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**Research Article**

# Learning Support with Semantic Forum System

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**Abstract:** Learning support is a service offers to assist learners learning process towards a desirable educational goal. Learning support is pertinent to fulfill the learning requirement and to complement the lack of interaction with tutors in e-learning education. However, there raise a concern that learning support provided is not effective enough to provide fast response to inquiries, relevant content of interest and reuse past discussion to resolve issues and difficulties in learning. Nevertheless, the ontological approach from semantic web technologies implementation offer certain affordance to enhance the learning support towards greater possibility as an effective e-learning facility. As such, it is the interest of this study to propose and introduce an ontological-based semantic forum by reusing the knowledge obtained from course modules and past forum discussion in order to enhance the learning support. Thus, a brief description of semantic forum development is presented in the acquisition and modelling the knowledge into an ontological structure. As well as evaluation conducted to ensure the effectiveness of the system use in enhancing learners' understanding of the subject. This study contributes to a new approach of learning support with new facilities designed to provide more meaningful and relevant learning materials that able to accomodate the desirable learning outcome.

**Keywords:** Domain ontology, e-learning, forum discussion, ontology development, semantic web technology, web application

## INTRODUCTION

Tait (2000) defines learning support as ranges of services for learners to complement the course materials or learning resources that are uniform for all learners. Thorpe (2002) defines learning support as all those elements that capable of responding to a group of learners, before, during and after the learning process. Learning support defined in this study is a service provided through an ontological-based semantic forum system using knowledge from a course module and past forum discussion in e-learning education. A module refers to a unit of teaching or an academic course taught in a semester or one academic term. It contain well-organized structured content presented in a hierarchical structure with chapters, sections and subsections on the subject of concern. Meanwhile, forum discussion is a communication platform that provides opportunities for reflective learning, sharing opinions, problem solving, articulation and collaboration among peers and tutors. This platform capable to build very large archives of question-answer knowledge across courses and semesters over the time. Thus, learning support provided is essential to assist learners difficulties especially when they are required to manage their own learning and develop their own understandings in e-learning setting.

Nevertheless, Thorpe (2002) and Tait (2000) raise a concern that learning support provided not able to cope with the individual learning needs. It requires a method to response more rapidly to needs and inquiries, relevant, reduce rework and just in time to help learners to learn (Abel, 2009). There also suggestion on elements needed in a quality learning support mainly induction to new technologies, direction and control, feedback and accessible resources (Alias and Rahman, 2005). Therefore this study aims to propose and introduce an ontological-based semantic forum by reusing the knowledge obtained from course modules and past forum discussion in order to enhance learning support provided.

Learning support by means of ontological structure able to semantically organized past forum discussion from huge textual resources with course module content. Furthermore it can classify, extract and access the relevant knowledge of interest to facilitate searching and reuse in order to resolve learners issues and difficulties in learning. Ontology is used to formally represent the knowledge structure of learning materials (Chi, 2009) and share the domain knowledge through modelling and the creation of concepts and relationships between those concepts (Noy and McGuinness, 2001). Ontology through semantic web technologies implementation has already been

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recognized and used in the e-learning education (Fischer, 2001; Aroyo *et al*., 2002; Holohan and Pahl, 2005; Pahl and Holohan, 2009) with different purposes ranging from the definition of a domain-specific terminology to the use of conceptual models and inference in the generation and composition of learning content and systems.

Therefore, the concern to enhance the support for learning is no longer an add-on to a predefined course, in fact it is a priority that defines what the course becomes and fulfill the learning requirement. As such the paper first presents a semantic forum development for brief description of modelling the knowledge into ontological structure. Second, detail discussion on semantic forum system in the aspect of facilities offer and its usage. Third, discussion on evaluation conducted to assess the effectiveness of the system and finally the conclusion.

## METHODOLOGY

**Semantic forum development:** The development of semantic forum as illustrated in Fig. 1 involved four main phases: knowledge acquisition, knowledge modelling, ontology evaluation and knowledge representation. Knowledge acquisition phase concerned with acquisition of knowledge from the course module and past forum discussion. In this study we used the System Analysis and Design (SAD) course module because it is a core subject in a mature computing discipline and it is offer for every semester to the learners.

The acquisition process from course module resulted in the identification of 135 concepts and relationships among the concepts. Concept is defined as key terms or keywords discussed in the course module. Fig. 2 indicates example of identified concept and types of relationship used in this study. Organization of concepts according to appropriate relationship types able to help learner to see the structure, understand what is important and what should be learned of such concept.

