

THE DEVELOPMENT OF REHABILITATION ASSESSMENT ONTOLOGY

Ashwaq Ibrahim Alwan, Lailatul Qadri Zakaria

Faculty of Information Science and Technology, University Kebangsaan Malaysia
43600 Bangi, Selangor Darul Ehsan, Malaysia

Email: mshten_fal@yahoo.com, lailatul.qadri@ukm.edu.my

ABSTRACT

The term rehabilitation which has been used in this study means to help a disabled person or elderly person return to normal life by therapy or training after illness, imprisonment and addiction. These activities can be divided into two parts which are activities of daily living (ADL) and instrumental activities of daily living (IADL). ADL and IADL are assessed by multiple rehabilitation standards and three assessments were considered in this research which is Lawton – Brody, FIM and BARTHEL. Each assessment has its own activities and different set of scale to evaluate their patients. However, these assessments sometimes share the same activities such as feeding activity is existed in BARTHEL and FIM standard but with different set of scale. The differences of scale measurements and activities observed in these assessments make rehabilitation information become complex and difficult to understand. Most of the information in the rehabilitation is in the form of documents such as website and booklet. Therefore, there is a need to have a better representation of this information to support knowledge discovery and help the user to understand information related to rehabilitation assessments. Ontology has been developed to help users to understand, compare and the differences of measurements available. The assessment ontology is developed by using the 101 ontology method. The development of the ontology has been implemented using a Protégé program. Results showed that different kinds of activities with the same measurement can be integrated using the ontology. The experimental results showed that people who used the ontology are able to obtain more information on rehabilitation assessment.

Key words: ADL, IADL, BARTHEL, FIM, Lawton – Brody and Ontology

INTRODUCTION

Rehabilitation refers to recovery from extreme disorder, contamination of surgical operation. Rehabilitation may involve slow recovery, re-learning, restoration of certain abilities. Most

often, rehabilitation involves the use of some kind of treatment like physical remedy (to strengthen an individual that has lost certain abilities, restore mobility or fitness), Occupational therapy that requires doing some sports daily, or speech remedy to help in restoring speaking ability, writing exercise, swallowing and ache treatment. When it comes to rehabilitation, different people may need different types of treatment depending on their health conditions, age, habit, and work requirements. For example, an elderly person who has suffered from stroke may need stroke rehabilitation so as to learn do things like taking a shower and wearing clothes without help, or a younger person that has suffered from heart attack may need cardiac rehabilitation so as to be able to return to normal life and activities, or even a person that has suffered pneumonia may need pulmonary rehabilitation to assist the person in breathing better (Rehabilitation 2019). The main aim of rehabilitation is to help patients recover their sensory, physical and intellectual capabilities that were lost due to sickness contamination or sickness. Rehabilitation involves assisting the person who is affected to catch up on deficits that cannot be medically reversed. Usually, rehabilitation is prescribed after contamination, harm or disorders like arthritis, cardiac ailments, injuries, amputations, cancers, spinal cord injuries, orthopedic injuries, traumatic mind injuries and stroke. For rehabilitation to be successful, it is important to have an effective program for therapists, and when such programs are designed, the patient deficit must be put into consideration. In other words, the physical interventions and activities designed for the rehabilitation of patients must be based on their needs.

Therefore, it is important to examine the results of performance evaluations quality, not only the general level of assistance and safety. The record of the quality of performance is very important when documenting the results of rehabilitation for individuals with medium to severe disability who may continue to need to assistance regardless of the improvements in the performance of ADL (Eva et al. 2010). The activities of daily life can be divided into two areas of daily life (ADLs) known as personal activities of daily life (PADLs) and basic activities of daily life (BADLs) or commonly called as IADLs. For the body to be properly taken care of, basic skills of ADLs are required. IDALs are required at a more advanced level in all aspects of performance. In general, IDALs require the use of executive function and social skills of the most complex IDALs environmental interactions. ADL includes activities as simple as wearing of socks and shoes, use of toilet, eating, bathing, getting in and out of bed, and walking. On the other hand, IADLs include making phone calls, cooking a meal, taking medications, managing finances, tracking expenses and paying bills.

