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DEVELOPMENT OF USER INTERFACE GUIDELINE FOR EDUCATIONAL SEMANTIC WEB APPLICATION

TINASHINI JAYADEVAN NAIDU

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ABSTRACT

This research is aimed to produce a guideline for an effective user interface for semantic application particularly educational. This is important in terms of information retrieval of semantic web application. Early study indicates that i-RPH, a lesson plan semantic application has less attractive interface which undeniably demotivated the teachers to use it. In order to develop the guidelines, a methodology of four phases; analysis, design, development and evaluation has been applied. Qualitative approach had been used in order to develop a guideline by using instrument checklist and interview questions with the experts in system design. A semantic application has been develop using the proposed guideline. The semantic application was evaluated using qualitative approach based on heuristic evaluation instrument involving a sample of ten teachers of secondary level. The user acceptance for this system was compared with a prior system i-RPH which has been developed without a semantic user interface guideline. The result shows that the system developed by the semantic user interface guideline has higher acceptance than the system without the guideline. Seven of ten teachers agreed that the most important principle in user interface design is effectiveness specifically the simplicity, aesthetic and minimalist design. Moreover, suggestion for future research entails the use of enhanced user interface lesson plan design using semantic application, specifically in terms of emotions, so that it could be integrated in the usability features. It is expected that with the proposed user interface design will serve as a guideline to the developers to develop an effective user interface design precisely for educational purposes.

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PEMBANGUNAN GARIS PANDUAN ANTARAMUKA PENGGUNA UNTUK APLIKASI WEB SEMANTIK PENDIDIKAN

ABSTRAK

Kajian ini bertujuan menghasilkan satu garis panduan untuk mereka bentuk antaramuka yang berkesan bagi aplikasi web semantik khususnya yang berkaitan dengan pendidikan. Ini adalah penting bagi menyokong capaian ke atas maklumat di dalam sesuatu aplikasi semantik web. Kajian awal menunjukkan aplikasi i-RPH iaitu aplikasi rancangan pengajaran berasaskan web semantik mempunyai antaramuka yang kurang menarik lantas kurang memotivasikan guru untuk menggunakannya. Metodologi kajian yang terdiri daripada empat fasa iaitu analisis, rekabentuk, pembangunan dan penilaian telah di aplikasikan. Pendekatan kualitatif digunakan dalam penghasilan garis panduan dengan instrumen senarai semak dan soalan temubual bersama pakar dalam bidang rekabentuk sistem. Sebuah aplikasi telah dibangunkan dengan menggunakan garis panduan antara muka semantik yang dihasilkan. Aplikasi semantik ini telah dinilai dengan mengunakan pendekatan kualitatif dengan instrumen penilaian heuristik yang melibatkan sepuluh orang guru sekolah menengah. Penerimaan pengguna terhadap sistem yang dibangunkan berasaskan garis panduan ini dibandingkan dengan sistem yang dibangunkan tanpa garis panduan ini. Dapatan kajian menunjukkan bahawa antaramuka yang dibangunkan menggunakan garis panduan antarmuka web semantik lebih diterima berbanding dengan antaramuka yang dibangunkan tanpa garis panduan ini. Tujuh daripada sepuluh orang guru menyatakan bahawa elemen yang paling penting dalam membangunkan anataramuka merupakan elemen keberkesanan dan secara spesifiknya dari segi kesederhanaan,estetik dan rekabentuk yang minimal. Garis panduan antaramuka untuk aplikasi web ini dapat menjadi panduan bagi para pembangun aplikasi semantik web khususnya untuk menghasilkan antaramuka yang berkesan.

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CHAPTER 3 RESEARCH METHODOLOGY

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LIST OF ABBREVIATIONS

ADDIE	Analysis, Design, Development, Implementation and Evaluation
AJAX	Asynchronous JavaScript
CLI	Command Line Interface
CSS	Cascading Style Sheets
ECL	Extraneous Cognitive Load
GCL	Germane Cognitive Load
GUI	Graphical User Interface
GWT	Google Web Toolkit
HCI	Human - Computer Interaction
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
ICL	Intrinsic Cognitive Load
ICT	Information, Communication and Technology
ISD	Instructional System Design
OWL	Ontology Knowledge Representation
PHP	Hypertext Preprocessor
RDF	Research Description Framework
RSS	Really Simple Syndication
RTM	Research Territory Map
SDK	Software Development Kit
SUIG	Semantic User Interface Guideline

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UI	User Interface
URI	Universal Resource Identifier
W3C	World Wide Web Consortium
XML	Extensible Markup Language

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CHAPTER 1

INTRODUCTION

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1.0 Introduction

The reformation and changes have been experience by the educational systems around the world. Getting into the new era, many agencies are serious and promisingly involved in an international rein formation. This rein formation has also been widely happening in teaching professions which changes happen rapidly all around the world.