In addition, acquisition of forum discussion that aims to identify question and answer knowledge from the discussion resulted in 320 questions and 543 answers from a total of 3219 messages in 15 discussion transcripts. Both acquisition process were conducted by two domain experts known as Subject Matter Experts (SMEs). The SMEs responsible to develop or enhance the module content as needed as well as to formulate assignment and final exam questions for every semester assessment.

To be usable in the semantic context as data with a well-defined and meaningful structure, the knowledge modelling phase was required to compile and map acquisition results to subject ontology using the Web Ontology Language (OWL) and the Top Braid Composer tool as an ontology authoring tool. OWL represents the meanings of concepts and their relationships as an RDF graph, illustrated in Fig. 3. Meanwhile, subject ontology functions to semantically model the course module knowledge by extending existing World Wide Web Consortium (W3C) standard ontologies, namely Simple Knowledge Organization Systems (SKOS). SKOS defines concept relationship types using semantic relationships properties by means of broader, narrower and related for better control of the level of detail and is best for reflecting content covered in the course module. SKOS uses documentation properties to provide descriptions and additional information for a concept through the use of WordNet for English language and Kamus Dewan for Malay language description.

Having designed and constructed the subject ontology, the next phase is to proceed with ontology evaluation phase with the goal is to evaluate the quality of the ontology modelled by confirming whether the domain knowledge is adequate to represent the