Disabilities are determined through different ways due to differences in the cultures between countries and the degree of disability (Kitty et al. 2012). Rehabilitation assessments provide a tool to understand the impact of an injury that is happening on a disabled or elderly and their family, and identify what actions are needed to help them return to work safely. Assessment examples are BARTHEL, FIM and Lawton - Brody. Information in the rehabilitation assessment can be organized by using ontology. Ontology is the study of a variety of current things; any entity in the world. The word is derived from Greek (being) and logia (written discourse or operative). It is an area of metaphysics that focuses on primary ideas or the essence of things. Ontology is the idea of things and their hyperlinks. It provides the standards for distinguishing exclusive types of items (concrete and summary, existent and nonexistent, real and perfect, unbiased and established) and their ties (members of the family, dependencies and predication).

RELATED WORK

Previous studies have combined temporal and ontological formalisms for composite activity modelling and recognition in smart home. Also, in another study, an approach to developing Activity of Daily Living and Instrumental Activity of Daily Living was presented in United States Adult Community-Dwelling Medicare Population as cited by Okeyoa et al. (2013, 2014) and Margaret et al. (2014). Previous studies have determined the kind of activities that fall under the ADL category, and these activities are simple daily activities that can easily be performed. On the other hand, other more complex activities fall under the IADL category as shown in table 1 below.

Table 1 Existing Ontology for ADL and IADL.

Sources/researchers	Type	Activities cover
Okeyoa et al. 2014	ADL	Have bath Brush teeth Wash hands Make Tea Make chocolate Make coffee Make pasta Watch television
Margaret G.et al. 2014	ADL	Eating Toileting Change of clothes Bathing Getting in or out of bed or chairs Walking
Margaret G.et al. 2014	IADL	the use of the phone money management put his/her personal meals light housekeeping Personal shopping Heavy housework
George et al. 2013	ADL	Make pasta Make tea Watch television Have bath Make chocolate

Okeyoa (2014) described some activities like (have bath, brush teeth, wash hands, make tea) as ADL activities. Others mentioned other activities that may be somewhat different (eating, toileting, make pasta, make tea) as being the same type, Margaret 2014 sheds light on some of

the activities that IADL considered, such as (light housekeeping, personal shopping), Where this comparator will give us a clear view to determine the ontology of activities and distribution according to the ability of the person with disabilities.

MATERIALS AND METHODS

As Natalya and Deborah(2001) has shown in *Ontology Development 101: A Guide to Creating Your first Ontology* isn't always an end in itself. Ontology development is much like specifying a hard and fast data and its shaped to use other applications . The problem-fixing techniques, area-impartial packages, and software dealers use ontology regulations and know-how bases constructed from ontology to be taken into consideration as information. For example, in this project, I will expand the ontology of activities, measurements and assessments appropriate to activities with the measure. I will then use this ontology as the basis for some of packages in a hard and fast of special care gear: software can create guidelines approximately activities completed by means of the character with disabilities or solution questions from assistants. Another software may examine a listing of Activities that may be performed with a particular disorder extra professionally and observe them to other measures (Natalya and Deborah 2001) as in the figure 1.

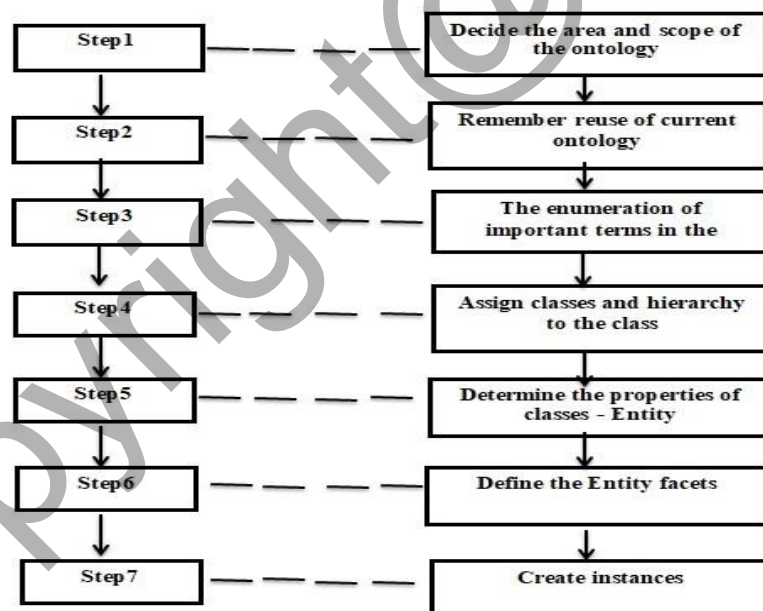


Figure 1 Stages of ontology development.