With the increasingly globalized education system of many countries around the world, it has become a challenge in the teaching profession to address the demands and expectations of the younger generations. In light with these demands, educators are not only seen as a knowledge agent but also expected to contribute in

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reshaping the nation. The education of 21st century has undeniably produced higher demand for the world to produce quality educator. On the part of the Malaysian government, great measures have been taken towards the graduate teachers, urging them to integrate ICT in teaching and learning, restructuring of teachers training, as well as fulfilling the core key point in education systems (National Key Results Areas, 2010).

The need to create new digital resources can be overwhelming on the part of the teachers and it would require additional time and effort for them. It urges the need for tools that can support teachers in finding, retrieving and selecting appropriate digital resources for compliment their teaching plans, in conjunction to assist the teachers in the task of creating a systematic lesson plan. In order to support teaching strategies and teaching process in an effective time, a tool is needed (Ghavifekr et al., 2014). Teaching materials plays important role in quality teaching and learning practise, in terms of assisting teachers in making instructions (Arnseth, 2012). The latest effort used to overcome the constraints is a web-based system which has semantic features for customising lesson. The semantic web's concept depicts the usage of computer oriented data in order to expand web and restrict only documents for reading and processing by computer, which in turn, aids the intelligent information sharing, and provides network active and dynamic service (Friess, et al., 2013).

Basically, semantic application is used for data sharing and data reusing within the organization. The Internet is known to be semantically rich to be understood by computers and support the operation of the attribute in the internet. Semantic systems are known to dynamically reuse resources as well as enhance the Human-Computer

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Interaction (HCI) and cooperation. Rapid development and increasing usage of the semantic system as searching and a teaching aid for teachers, the importance of semantic usability is enhancing. Many framework and guideline have been developed focusing on the backend of semantic application. Yet the features line font and colour, navigation, alignment of text and interaction as this are the main medium to prompt the user for interaction, and eventually to urge them to use the application.

In this light, this research will focus on creating a user interface design for semantic application for lesson planning that meets the needs of the teachers, through the integration of the learning theory, instructional design model and user interface guidelines.

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1.1 Background of the Study

Differentiated instruction is a common way used by a teacher to enable the instruction delivered to the students providing further impact in teaching and learning (Garderen et al., 2009). In spite there are many alternatives being used by the teachers in their daily lesson delivering, in terms of lesson preparation it has been still done manually (Saad, 2011). Whereby, those lesson delivery and experience are being transferred with many constraints and limitation such as workload, time consume, extra-curricular activities, exams and effort has been done by developing a web based system, but it has limitation in term of data in the database.

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It is enclosed that in the context of educational semantic application consists of three fundamental elements (Anderson, 2004). Primary to this element is ability of an effective storage and retrieval of information's. Another element is the mechanism for machines agents to understand the process of learning and retrieval of information taking place in humans. Finally, in order to overcome constraints like overloading information in the internet, semantic application with specific domains are built.

As a tool to assist teachers in this task, an educational semantic application was designed. Referring to the phases of semantic content in the educational application, the researcher found that there has been various progress on the backend part in terms of data storage and data linking. Nevertheless, the least concerning part and developed in the educational semantic web application is the front end which is the user interface. Due to the effectiveness of the applications that supports pedagogical research is given more attention as their capability to support IT tools compared to the manual data retrieving methods. The complexity of real life learning situation are gaining back its opportunity as the using technology in pedagogical research trend is enhancing. Thus, in conjunction to this situation it is in need of a system with rich synchronized user friendly interaction required (Siipo et al., 2014).

