. Then, Process Planning phase. Key part characteristics are transformed into process parameters or operations. Lastly, Production Planning which is transforming the process parameters or operations into production requirements or operations[12]. Figure 4 below illustrate the process of the Four-Phase Model of QFD.

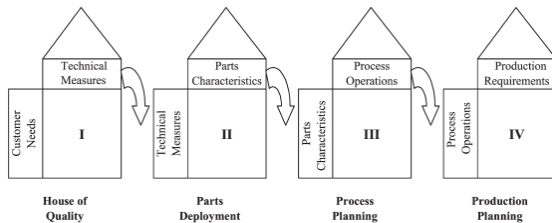


Figure 4. The Four-Phase Model of QFD

3.0. Methodology

Iterative Development Methodology is used for this project as it is easy and measurable as small iteration occurred. Iterative methods also help us to testing and debugging code in testing stages. This methodology consists of 8 stages. The stages are initial planning, planning, requirements, analysis and design, implementation, deployment, testing and evaluation [13].

Initial Planning:

- A discussion and decision on the type of project and the key area we wanted to focus on.
- Several brainstorming sessions and compiled ideas for the project.

Planning:

- Proposing several names for web application and understanding algorithm.
- iTherapy was chosen as our web application name.

- Identified the functional, non-functional and users who will use our web application

Requirements:

- The requirements gathered from our stakeholder PSLC.
- Types of learning disabilities and therapy plan assessment.
- For therapy plan assessment, the scale for sub-component consists of 5 types scaling in Figure 5. Which are:
 1. Not important.
 2. Slightly important.
 3. Moderately important.
 4. Important.
 5. Very important.

SCALING TREATMENT ACTIVITIES			
<i>Instruction: You are required to select the suitable scale for treatment activities, if the sub-component is rated as "Not Important"</i>			
Equally important	Two activities contribute equally to the objective		
Important	Experience and judgement slightly favor one activity over another		
More important	Experience and judgement strongly favor one activity over another		
Strongly more important	An activity is strongly favored and its dominance demonstrated in practice		
Absolutely more important	The evidence favoring one activity over another is of the highest possible order of affirmation		
Component	Sub-component	Treatment Activities	Treatment Scaling
	Visual (Spotting activities)	Spotting which item has been removed from a tray of items	
		Finding the letters/ words in a clear basin or bottle of water with coloured glitter	
	Visual (Measuring activities)	Measuring water or coloured water into jugs then pouring into items	
		Measuring lengths and distances between objects, areas of the school etc.	
		Catch a ball	
		Hit a tennis racket at a target	
		Scavenger hunts - try doing these while crawling	
		Catching butterflies in a net	
		Visual scanning between targets	
		Bubble pop	
Auditory	Play with musical toys: whistles, party favor blow toys, plastic instruments		

Figure 5. Scaling sub-component

- While the scaling for treatment activities is shown in Figure 6.
 1. Equally important: Two activities contribute equally to the objective.
 2. Important: Experience and judgement slightly favour one activity over another.
 3. More important: Experience and judgement strongly favour one activity over another.
 4. Strongly more important: An activity is strongly favoured, and its dominance demonstrated in practice.

- Absolutely more important: The evidence favouring one activity over another is of the highest possible order of affirmation.

	Spinning	Absolutely more important
	Hanging	Strongly more important
	Scooters boards	Equally important
	Climbing	Absolutely more important
	Obstacle courses	Absolutely more important
	Balance beams	Absolutely more important
	Swinging and spinning	Absolutely more important
	Wheelbarrow walking	Strongly more important
	Yoga poses (especially great for avoiders!)	More important
	Dancing	Strongly more important
	Jumping rope	Strongly more important
	Rolling down a hill (a great way to start with avoiders)	More important
	Somersaults	Absolutely more important
	Cartwheels	More important
	Gymnastics	Important
	Walking the line (use painters tape on the floor in a straight or zig-zag line)	Strongly more important
	Play twister	Strongly more important
	Climbing and sliding at the playground	Strongly more important
	Do a handstand	Absolutely more important
	Riding a bike	Strongly more important
	Swimming	Strongly more important
	Using a ball chair or wiggly cushion for seated activities	Strongly more important
	Scratch-n-sniff books	Equally important
	Scented play dough	Important
	Scented toys	More important
	Scented bubbles	Strongly more important
	Scented markers	Absolutely more important
	Scented ink pads	Equally important
	Scratch-n-sniff stickers	Equally important