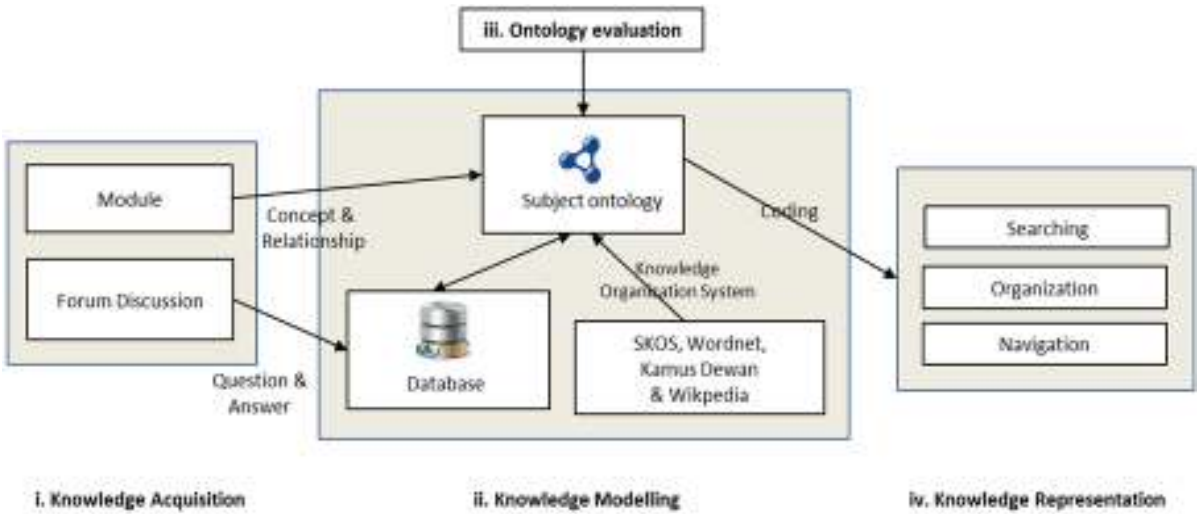


Fig. 1: Semantic forum development phases

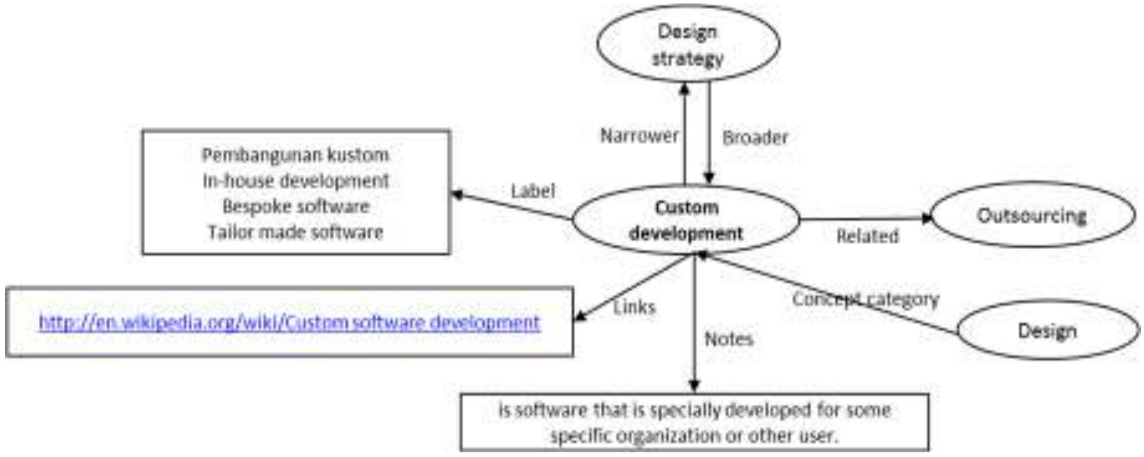


Fig. 2: Example of a concepts and its relationship

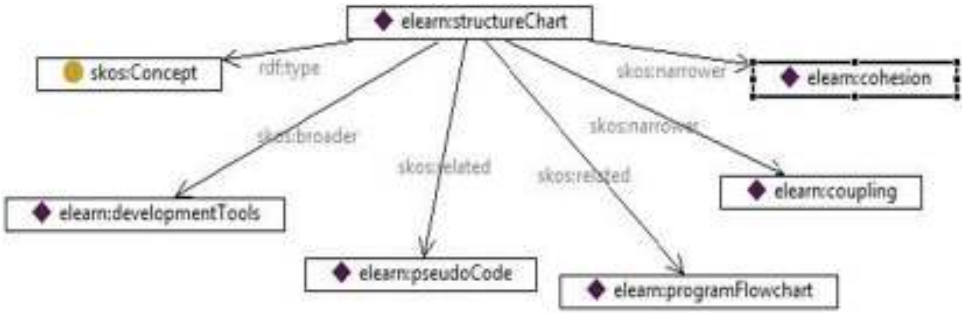


Fig. 3: Concepts with semantic relationship properties

ontology according to the assessment of experts. The methods of ontology evaluation are via the use of semantic forum system, a concept annotation task and responding to questionnaires conducted by tutors who have experienced in tutoring SAD subject in face-to-face tutorial as well as in the forum discussion session. The findings contribute to positive perception and demonstrated that the ontology model was adequate to represent the subject domain and meets learners needs. Finally the phase ends with the development to improve the design aspect of semantic forum system namely searching, organization and navigation facilities in order to manage more meaningful and relevant course content are described in detail in the next section.

**Semantic forum system:** A semantic forum is an internet forum that has an underlying model of the knowledge described in its content (Abel, 2009). We defined semantic forum as a forum that organized the knowledge by means of ontology. Such forum integrate forum discussions and module knowledge based on ontological structures, offer a new way of storing, indexed and exchange the communication in order to enhance learning effectively. Thus, this section discuss in details semantic forum system in the aspect of facilities offer and its usage.

Figure 4 illustrates the main interface of the semantic forum system. On the left side of the screen are facilities such as Search for Concept and Concept Category button. Concept category functions to represent the delivery sequence of the knowledge structure in the course module. If learner search for a concept, details of such concept illustrated as in Fig. 5 provides learners with variety of concept information that includes: concept relationships section which can be narrower, broader or related concepts; notes section that provides notes taken from module by such concept; other section: list of synonyms or alternative words in English or Malay language to be represented and link to Wikipedia or other sources that is relevant by such concept; and related question section provides relevant questions from several semesters of forum discussion collection.

Meanwhile, if learner choose any option from the seven concept category provided, list of questions organized under such concept category will be displayed as illustrated in Fig. 6. Learner able to navigate from one question to another with additional information provided in the interface such as to which concept (s) the question belongs to, types, author and date and time the question posted. Upon selection from any of the question listed, several answers for such question are displayed as illustrated in Fig. 7. In this