The user interface also serves as an essential part of the program because it serves as the medium that connects program to users. Even with having the best application function, if it still with a bad user interface, then the end result will still be bad. The interface acts a key point to evaluate the weather is the application is being accepted in market (Siorpaes et al., 2010). It was proven in a study that 48 percent of the source code is dominated by the user interface. As more and more applications

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and functions are related to real world, the importance of a good user interface is still undeniable (Myers, 1992).

A major element that is lacking from a semantic application is that the ontological knowledge is used only for keywords from which is only understood by the experts and the user are left guessing the keyword which will result in the instance sought. At a glance it can be clearly seen that there are difficulties at the interface level, whereby the ontology keyword in the semantic web is not being presented to user in an appropriate and understandable way (Maedche et. al., 2001). Semantic application is known for the language that is used which is Ontology Knowledge Representation (OWL). OWL is a machine readable language that is hardly understood by novice users.

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1.2 Problem Statement

A research was carried out on an existing semantic web. An evaluation was conducted and the finding shows that less effort are given in designing the interface part of the system compared to the other back end work of construction in the application. The challenges faced by semantic webs are usability and visualisation. It is known that the context of ‘ease of use’ is essential for both developer and user interfaces. To be able to use Semantic web, Semantic Web and Web standard expertise may be needed. It is viable that Semantic Web tools and applications should be simple and easy to use by both users and developers (Bryar, 2015). A systems

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drawback is not solely based of functionality or the knowledge representation but most importantly the interactions and where it happens.

Among the issue pointed out whereby the users are expecting for different interfaces for different function instead of “all in one” function which most of the semantic applications has. In extending this issue, to enable a user friendly user interface each function should be provided with each effective interface (Keskinen, 2015). Thus, the users are looking for each functions represent by each interface in a simplified version rather than all the functions in an interface.

The lacking point in an educational semantic web as in the user interface is none other than motivation element, whereby is the main element for users to act. Pedagogic stimulus consists of willingness that will trigger the extreme willingness for learning process. From these issues it clearly shows that very little attention has been focused on these above matters in the quest of creating a user friendly user interface (Munir, 2018). The remaining challenges in the semantic web are certainly not the underlying technologies as many work is been carried out in order to enhance it. Instead, it lies on the user interfaces and usability of the semantic application (Munir, 2018). This clearly shows that the main issues that have been popping out is the issue of usability and interfaces because that is the only medium used by the users to access these websites.

User interface is where the interaction happens between a user and educational bodies. The goal in learning process is not obtained due to unsuccessful correlations, even though the educational body was well selected as well as the user are willing to

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learn. Whereby, it is clear that the minus point in teaching and learning is because of poor interaction. When it comes to educational semantic web, the lacking of interaction between the user who is addressed as the educational body and the interface brings to poor interaction which leads to failure in the teaching and learning session (Jensen, 2017). Semantic application has been growing in terms of it functionalities. However, it is not often the case that ontology resources are followed by human understandable lexicalisations (Damljanovic, 2010). There are many revising work have been carried out for back end but least concentrated aspect of the application is the user interface in the existing semantic lesson plan application (Aslina, 2011). The results of the finding clearly show that the disclosure is mainly focused on the user interface.

The semantic data web is still proven to be challenging when it comes to the interaction with the end users. There is a large amount of structured data adhering to the RDF (Research Description Framework) data model being published on the application. However, it is a huge constraint in terms of discovering, accessing and exploring this data. Furthermore, the data web is currently still a read web rather than read write web (Auer et al., 2012). Less attention was given to the human-computer interaction medium which is the user interface which leads to difficulties in using a semantic web. In this context, the study claims that the main concern in semantic application is usability. To facilitate the use of the framework, especially for non-technical users, it is necessary to improve the graphical interface (Luciano, 2015). To overcome the limitation and to encourage understanding in a semantic application, interacting by by engaging visually should be embedded. Undeniably, it is common that the importance of having a visual user interface is neglected. Thus, in order for

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the users to understand the knowledge representation that is represented by ontologies as well as to utilize the capabilities of application and domains, its indeed a room for visualization and interactions (Hsu et al.,2017).

In this research, a user interface guideline is proposed for educational semantic application which intent to simplify the complexity of underlying technologies in semantic content designed by the web designer. Addressing these above issues, the research will explore from design concepts in building an effective user interface for educational semantic web application by applying the reaserch approach as well as user assessment studies.