Figure 6. Scaling treatment activities

Analysis and Design:

- The use-case diagram is visualized in Figure 7. Further explanation on the role of actors is in section 4.1 below.



Figure 7. Use case diagram

- Figure 8, Figure 9 and Figure 10 represents the system's flowchart. For prototype design, we are using adobe XD.

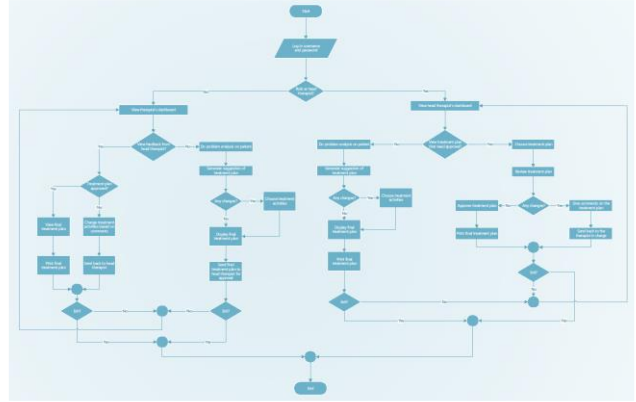


Figure 8. Overall flowchart of iTherapy

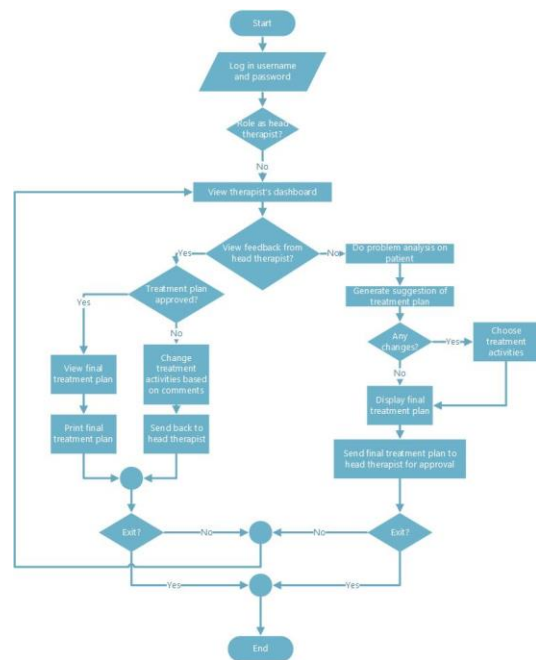


Figure 9. Flowchart of iTherapy from therapist side

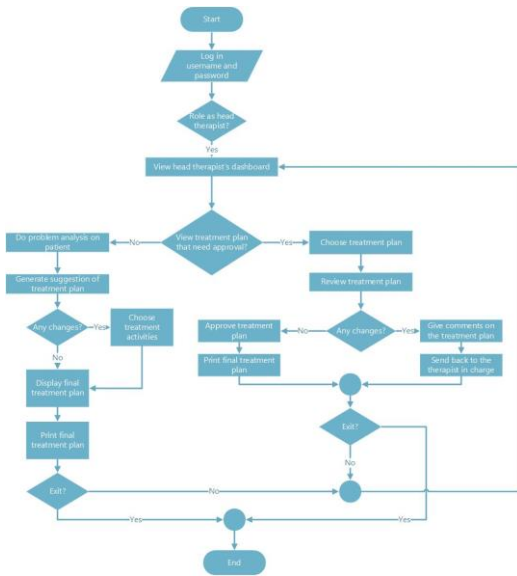


Figure 10. Flowchart of iTherapy from head of therapist side

Implementation:

- Visual Code Studio as the development platform, with Hyper Text Markup Language (HTML), Cascading Style Sheets (CSS) for frontend development.
- We used Structured Query Language (MYSQL) to construct the database framework.
- Hypertext Preprocessor (PHP) used for backend development.