Fig. 4: Main interface of semantic forum system

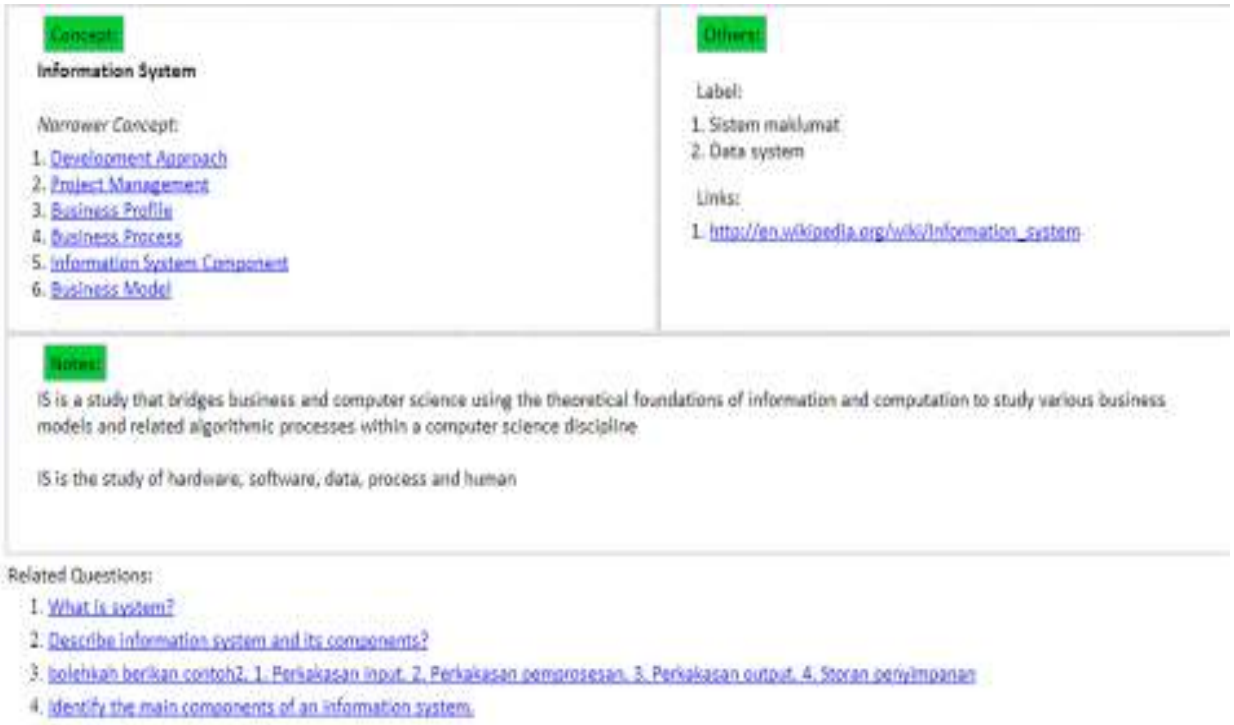


Fig. 5: Example of concept detail interface

interface learners have an option to add new answer for further choices of the answer or option to recommend whichever answer that best reflect their understanding.

Semantic forum system also provide facilities to model concepts and the relationships between the concepts using concept maps diagram as illustrated in Fig. 8 interface.

Overall, the facilities described earlier in the system able to manage course module and forum discussion knowledge in much better presentation and offer more relevant content to enhance learning. For instance, the concept map diagram and concept categories organization contributes to reflect the essential aspects or the big picture of the subject taught.