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1.3 Research Questions

In this research, a user interface for semantic web application for lesson planning is created in the goal of achieving usability, effectiveness and interactivity for the end users. It is believed that by having user interface guidelines as well as the learning theory and instructional design model, it will improve usability interactive and effectiveness aspects of a user interface for educational semantic web application. To achieve the above objectives, the present study attempts to focus in answering the following research questions:

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i. What are the suitable features for user interface guideline for educational semantic application?

ii. Does the developed user interface with proposed Semantic User Interface Guideline supports educational semantic web application?

iii. Does the developed user interface with proposed Semantic User Interface Guideline (SUIG) accepted by the user?

iv. Does the usability, effectiveness and interactivity occur in the design of user interface with proposed Semantic User Interface Guideline (SUIG)?

1.4 Research Objectives

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The main aim of this study is to develop an effective user interface for educational semantic web application with a refined user interface guidelines. The purpose of the research is to investigate the effectiveness of the user interface of educational semantic web application. In order to reach this goal, the following objectives need to be addressed:

i. To produce a user interface guideline that supports educational semantic web application

ii. To design an interface using the produced user interface guideline that supports educational semantic web

iii. To evaluate the user acceptance towards the developed prototype based on produced user interface guideline.

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1.5 Working Hypothesis

A working research hypothesis is advanced to assist the researchers in order to produce a qualified research. Based on prior research and finding these hypotheses are produced. A pair of hypotheses that have been produces is identified as below:

H1: The proposed Semantic User Interface Guideline (SUIG) supports educational semantic application.

H2: There is usability features in the design of user interface with proposed Semantic User Interface Guideline (SUIG).

H3: There is effectiveness features in the design of user interface with proposed Semantic User Interface Guideline (SUIG).

H4: There are interactivity features in the design of user interface with proposed Semantic User Interface Guideline (SUIG).

1.6 Scope and Limitation of the Study

This research is limited to five schools in Kuala Lumpur region. The evaluation is limited to a sample of ten teachers from both secondary and primary level who has been working in several schools across the nation. This research does not include the effect of certain demography factors such as gender, race and the computer skills Selection procedures were based on convenience, but care was taken to ensure that the participants were selected to represent the various dimensions that are important to the study in terms of age, gender, professional experience and qualifications. The

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research is only limited on evaluating the user acceptance towards user interface design with produce Semantic User Interface Guideline (SUIG).

1.7 Research Territory Map

A research territory map keeps the researcher focused during the research project, since it literally shows the researcher the big picture of the workflow, formulated in terms that are characteristic of existing research. The research territory map is produced by first listing all the keywords that are related to the research topic such as the user interface design, education and semantic. These loose concepts for instance, are represented by circles in a concept map. Then the researcher connects the circle with each other by listing out the problems encountered in each linked areas. With the problems being enumerated on each research concepts, the research gaps are also significantly determined.