Step1. Decide the Area and Scope of the Ontology

The first step in ontology improvement is to determine the scope and scope of ontology. There must be answers to many basic questions that include determining the area in which ontology will disappear, and determining the areas in which we use ontology. What areas should ontology define? Why do we use ontology? What kinds of questions should facts on ontology provide, and who will use ontology?

There may be an exchange of solutions to these questions during the ontology planning procedure, but at times they help restrict the scope of the model. A reminder about the ontology of ADL and IADL that we mentioned in the previous chapters, representation of ADL and IADL is the area of the ontology. At this stage we plan to use ontology to evaluate the different activities performed by disabled men or women, obviously the criteria that describe the distinct types of activities of daily life ADLs and effective activities of each day IADLs, the idea of correct integration and incorrect integration, can be within our ontology. Competency questions: These questions represent one of the important strategies in determining the scope of ontology, i.e., identifying a list of important questions that must be answered by ontology. These questions should be effective. For example, can these questions be answered by ontology and its data? Do the answers need a certain level? Are these questions to determine the competence of the ontology or should they be comprehensive inside the vicinity of ADLs and IADLs? The following are ability performance questions:

Table 2 competency questions

	questions
1	What type is the relationship between "needs_help" and "Feeding" ? What is feeding about?
2	Is the ADL an activity or an assessment?
3	What is the "scaleBarthel"?

-
- | | |
|---|---|
| 4 | Is the "Stair" a class? Is it a sub class of another class? |
| 5 | What is "lawtonBrodyMeasure"? |
-

From this listing of questions, ontology will encompass facts approximately the various activities, traits and kinds of Activities, clean and complex, their classifications, this difficulty in the selection of effectiveness and evaluation and the appropriate dimension.

Step2. Reuse of Current Ontology

Often we should check the research done by people before that for our scope of work, to see if it can be developed and improved. It is able to be re-use of existing ontology is a necessary condition if our gadget wishes to engage with different programs which have already devoted to positive ontology or observation vocabulary. The bulk of ontology is digitally generated and can be imported into the environment in which we operate, where the formalism expressed in ontology is not necessary. Consider the fact that many of the technical know-how structures can import and export ontology. Where the transformation of ontology from one format to another is not difficult, which is called the project of translating ontology, there may be ontology that represents our project, but we will justify that it does not exist our ontology, Likewise, the previous ontologies are insufficient, incomplete and do not meet all our demands in developing an ontology to assess rehabilitation.

Step 3. Focus on Important Terms in Ontology

It is useful to write down a list of all terms we would like either to make statements about or to explain to a user. Important terms related to the use of include terms, measures and ADL and IADL, and sub-terms, such as the possibility of answering the phone or taking care of "personal_hygiene" such as showers and their measurements and so on. The terms are identified based on the three assessments that were used in this project which are LAWTON-BRODY, BARTHEL and FIM. In the beginning, a list of terms is necessary where there is no need to worry if concepts, relationships, terms and properties overlap even if the concepts are classes or properties of the object. In the next steps we will see some overlap where it is difficult to do one step without the other, we will define some definitions of standards in the hierarchy, and then describe the importance of those concepts, as well as the next two steps are the basic steps in the design of ontology and here in this step we have briefly described the next steps The explanation will be detailed and comprehensive where the complex problems and procedures to be followed are mentioned.

Step 4. Classes and Hierarchy to the Class

The class hierarchy view displays the asserted and inferred class hierarchies. The asserted class hierarchy is visible by default. The asserted class hierarchy view is one of the primary navigation devices in Protégé. It is presented as a tree where nodes in the tree represent classes. A child-parent relationship in the tree represents a sub/super class relationship in the class hierarchy.

A hierarchy containing a number of tactics for its development: The development process starts from top to bottom with the broadest definition of principles within the scope and subsequent specialization of standards. For example, we will create concept classes in general for ADL and IADL. Next, we can customize the activity by creating a number of subcategories: ambulation and "continuity - management" we will additionally classify "Continental _ management", for example, "toilet, bowel and bladder".