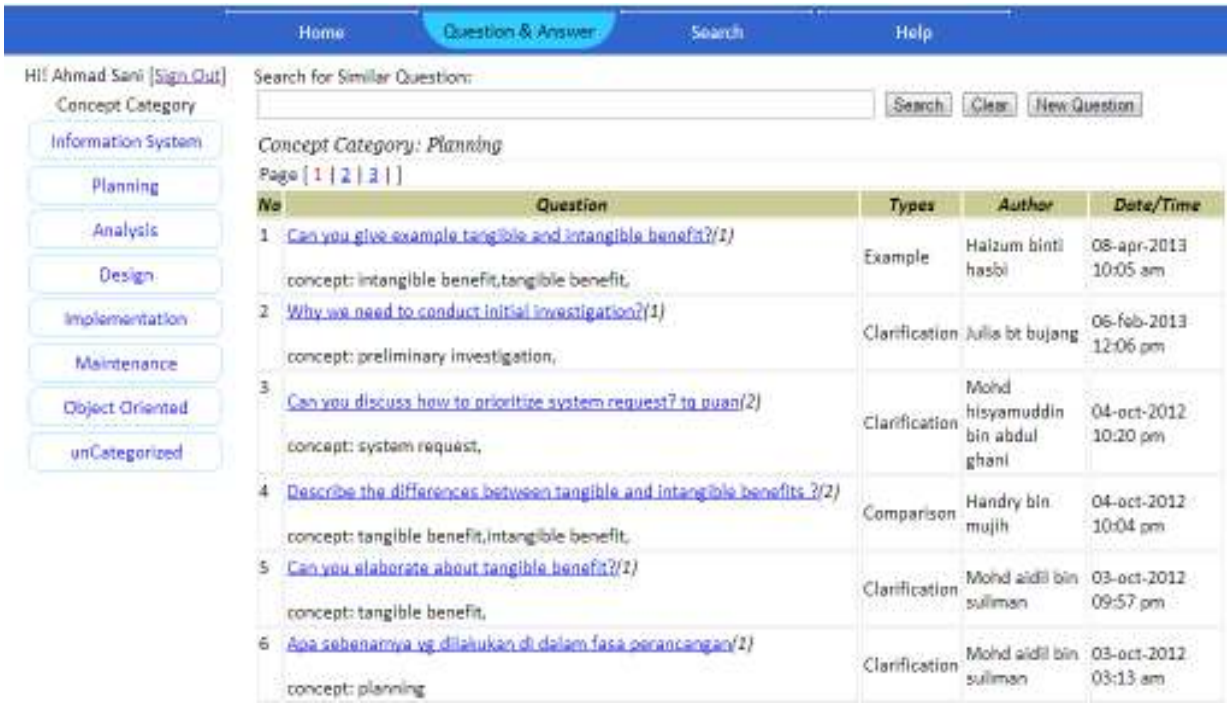


Fig. 6: Example of list of questions interface

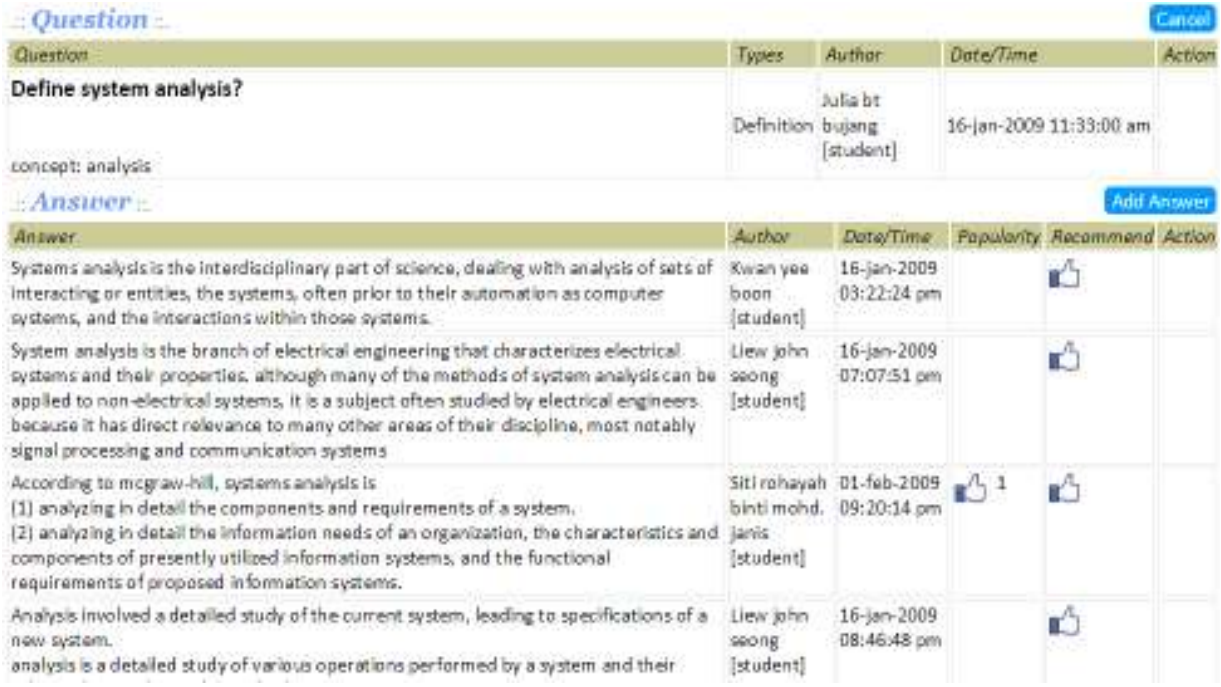


Fig. 7: Example of question and answer interface

In addition, the details of concept information with relevant questions and answers reused from forum discussion collection allow the knowledge to evolve for further discussion, understanding and revision for current and future members of the learning community.