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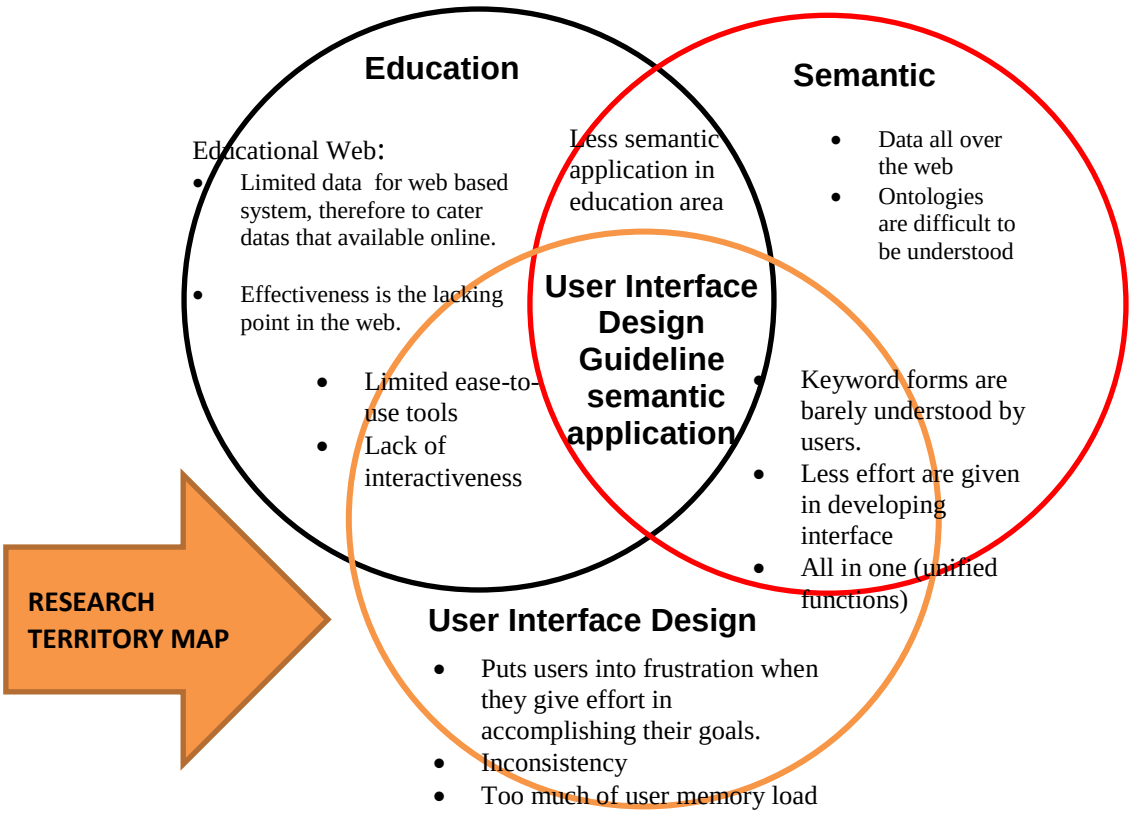

Figure 1.1. Research Territory Map

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1.8 Conceptual Framework

A conceptual framework of a theory is a visual display of that theory also known as a picture of what the theory says is going on with the phenomenon that an individual is studying. These maps do not depict the study itself, nor are they a specific part of either a research design or a proposal (Miles et. al., 1994). Referring to the conceptual framework that have been designed by the researcher, the research is being

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conducted by using ADDIE instructional Model as the guideline in order to create a user interface guideline for educational semantic web application.