Deployment:

- Deployed our website using a free and open-source cross-platform web server solution stack package developed by Apache Friends named XAMPP.

Testing and Evaluation:

- The alpha testing was done by programmers.
- Evaluation from the users to ensure the website performed well

4.0. Results

4.1. Actors and Use Cases for iTherapy

Based on Figure 7 in section 3.0 above, there are total of 3 actors for this system which is therapist, head of therapist and the system itself. The therapist and head of therapist can access to the same features of the system which is log in to the system, record patient's information, view patient's record and analyse patient's problem. But for the head of therapist, they have additional features that are made specifically for them which is assessing the treatment plan and give approval to the treatment plan made by the therapist. Other than that, both therapist and head of therapist have option to print the patient's record if they want to.

Next, the system. The system handles data of patients, the problem analysis of the patient and therapy plan made for the patient. All this data will be stored in the database. For now, we use Phpmysql as our local database.

Table 1 below explains the use cases from Figure 7 in section 3.0

Table 1. Description of use cases

No.	Use cases	Description
1.	Log in to the website	Users need to enter their username and password for authentication before access into the system.
2.	Record patient's information	Users can record patient's information such as personal information and detail of their parents.
3.	View patient's record	Users can view their patient's information such as their personal details, treatment plan assessment and treatment plan.
4.	Analyze patient's problem	Therapist and head of therapist can analyze patient's problem by doing treatment plan assessment on patient.

5.	Generate treatment plan	List of treatment activities will be generated based on the score from treatment plan assessment. Users will choose suitable treatment activities to create a complete treatment plan.
6.	Assess treatment plan	Head of therapist is the only person that can assess the treatment plan made by therapist. They also can give comments or feedback for the therapist to review and make correction.
7.	Approve treatment plan	Approval of treatment plan will be made by the head of therapist. Once the treatment plan is approved, the therapist can proceed with the treatment plan for that patient.

4.2. System Architecture

In developing a web application, there will be two side which is the front-end and back-end. First, the front-end which also known the client-side. This is where the user sees the interface of the web application and interacts with it by giving appropriate input[14]. Based on iTherapy system, user will login to the system first. Then, user can choose either to view patient's record, do treatment plan assessment, print patient's therapy plan, etc. In treatment plan assessment, user will see a form for them to insert information for the system to process and generate suitable therapy plan.

Next, is the back-end or server-side. This part is where the data from user is process and it is not accessible to the user. The data are fetch from the front-end using HTTP requests which are then process using PHP and Javascript languages[14]. Then, the data will be stored in the database. Stored data can be retrieved or manipulated based on the user requests. Figure 11 below shows the architecture of web application.

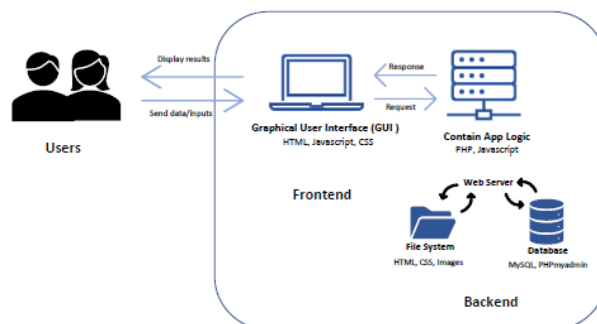


Figure 11. Web architecture

4.3. iTherapy Pages and Features

Based on our planning in the early stages, we decided to create several pages for our iTherapy system. First is the login page which is shown in Figure 12. This page will appear when our user which is the therapist or head therapist enter the system.

