iTherapy: An Automated Web-Based Therapy Plan for Learning Disability Children

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Abstract— iTherapy is an automated web-based system for the head of therapist and therapist of Penawar Special Learning Centre (PSLC) to produce a 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 more than 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. For future works, a proper system evaluation can be conducted, and the system can be enhanced by having the knowledge repository.

Keywords— automated system, iTherapy, learning disability, web-based system.

I. INTRODUCTION

Learning Disabilities (LD) is an example of the neurological disorder [1]. In general, if there is a discrepancy in the way a person's brain is functioning, it will be resulting in a learning disability. In Malaysia specifically, the number of registered people with LD problems are increasing year by year. In year 2018, the new registered people with LD was 14,876 and the number was increasing to 19,429 in year 2019 [2]. The LD problem is the second largest group in Malaysia under persons with disabilities [2].

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 key-in all patients' details and treatment by using paper-based approach. In a manual or paper-based approach, the therapist in PSLC have to insert manually the details of patients and conducting the problem analysis, state every objectives of problem analysis based on the short term or long term treatment plan duration, and also list out the best treatment plan regarding patient conditions. In the problem analysis, the therapist is required to analyse the patient according to the determined categories which are sensory, cognitive, behaviour, social, psychomotor, activity daily living and communication. The number of sub-categories associated with the categories that need to be examined by the therapist is more than fourty. The therapy plan produced by the therapist is required to be verified by the head of therapist prior to execute the treatment to the patients. If the therapy plan is not suitable for the patient, the head of therapist will give her comments through WhatsApp platform to be ammended by the therapist. There is only one head of therapist in PSLC and she needs to monitor, review and verify the produced therapy plan by the therapist in all PSLC branches. As of now, the number of patients in PSLC are more than 3000. This approach is very time consuming, inefficient and data are decentralised.

In order to overcome the above-mentioned problems, the automated iTherapy web-based system is suggested. The highlight of the iTherapy is the automated features in producing the therapy plan that mimic the decision of the head of therapist. In addition, the PSLC therapists are able to record their patients' details in one central database conveniently. With this approach, the system can be accessed by the therapist in different branches. In addition, the activities of reviewing and verifiying the therapy plan can be done more systematically between the therapist and head of therapist regardless of different geograpy locations of PSLC in Malaysia. The objective of this paper is to describe the automated web-based iTherapy system, the

methodology that had been conducted to produce the system.

The remainder of this paper is organized as follows: Section II discusses the related works, Section III highlights the research methodology, Section IV presents the results and discussion. Finally, Section V concludes the paper

II. Related Works

A. 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 [3]. 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 [3]. 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 [4].

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. One of the ways is 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 [4]. In 1999, Elbaum et. al. [5] found that students that were taught in a small group have greater effects compared to students that are learning within the whole class.

Research suggests that the learning disabilities can be managed effectively using comprehensive behavioural and educational treatments [6]. With the advanced of technologies, robots are used as an assistive mechanism to conduct the therapy treatment to the autism specifically [7-9]. Other than that, multimedia approach also can be used as an assistive mechanism in providing treatment therapy to the learning disabilities people that having problems in terms of behaviour, dyscalculia and dyslexia [10-13].

B. Available Techniques in Decision-Making

There are many techniques available that can be integrated with the decision-making system in the healthcare domain. Few examples that be listed are Artificial Intelligence (AI), Expert Systems, collaborative decision making and Case-Based Reasoning (CBR) [14].

Case-Based Reasoning (CBR) is a process of solving current problems based on the solutions from similar past experience [15]. 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 [14]. 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 [15].

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 [16]. 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 [17].

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 [18]. 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 [19]. 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 [20].

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 [20]. 1 below illustrate the process of the Four-Phase Model of QFD.

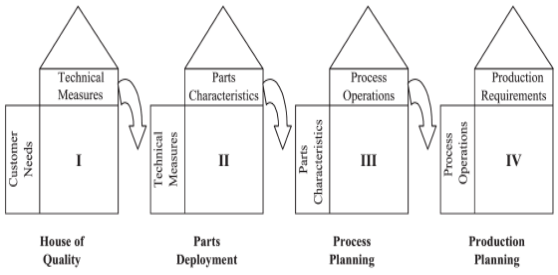

Fig. 1 The Four-Phase Model of QFD

III. METHODOLOGY

Iterative Development Methodology is used for this project as it easy and measurable as small iteration occurred. Iterative methods also help us to testing and debugging code in testing stages. This methodology consists of eight stages. The stages are initial planning, planning, requirements, analysis and design, implementation, deployment, testing and evaluation [21].

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 the PSLC head of therapist in terms of types of learning disabilities and therapy plan assessment.
- For therapy plan assessment, the scale for sub-component consists of 5 types scaling which are: 1-Not important, 2-Slightly important, 3-Moderately important, 4-Important and 5-Very important.
- Meanwhile, the scaling for treatment activities are as follows which are adapted from [22]:
  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.
  5. Absolutely more important: The evidence favouring one activity over another is of the highest possible order of affirmation.