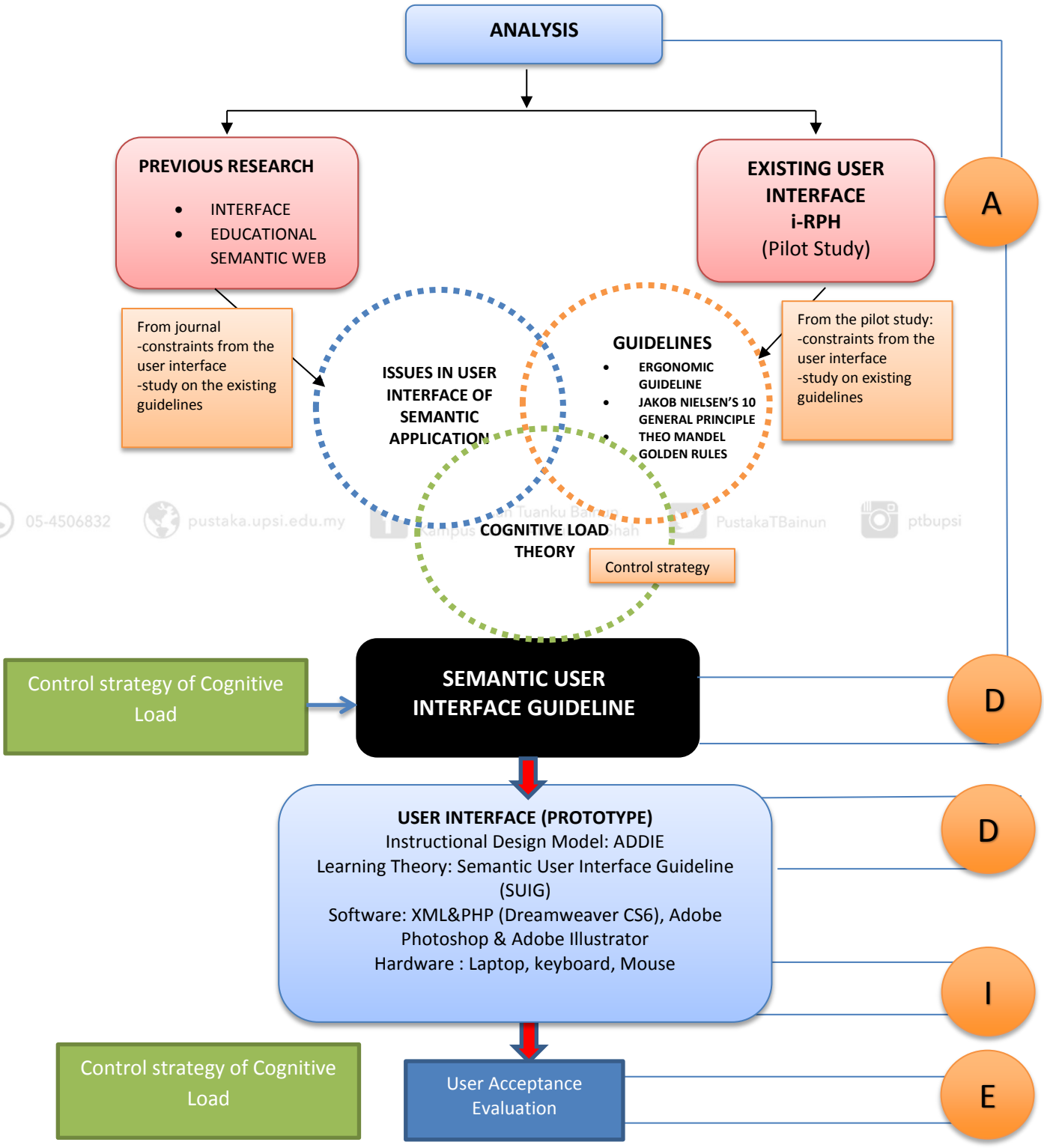

Figure 1.2 . Conceptual Framework

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For the initial study, which is in the analysis phase, the research started with pilot study on existing semantic application i-RPH with the aim to get feedback on the constraints in the application and studies on existing research and example projects done by other researchers or developer. This consists of comparing the user interface guidelines in order to identify the features in user interface guideline used in various semantic webs and venturing on the existing educational semantic web. Constraints in semantic application are identified as well. Meanwhile, the second phase is the design phase, whereby the researcher will come out with two different sections. These two different sections, where in the first section a control strategy for cognitive load will be contributing in producing Semantic User Interface Guideline.

For the development phase, the researcher will apply the proposed user interface guideline in a new interface. Next, in the implementation and evaluation phase, designed user interface is evaluated in terms of the interactivity, usability and effectiveness. The evaluation will be conducted to evaluate user acceptance towards user interface with proposed user semantic guideline. This evaluation on user acceptance will be carried out on the real user, whereby the user will be evaluated by interview questions as well as user comments on the developed user interface design.

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1.9 Operational Definition

Within the scope of the research, a few terms have a tendency to appear most frequently throughout the evaluation and development process. It is important that these keywords be highlighted according to their definitions and operational feasibilities.

1.9.1 Semantic Web

The semantic web is a mesh of information linked up in such a way as to be easily process able by machines, on a global scale. It is an efficient way of representing data on the World Wide Web, or also known as a globally linked database. A simple example used to motivate the Semantic Web is the need to discover documents on the Web, not only from their textual content, as conventional search engines do, but also from a description. The problem is exemplified by the frustration in finding articles written by a particular author, rather than those which include the author's name.

When contents are semantically structured, one can find more benefits as compared to unstructured information. Among these benefits include the following:

- *In retrieval and search of information, there is a more effective and efficient search interfaces like the faceted search and even in answering questions*
- *In the presentation of information, one is able to flexibly visualized information in more sophisticated manners such as through semantic overlays*

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- *In the integration of information, heterogeneous data being stored in various applications can be viewed in a unified manner through the creation of composite applications like the semantic mash-ups*
- *In terms of personalisation, documents that are semantically enriched can provide information that are context-specific and*

The Semantic Web can allow each document on the Web to be annotated stating who its author was, when it was created, and what content it has then those with the appropriate author will be returned.