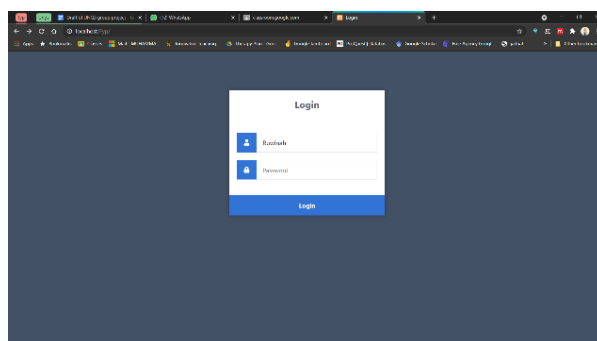


Figure 12. Login page

After successfully login, the dashboard page for user will appear as shown in Figure 13. There will be two buttons for user to choose which is "Patients" and "Logout".

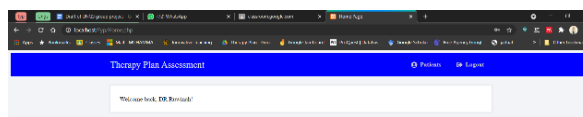


Figure 13. Dashboard page

When user chose to click on "Patients" button, list of patients will appear as illustrates in Figure 14. There will be a search bar for user to search for patient's name. When user found the patient's

name, user can choose either to view the patient's information, check the status of therapy plan or print the therapy plan.

Patient Name	DOB	Gender	Ethnicity	Consulted by	Therapy plan
Aris Alkhatib bin Ahmad Jamal	2007-03-01	Female	PLIC TANAH MELAYU, GURU LUMPUR		View Edit Assessment Print
Teri Aji L	2011-06-06	perempuan	PLIC MELAYU, JOHOR	ERINAWATI	View Edit Assessment Print
ELISSA ANWEL PERMADIANIB	2011-09-14	FEMALE	PLIC SINDHANG, JOHOR		View Edit Assessment Print
Mika Zahra Nurcahya Adhira Sultan	2011-12-09	Female	PLIC PLAWAS, PADANG		View Edit Assessment Print
Aris Hasmah Bin Fauziah	2012-07-08	Male	PLIC MELAYU		View Edit Assessment Print
Wahyuni	2012-08-17	Stress	PLIC MELAYU, JOHOR	ERINAWATI	View Edit Assessment Print

Figure 14. List of patients

Figure 15 is the page when user chose to view patient's information. There is also a button named "Diagnosis" that leads the user to the problem analysis page.

No	Patient ID	Patient Name	Age	Date of Birth	Gender	No Number	Status	Branch
1	1P00000001	Wahyuni	1	2012-08-17	Stress	101	Not	PLIC MELAYU, JOHOR

Figure 15. View patient's information

Figure 16 and Figure 17 illustrates the interface of problem analysis page after clicking the diagnosis button. This page is use for the therapist to do treatment plan assessment on patient. The purpose of doing this assessment is to know how relatable the problem is to the patient so that suitable treatment plan can be generated for that specific patient. Each scale will generate different treatment plan and the scale is important because we want the system to mimic the decision from the head of therapist. In order for the system to mimic this process, we need to get experience from head of therapist in doing assessment and implement it in this system through scaling. This process is adaptation from the concept of CBR.

Then, user must click on each components' button on the left and choose the level of importance for each subcomponent that appears which related to the patient. Click on submit button as shown in Figure 17 to store the score of the assessment into the database and to generate the treatment activities.

Figure 16. Problem analysis page

Figure 17. Submit button on problem analysis page

Figure 18 shows the list of treatment activities based on the assessment. User will choose each treatment activities that they think suitable for the patient and write a comment if it is necessary. Then, they will click submit button as shown in Figure 19 to store the treatment activities in the database.