Furthermore, the semantic forum system also offer several types of searching facilities, such as searching for concepts, similar questions, unanswered questions, new questions, new answers, question types and recommended answers. Figure 9 illustrates example of search for similar question interface. This searching facility is to check whether the intended question is available in the system. This search result will not only search availability of the intended question but also

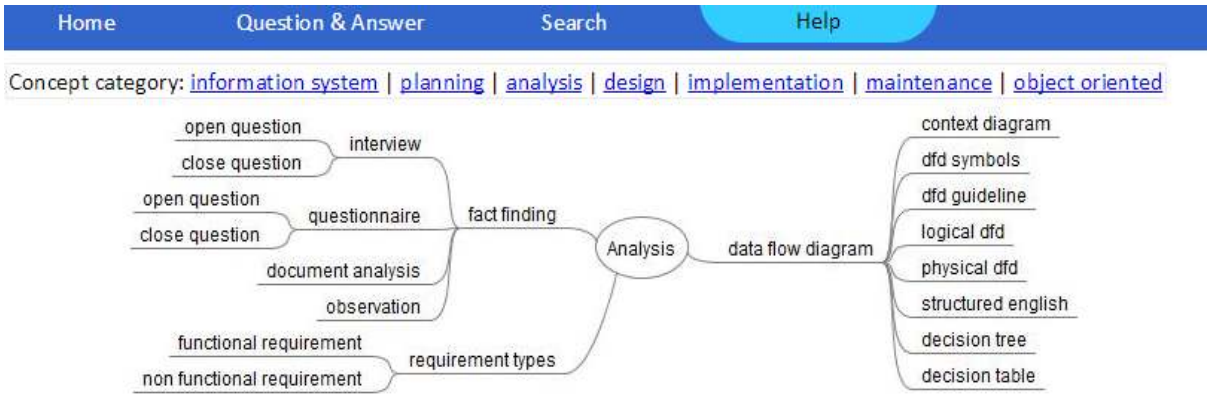


Fig. 8: Example of concept map interface

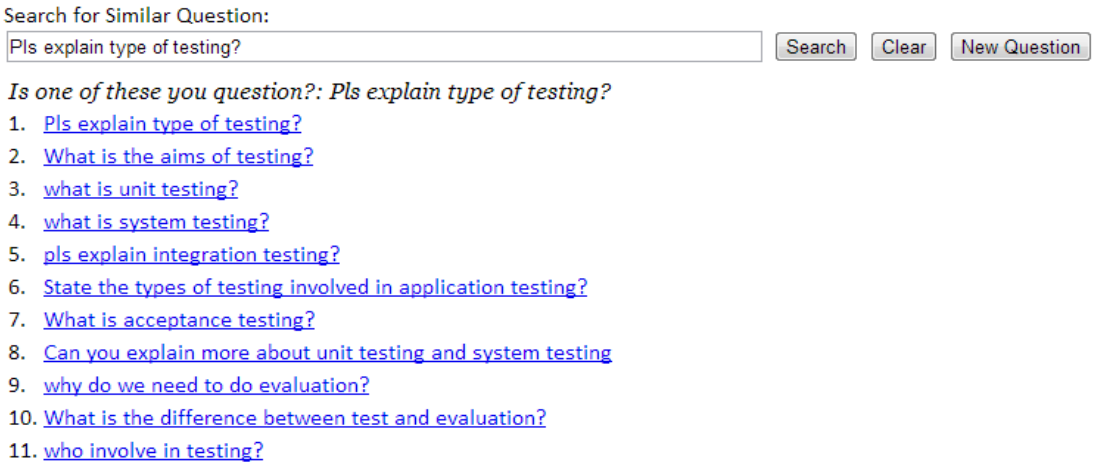


Fig. 9: Example of search for similar question interface

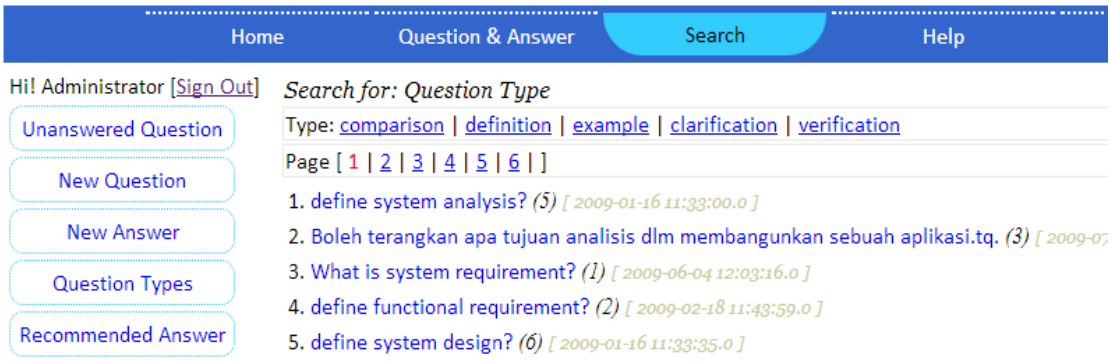


Fig. 10: Example of question type search interface

search related question (s) for learners to further investigate similar questions that exist in the system.