1.9.2 Semantic Web in Education

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The field of education has significantly developed through the diffusion of web technologies. In Web 1.0, web-based systems were developed as characterised by educational resources that are read-only. Web 2.0 has later on paved the way for the creation of educational systems that are collaborative and interactive such that, it allows the participation of users in real-time and asynchronous communications as well as synchronous group learning activities through social networking tools, blogs, wikis and other online virtual environments

Integrating web technologies of today through the involvement of Semantic Web, Educational Web Mining, Big Data involving Linked Data together with new fields as well as the application of education pedagogy, affective computing and artificial intelligence has resulted to the ability of customizing the instruction process based on the background of the learners, their motivations, learning objectives, skills,

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preferred activities and knowledge. The increasing availability and accessibility of information through the early years of the 21st century has obvious benefits, but also poses a challenge to learners and educators. Sorting and evaluating information rather than locating it is now frequently a daunting task, requiring strong skills in information literacy and a significant investment of time and effort. The Semantic Web provide solution to this information overload by organizing information meaningfully so we can retrieve what we want without getting lost on the Web.

1.9.3 User Interface

User interface pertains to everything, under information technology, that is designed into an information device in order for human beings to be able to interact. The design usually includes desktop's appearance, help messages, light pen, mouse, keyboard, display screen, illuminated characters and even the manner in which a website or an application program invites or responds to interaction.

The UI consists of both hardware and software. The design of an user in UI affects the amount of effort the user must spend to provide input for the system and to interpret the output of the system. The output interface is used in terms of user assist by displaying the feedback from the system. The design of a user interface is the major factor that determines the user experience and the user's decision on whether to keep on using a certain product or abundant it.

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1.9.4 Educational Web

The Web 1.0, being a read-only, can present resources, like lesson plans, that can be used by teachers. Online reference materials are indeed a lot but only few people have access to it. As for Web 2.0, it has potential to create a more humanized teaching approach and empower the teacher's teaching skills. Web 2.0 is a "read and write web" where the teachers use Web 2.0 for lesson planning. In the case of Web 3.0, which is also known as the semantic web, it allows the synchronous collaboration, real-time as well as simultaneous collaboration. With semantic application, the data is structured for a more effective discovery, integration of automation and reuse various applications.

Educational webs can include websites that have games, videos or topic related resources that act as tools to enhance learning and as supplement in classroom teaching. These websites help make the process of learning appears to be entertaining and attractive to the student.

1.9.5 Ergonomic Guideline

The following points are guidelines to good software interface design, not an absolute set of rules to be blindly followed. These guidelines apply to the content of screens. In addition to following these guidelines, effective software also necessitates using techniques, such as 'storyboarding', to ensure that the flow of information from screen to screen is logical, follows user expectations, and follows task requirements.

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The development of information systems shows that the competition of products from functional changes in the area of comfort and convenience for the users. Has long been a technology to significantly improve the UI. However, by themselves they do not make ergonomic interface. For example, graphical user interface (GUI) is more ergonomic than the text-based interface, and, as research shows, may be less suitable for use, if developed without taking into account the requirements of ergonomics.

1.10 Significance of the Research

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This study is a significant endeavour in creating a user interface guideline for educational semantic application. This study is hoped to be beneficial for users, the teachers in using the educational semantic application. By understanding the needs of the teacher and benefits of quality education to be assured of a competitive advantage, this guideline user interface for educational semantic application is created according to the investigated user interface guidelines. It will also serve as a future reference for researchers on the subject of user interface design and semantic web as well as education. And importantly, this research will educate web developer in deciding on whether the importance of user interface design for semantic web is really fulfilling user needs.

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1.11 Organisation of Thesis

A review of the organisation of this thesis aims to enlighten the readers in order to follow through the development process of this investigation. Chapter 1 contains a relatively short summary of the basic concepts of the background of the research including the educational web, the constraints, the semantic web, the collaboration on semantic application in education sector and the most important part is the issues of user interface in semantic application specifically in educational purposes, the objectives of the research as well as the working hypothesis and the conceptual framework of the research. Chapter 2 introduces in depth the field of semantic application the field of education and interaction design. Reader will be introduced with the types of user interface guidelines.

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Moreover, Chapter 3 presents the methodology for the investigation as well as the design and development of user interface while Chapter 4 the description on studies to evaluate the features, user acceptance and effectiveness of the user interface for educational semantic application. Chapter 5 complies the research with recommendations and future work on the use of user interface guidelines as well as the user interface design.

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