Figure 18. List of treatment activities page

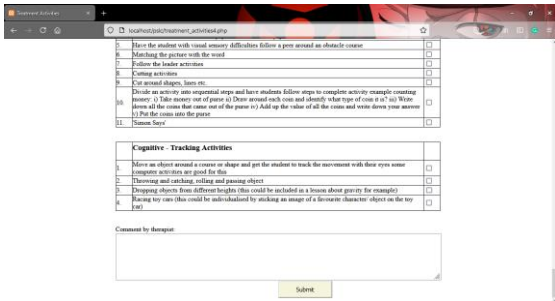


Figure 19. Submit button on treatment activities page

After clicking the submit button, new page with the confirmed therapy plan will appear as shown in Figure 20. Then, user can click the “Go to Dashboard” button to go back to the dashboard page.

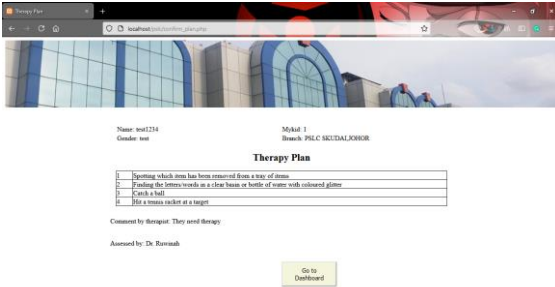


Figure 20. Confirmed therapy plan for the patient

In the list of patients’ page, the head of therapist can click the approval button to check the therapy plan that have been made by the therapist as shown in Figure 21. After reviewing the therapy plan, the head of therapist can choose either to approve or not approve the therapy plan. The head of therapist can add necessary comment for the therapist to review back the therapy plan.

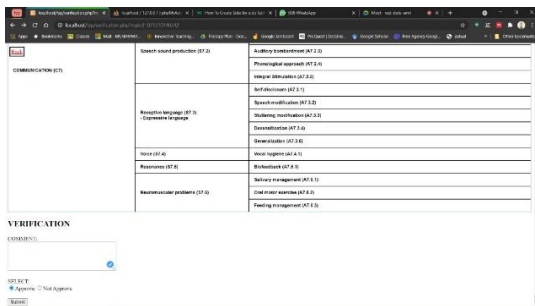


Figure 21. Therapy plan for approval

5.0. Future works

There are several things that can be improved for our iTherapy system. First, the system can include the Multi-Criteria Decision Making (MCDM) technique for example the Fuzzy Multi-Criteria Decision Making (FMCDM) that uses fuzzy set theory. By using this method, the sorting of treatment activities can be done automatically by following the specific fuzzy formula. The FMCDM technique is suitable to use if there are many decision makers involved in decision-making process. In future, if PSLC increase the number of decision makers in providing the therapy plan, this technique can be considered to be used. Currently, this method cannot be implemented to our current system because there is only one decision maker which is the head of therapist from PSLC.

Other than implementing FMCDM, we can also implement QFD. QFD is a way to translate the customer’s requirement into an appropriate technical requirement for each stage of product development and production [10]. This method is a customer-oriented approach to innovate a product which helps guiding product managers and design teams through the conceptualization, creation and realization of new product[11].

6.0. Conclusion

iTherapy is a web-based application that helps therapist in PSLC to generate therapy plan automatically by approval of head of therapist. This website will be uploaded to server of Penawar Hospital and be a part of their assessment module. This website is developed to replace the paper-based system that create a lot of tedious tasks and miscommunication between them when tracing patients’ records. In addition, the generated therapy plans able to reduce their task which inserted manually using paper-based approach. Furthermore, there is a feature for the head of therapist to review generated therapy plan as avoiding wrong input scale from therapists. The main objective of this website is transferring traditional system into a web-based system that assist the therapy and head of therapist in PSLC.

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