Bottom-up is a development method to identify the unique classifications of the hierarchy sheets, and then do a later synthesis of those classes into larger concepts, for example we start by identifying transport training such as Stairs and Shopping) We then create a not unusual subclass for those three classes "Ambulating" which in turn is a subclass of activities. Overall optimization is a set of top-down strategies where we first identify prominent concepts and then generalize and customize them correctly. We may start with some top notch ideas like activities and some subtle ideas that include "Bathing". We can then connect them to a middle-class idea, such as "Personal_ hygiene". Then we may also want to create all classes of local Activities at the local level, thus producing some intermediate level concepts As in Figure 2

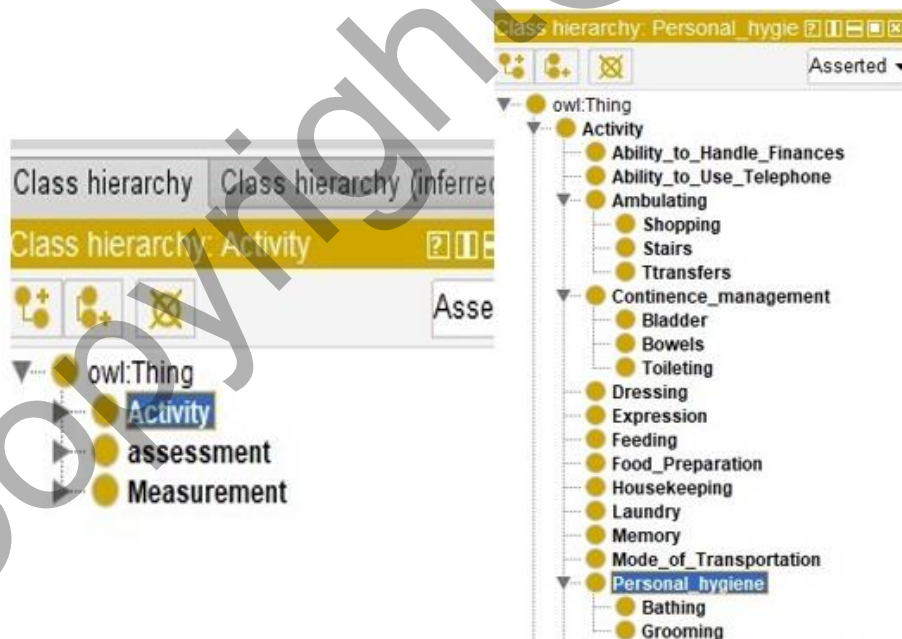


Figure 2 Assign classes and hierarchy to the class (top-down and bottom-up).

None of those three techniques are inherently advanced to others, depending on heavily at the the typical bandwidth, if the developer has a top-down systematic view of the domain, it will likely

be less complicated to use the ascending approach. Mixing is mostly less difficult from the point of view of many ontology developers due to "in-middle" standards which can be an additional descriptive tool within the system, If your ideas tend to be "Activities" where you distinguish the highest standard category first, the "top down" technique may be better for you, but if you start choosing an alternative by getting unique examples, the lower method may be very appropriate no matter how we choose. From the list created in step 3, we will start by selecting Training, and then we choose terms that describe independent living organisms rather than terms that describe those elements. These terms can later be ontology lessons and become anchors in a distinct hierarchy. With the help of the question whether the element is within the same class we arrange the training in a hierarchical classification, which will always be (i.e., by using definition) be an example of accuracy, if a class (A) is a subclass of class (B), then each instance of (B) is likewise an instance of (A) In other words, the class (B) represents a concept that is a "type of" (A) as an example, Bathing is always a (personal_hygiene), therefore the "Bathing" class is a subclass of the "personal_hygiene" As in Figure 3



Figure 3 Methodology of identifying the Activity and linking it with ontology.

Step 5. Determine the Properties of Class — Entity

Classes do not give enough information to answer the competency questions mentioned in the first step, which was a definition of some classrooms, but the internal structure of the concepts are necessary, so we chose some classrooms from the list of terms we talked about in step three, the remaining terminology is a description of the other class, for example, type and measurement of activity, and types of measurement.

For every Entity within the listing, we have to outline the class that describes that object, and then those properties emerge as Entities linked to the module, therefore, the Class Activities will have the following object properties: type, the ability to carry out the activities and the degree of performance. Then the class ADL and IADL will have a site entity. In trendy, there are several styles of object properties that can come to be item entity in ontology: - "Actual" characteristics such as activity scale; - "Virtual" characteristics such as activity name and ability to do; - "Parts", either if the object is orderly; in this case these "parts" may be physical such as care courses.