Analysis and Design:

- In the analysis and design phase, we have produced the use case diagram and flowchart diagram prior to the system development. However, in this paper we can only afford to visualize the use case diagram due to number of page limitations.
- There are total of three 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 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 an option to print the patient's record. The system actor handles data of patients, the problem analysis of the patient and therapy plan made for the patient. All this data was stored in the database.

- The use case is illustrated in Figure 2 while the description of each actor is tabulated in Table 1.

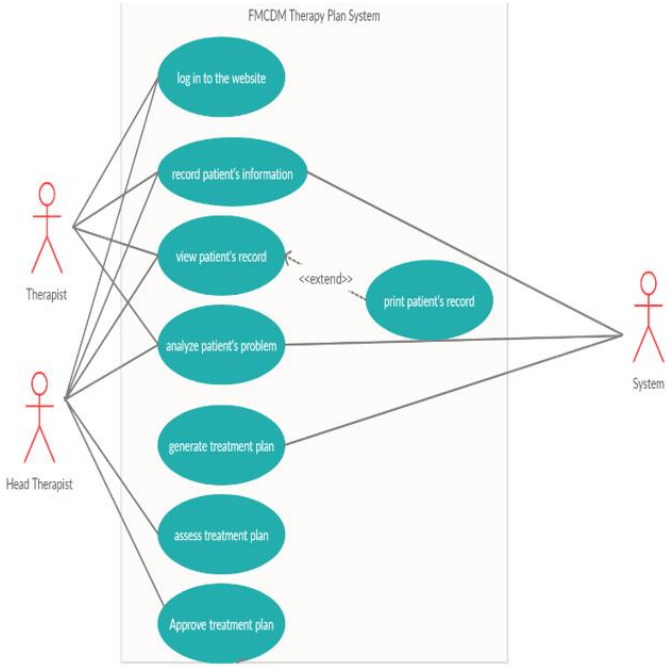

Fig. 2 Use Case Diagram

Table I
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.	Analyse patient's problem	Therapist and head of therapist can analyse 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.

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) was 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 before uploading to the client's web and database server. Once the system was uploaded into the client's server, the stakeholder was requested to test the system at their convenient time. A manual for the using the system was provided to the client.

IV. RESULTS

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 3. This page will appear when our user which is the therapist or head therapist enter the system. The users are required to key in their user ID and password that they have created before using the system.

The list of patients who have registered into the system will appear as illustrated in Fig. 1. We list the patients by 10

and the users may find the patient by click pagination button (First/ Prev/ Next/ Last). However, to ease the burden of searching one by one, we provide an advanced search bar (Patient name and Branch) where the users can type name of a patient or by selecting a branch to locate the patient.

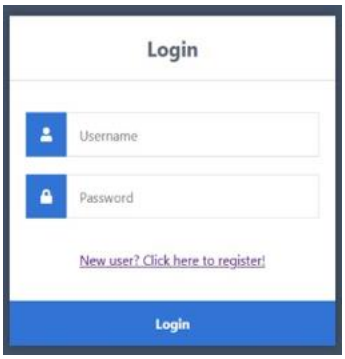

Fig. 3 Login page for Therapist and Head of Therapist

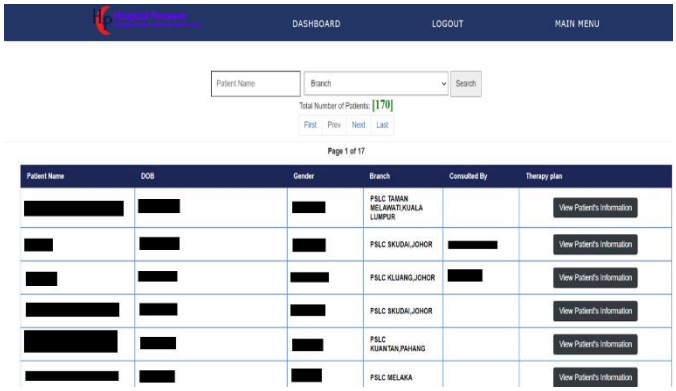

Fig. 1 List of patients (the patient's name is blurred for confidentiality)

The treatment activities for the therapy can be generated after conducting the problem assessment as illustrated in Figure 5. The therapist is required to assess the patient according to the specific components (sensory, cognitive, behaviour, social, psychomotor, activity daily living and communication) and its' respective sub-components. The purpose of doing this assessment is to know how relatable the problem 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 record the experience from the head of therapist in doing the assessment and implement it in this system through different scale as explained in the requirements phase. This process is adapted from the concept of CBR. Then, the 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. The score of assessment will be calculated and the treatment activities will automatically generate once the "Submit" button is clicked.