Another example of searching facility is question type search as illustrated in Fig. 10. This search result is based on question types classification namely comparison, definition, example, clarification and verification. In the left side of the interface, learner do have option to choose several other types of searching facilities provided in the system.

## SEMANTIC FORUM RESULTS

In order to ensure the effectiveness of the learning support provided. This section briefly describes evaluations conducted from the use of semantic forum system. Three dimensions were used to measure system effectiveness: learners' perceptions, system design perceptions and system content perceptions (Anderson and Kanuka, 1997; Finegold and Cooke, 2006;

Table 1: The dimensions, factors and descriptions for the evaluation

| Dimensions | Factors |
|---|---|
| Learners' perceptions | • System value-whether the system is a valued tool for learning |
| | • System usefulness-whether the system is useful for learning |
| | • Ease of use-whether the system is easy to use for learning |
| | • Ease of understanding-whether the system eases the learning process |
| System design perceptions | • System search-whether the provided search feature can fulfill learning needs |
| | • System organization-whether the system organized with the concept organization can enhance learning |
| | • System navigation-whether the system is easy to navigate for finding the required information |
| System content perceptions | • Content availability-whether the content is available to be used, with a variety to be chosen from |
| | • Quality content-whether the content is easy to understand, clear and relevant |
| | • Useful content-whether the content indicates what is important and needs to be learned |

Table 2: Regression analysis

| | R | $R^2$ | Adjusted $R^2$ | S.E.E. | |
|---|---|---|---|---|---|
| Model summary | 0.874a | 0.764 | 0.754 | 0.235 | |
| ANOVA[a] model | Sum of squares | df | Mean square | F | Sig. |
| Regression | 12.631 | 3 | 4.210 | 75.642 | 0.000[b] |
| Residual | 3.896 | 70 | 0.056 | | |
| Total | 16.528 | 73 | | | |
| | Un-standardized coefficients | | Standardized coefficients | | |
| Coefficients[a] | B | S.E. | Beta | t | Sig. |
| Learners' perception | 0.340 | 0.123 | 0.274 | 2.758 | 0.007 |
| System design perception | 0.462 | 0.138 | 0.374 | 3.337 | 0.001 |
| System content perception | 0.405 | 0.128 | 0.302 | 3.169 | 0.002 |

[a]: Dependent variable: perceived effectiveness of the system; [b]: Predictors: learner's perception, system design perception, system content perception; S.E.E.: Standard error of estimate; S.E.: Standard error

Holsapple and Lee-Post, 2006; Wang *et al*., 2007; Liaw, 2008; Shee and Wang, 2008; Sun *et al*., 2008; Li *et al*., 2009; Ozkan and Koseler, 2009), as described in Table 1.

This study conducted three types of evaluation in order to evaluate the effectiveness of the semantic forum system with three postulated hypotheses:

**H1 :** Learners' perceptions are positively related to the perceived effectiveness of the system in enhancing learners' understanding of the subject.

**H2 :** System design perceptions are positively related to the perceived effectiveness of the system in enhancing learners' understanding of the subject.

**H3 :** System content perceptions are positively related to the perceived effectiveness of the system in enhancing learners' understanding of the subject.

The first evaluation was the main evaluation that was conducted in this study to test all the postulated hypotheses. The objective was to collect online learners' perceptions about system design and system content by using close-ended online survey questions. The analysis includes descriptive statistics and hypothesis testing results from multiple regression analysis.

The second evaluation used open-ended online questions to test two of the hypotheses, with the objective of obtaining more in-depth information about how online tutors' perceptions of system design and system content correspond to the system's effectiveness, as well as soliciting their opinions concerning further improvement of the system. Thus, this second evaluation presents the online tutors' perspectives.

Finally, the third evaluation was conducted by having online learners individually perform predefined tasks in the lab setting. The objective was to observe the experiences of the online learners using the system and to examine them immediately afterward with close-ended online questions concerning their system design perceptions. Descriptive statistics and observation results are presented for this third evaluation. All evaluations were conducted after the learners' interactions with the system either in their own workplace or in the lab setting (third evaluation only). Data from the second and third evaluations are used to substantiate and extend results from the main evaluation findings.