There are relationships that may be with other individuals, which bind class individual members and other objects, for example, the person doing the Activity, representing a relationship between an activity and a ADL or IADL and the ability of an "Activity" is done as in the table 3.

Table 0 the relationship between assessment and Activities.

Domain	range	Relationship
ADL	Feeding	Type of ADL
IADL	Shopping	Type of IADL
FIM	Bladder	Measured FIM
BARTHEL	Bathing	Measured BARTHEL

So, we may need to add the following in addition to the properties we previously assumed: That is, classes are questions that contain one argument, for example, “Is this being an activity?”, or contain two arguments. For example, “Does he have the ability to do it?” “What is the assessment of this object?”

The activities are composed of categories and there are categories with their own characteristics, the other ones that come from the same class and which have special characteristics inherited from the original class. Such as Bathing and Grooming inherits all object property from "Personal_hygiene". That will be inherited to the bottom layers. "Bathing" will be associated with ADL as in "Personal_hygiene".

Step 6. Entity and Define its Aspects

There are different aspects of the Entity that describe the type of value, other permissible values, as well as the number of base values and other attributes that represent the entity, for example, when the value of the Entity represents the measure of activity as a number.

The value type describes the number of types of values that can be populated in the entity. The most common types of values include in the table below.

Table 4 the value type

type	Descriptions
String	The simplest type that describes the values of entities used such as name and represents a simple string value.
Numbers	In this case, we use more specific types of Entity value (Float and Integer), which describe the numeric values of entities.
Boolean	This entity represents a simple description which is represented by only two words yes or no
Domain and range	The allowable classes for an instance often called the range of Entity.

In the example shown in Figure 4, Class activity is the Entity range.



Figure 4 Domain and range for the Entity.

Step 7. Create Instances

In this step, we will create individual instances of the classes within the hierarchy, where we will define an individual instance of the class, first select a class, secondly create a specific individual instance of that class, and thirdly the Entity values we must fill. For example, to represent some activities it's possible to create an individual instance of "need-help". "need-help" is an instance of the class Dressing, Feeding etc., and representing part of the types of Activities. The following entity values specified in Figure 5 refer to the above instance.

Description: Dressing, Feeding, Grooming, Stairs, Toileting. Property assertions: Scale LAWTON-BRODY = 4, Scale BARTHEL = 1.

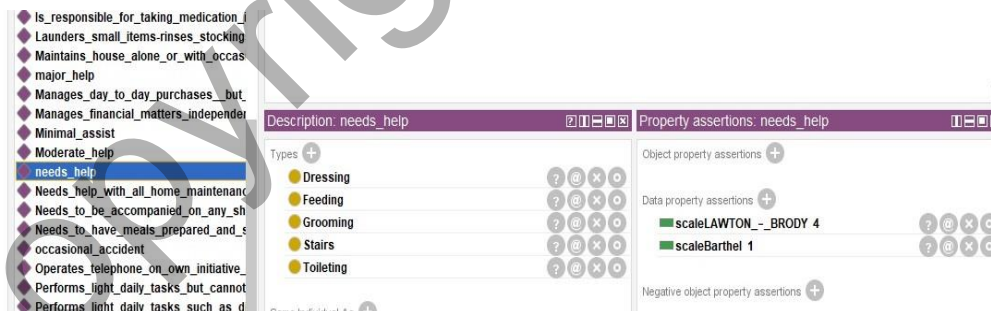


Figure 5 Rating Scores Using Numbers.

RESULT

As for the ontology that links instances between them, this is considered the most important result that we obtained, as it was concluded that the instances are linked between them, where there is a link between instances of one category with the same instance of another category. An example of this "need _ help" is linked between several classes of them "Feeding", "Grooming", "Toileting", "Stairs", and is measured by two types of measures "Barthel" and "Lawton_Brody", and also takes a different degree of measurement between these two sizes "Barthel"=1 and "Lawton_Brody"=4, and thus ontology linked a group of activities by one instance as shown in the figure below.