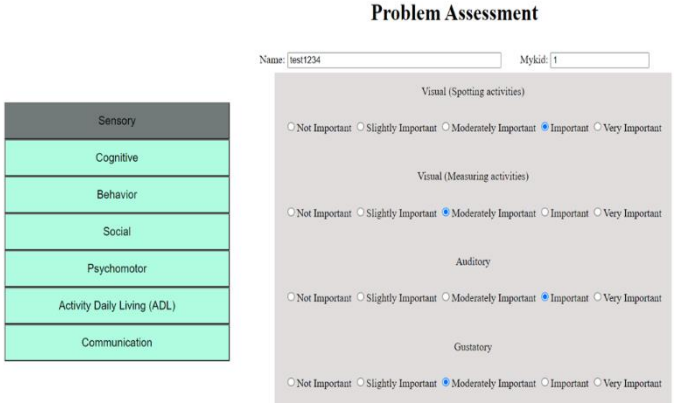

Fig. 5 Problem analysis page

Figure 6 shows two of the list of treatment activities (Sensory – Visual (Spotting Activities) and Sensory – Visual (Measuring Activities)) based on the assessment. The treatment activities are suggested based on the assessment score selected by the therapist. The system is flexible whereby the therapist may choose all suggested treatment activities, or it can be further customised according to the suitability to the patient's needs.

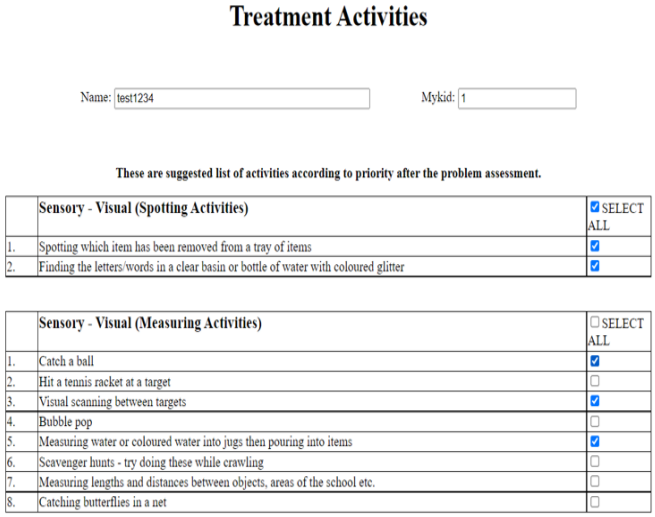

Fig. 6 List of treatment activities page

The head of therapist is able to view the produced therapy plan by the therapist. The head of therapist is responsible to review and verify the therapy plan prior to execute it to the patient. Figure 7 shows the approval page from head of therapist view. The system also allows the users to print the therapy plan after approval by the head of therapist.

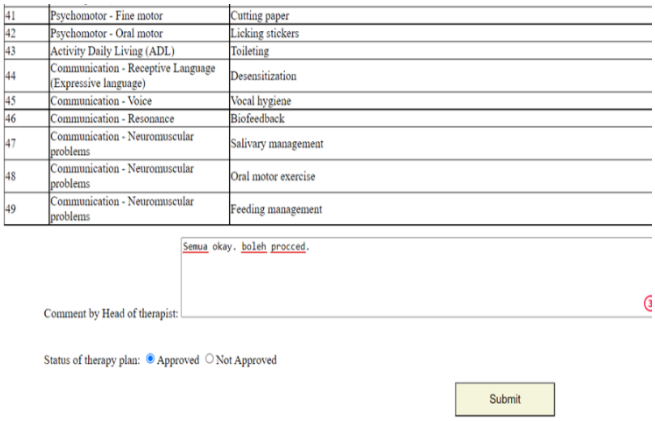

Fig. 7 Therapy plan for approval

V. Conclusions and Future Works

iTherapy is an automated web-based system that helps therapist in PSLC to generate a therapy plan automatically which mimic the decision of the head of therapist. The therapy plan is produced according to the patient's needs in terms of the sensory, cognitive, behaviour, social, psychomotor, activity daily living and communication. This system is developed to replace the paper-based approach that creates a lot of tedious tasks and miscommunication between the PSLC therapist and head of therapist when producing the therapy plan.

The iTherapy system involves the decision-making process from the experts. To produce the effective therapy plan, a knowledgeable therapist is needed. That is why the head of therapist expertise is used in the system that mimic the expert's (in this case the expert is the head of therapist) decision. The knowledge-based repository is important especially during the diagnosis activity [23]. The possible future work is that a proper system evaluation can be made with the head of therapist and therapist in PSLC. In addition, the knowledge repository can be enhanced by having the similar cases and solutions from the experts in order to enable the system to learn better from the human and system. The current system has the limitation in terms of the decision made by only one decision maker. It is good to enhance the system with multiple decision makers, whereby the decision and solution will be aggregated.

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