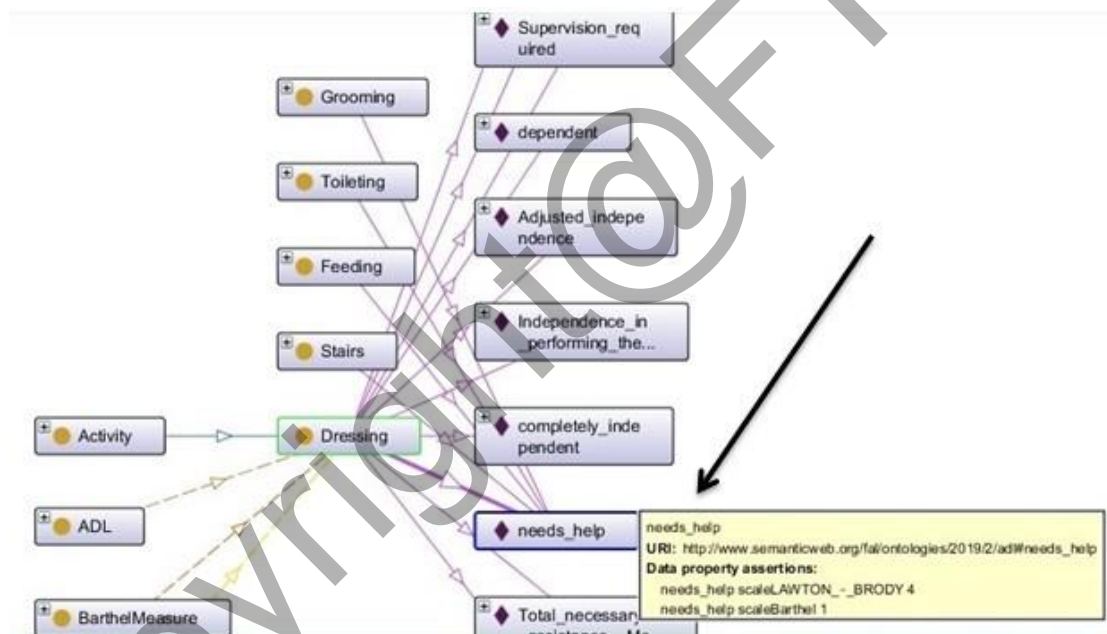


Figure 6 Instance and its connection to activities

After using SPARQL (Protocol and RDF Query Language) we have obtained the answers to efficiency questions we have, where we got the results after the work of query, that FIM is a type of scale likewise, for BARTHEL and Lawton_Brody. As well as "Completely_Independent" is individual of "Bathing", as for (Bathing) it is of the class type in "personal_hygiene".

Q1: what type is the relationship between "needs_help" and "Feeding"? What is feeding about? "needs_help" is the individual of "Feeding", and feeding is one of the activities.

The screenshot shows a SPARQL query interface with the following query:

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>

SELECT *
WHERE {
?ind rdf:type ?type .
OPTIONAL { ?type rdfs:subClassOf ?class }
}

```

The results table shows the following data:

ind	type	class
Performs_light_daily_tasks_but_cannot_maintain_acceptable_level_of_cleanline	owl:NamedIndividual	
Activity	owl:Class	
Ability_to_Handle_Finances	owl:Class	
measured_FIM	owl:ObjectProperty	
FimMeasure	owl:Class	
needs_help	Feeding	Activity
Feeding	owl:Class	
needs_help	owl:NamedIndividual	
Total_necessary_assistance__Maximal_assist	Bladder	Continence_management
Total_necessary_assistance__Maximal_assist	owl:NamedIndividual	
Bladder	owl:Class	
occasional_accident	owl:NamedIndividual	

Figure 7 Relationship between "needs_help" and "Feeding"

More than 75% of the people who read the project have considered this research useful and provide an understanding of helping the disabled and the elderly. After introducing the participants to the ontology, we asked them six questions, and the response ratios differed between them, as mentioned in the table.

Table 0 Evaluate users.

Questions	Very satisfied	Somewhat satisfied	Neither satisfied nor dissatisfied	Somewhat dissatisfied	Very dissatisfied
1 Do you gain more information related to rehabilitation?	8	2	2	—	—
2 Does the ontology provide reasonable information on activities?	7	3	2	—	—

3	Does the user understand the differences between ADL & IADL activities?	7	4	–	–	1
4	Does the user understand the differences between each measurement?	3	4	3	2	–
5	Does the user understand the differences between scales used to measure the activities?	4	5	2	0	1
6	Is the concept used to represent the rehabilitation clear?	2	4	3	2	1

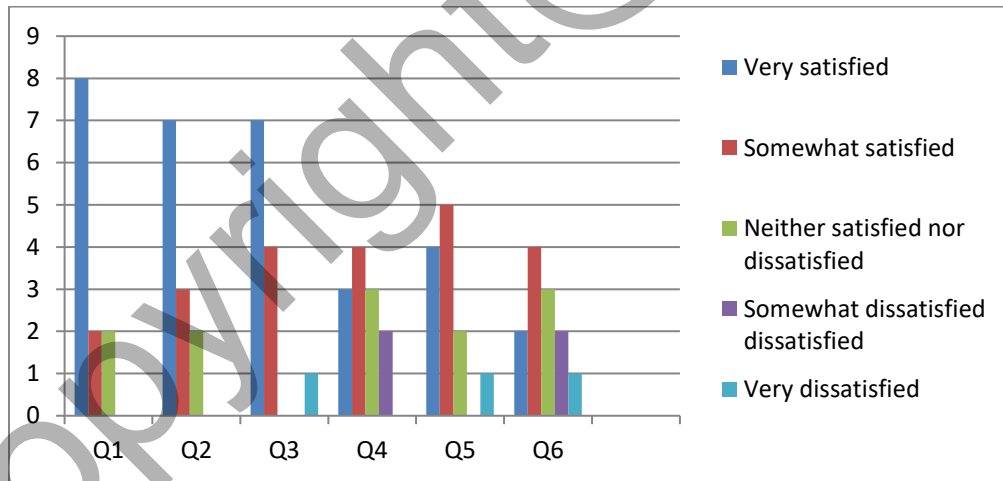


Figure 8 Evaluation rate

CONCLUSION

This study has yielded knowledge of the important activities that the elderly and the disabled need to be rehabilitated to return to their normal lives, albeit to a lesser extent than in the past. The activities identified and evaluated with a detailed classification of the need for assistance.

This ontology is considered as a guide or educational book for users who help the disabled and the elderly.

After introducing the ontology to the group of people in the evaluation, this study showed that they have optimism in the future to restore to the disabled and the elderly some of their important activities and it also gave them hope to depend on themselves, and this is also a benefit for the helpers as it reduces the rate of dependence on them, where assistance can be in only complicated activities.

REFERENCES

- Rehabilitation. 2019. MedlinePlus. <https://medlineplus.gov/rehabilitation.html/>. U.S. National Library of Medicine 8600 Rockville Pike, Bethesda, MD 20894 U.S. Department of Health and Human Services National Institutes of Health.
- Kitty S. Chan, Judith D. Kasper, Jason Brandt & Liliana E. Pezzin. 2012. Measurement equivalence in ADL and IADL difficulty across international surveys of aging: findings from the HRS, SHARE, and ELSA. *J Gerontol B Psychol Sci Soc Sci*. 2012 Jan; 67B(1): 121–132. PMC 3267026, Published online 2011 Dec 12. doi: 10.1093/geronb/gbr133.
- Margaret G. Stineman, Qiang Pan, Joel E Streim, Jibby Kurichi, 2014. Establishing an Approach to Activity of Daily Living and Instrumental Activity of Daily Living Staging in the United States Adult Community-Dwelling Medicare Population. *PM R*. 2014 Nov; 6(11): 976–987.
- George Okeyoa, Liming Chenb, Hui Wang c, 2014. Combining ontological and temporal formalisms for composite activity modelling and recognition in smart homes. *Future Generation Computer Systems*, Volume 39, October 2014, Pages 29-43.
- George Okeyo, Hui Wang, Liming Chen, 2013. An Agent-mediated Ontology-based Approach for Composite Activity Recognition in Smart Homes. *JOURNAL OF UNIVERSAL COMPUTER SCIENCE* 19(17):2577-2597.
- Natalya F. Noy and Deborah L. McGuinness. 2001. "Ontology Development 101: A Guide to Creating Your First Ontology". Stanford Knowledge Systems Laboratory Technical Report KSL-01-05 and Stanford Medical Informatics Technical Report SMI2001-0880, March 2001.
- Eva Ejlersen Wæhrens, Kirstine Amris, Anne G. Fisher. 2010. Performance-based assessment of activities of daily living (ADL) ability among women with chronic widespread pain. *Medicine* Published in PAIN 2010