The participants were limited to online learners who had enrolled in the SAD course during a particular semester. The total target population size was 92 learners. However, only 74 online learners responded to the close-ended online survey, the first evaluation after their interactions with the system. This represented an 80% response rate among the participants. Five online tutors with more than 5 years of experience teaching SAD in face-to-face tutorial classes as well as in the online forum participated in the second evaluation. Five voluntarily from the 74 online learners, participated in the third evaluation.

**First evaluation result (close-ended survey):** The results are presented in the form of descriptive statistics

and multiple regression analysis. Based on the descriptive data for each dimension under study, the average mean value for the independent variables, namely, learners' perception, system design perception and system content perception dimension, are 4.25, 4.24 and 4.06, respectively and the mean value for the dependent variable, namely, perceived effectiveness of the system is 4.36.

A multiple regression analysis was carried out to examine hypotheses H1, H2 and H3. The results are presented in Table 2. This analysis was conducted to evaluate whether the independent variables (learners' perception, system design perception and system content perception) are significant predictors of the criterion variable (perceived effectiveness of the system).

The standardized beta value gives the relationship between the criterion variable and each predictor. The results in Table 2 show that the predictors have positive beta values indicating positive relationships. Thus, learners who have a positive learner's perception or a positive perception of the system design or system content or a combination of these will tend to have a positive perception of the effectiveness of the system. The beta value for learners' perception is 0.274, for system design perception it is 0.374 and for system content perception it is 0.302. In this model, all predictors made a statistically significant contribution, with learner's perception, $t(74) = 2.75$, $p<0.05$, system design perception, $t(74) = 3.33$, $p<0.05$ and system content perception, $t(74) = 3.16$, $p<0.05$. The results indicate that system design perception made a greater contribution to perceptions of effectiveness than the other two predictors, with a higher t-value. Therefore, we can conclude that learners positively perceive that the system design is the most effective criterion for enhancing their learning process.

**Second evaluation result (open-ended survey):** The descriptive statistics and multiple regression analysis provide useful information and answers to the hypotheses based on the quantitative data collected. However, there may be aspects that cannot be comprehensively explained using quantitative data alone. Therefore, qualitative perspectives collected through open-ended questions answered by 5 online tutors were taken into account to gain insights in terms of system design perception, system content perception, perceive effectiveness of the system and suggestions for further system improvement.

However, due to lengthy responses from the participants, the results are not presented here. However, the findings from the tutors' indicated that the system's design with concept and relationship organization could help learners to see the larger picture, or the whole of the content that they want to learn. The easy navigation and search features the system offers are crucial for successfully searching and navigating and filtering out irrelevancies, especially when the learning resource grows larger. Tutors perceived that the effort to provide relevant learning material by indicating what is important and needs to be learned is useful to support the understanding and the quality of learning. The tutors also highlighted benefits from the use of prior forum knowledge to help learners in making sense or revising their understanding through the variety of available discussion. Their hope is that this effort should be sustained and the system should be implemented for other subjects as well.

**Third evaluation result (task-based study):** Five online learners were provided access to the system with tasks to be performed individually in laboratory settings. The objective was to observe the online learners' experiences using the system and then examine them immediately afterward with close-ended online questions concerning perceived ease of use. The results from the task-based study supported the main analysis findings with a high mean value for ease of use, which thus makes a significant contribution to perceptions of system design. Observations from the task-based study indicated that the system is easy to use and that learners felt confident in performing the predefined tasks.

## CONCLUSION

The demands made by a course or programme will strongly depend from element of learning support that is delivered. Driven by the demand, this study offer a new way to enhance the learning support through the use of semantic forum system which will benefited not only to the insititution but more to the interest of learners. The evaluation conducted able to indicate that learners and tutors positively perceive that the system is an effective tool to enhance learner's understanding of subject taught. This system integrate the module and forum discussion knowledge and structure it into ontological means through the implementation of semantic web technologies. The system was designed with a concept and relationship organization, variety of search features and easy navigation from concepts and questions can be a valuable means to enhance the learning support delivered. These designed have shape the structure of learning to emphasis on what is important and needs to be learned with continuous content enhancement by subject matter experts. The content provided in the system are only related to subject matter context able to increase learners concentration, accomplish the learning objectives and provide conducive learning environment.

Semantic forum system has made an effort to enrich the knowledge with prior forum discussion knowledge offer an advantage to learners in making

sense with choices of questions and answers available. By then learners can enhance their learning by seeking and developing their own understanding to be more reflective and critical especially when they are required to manage their own learning pace. In addition, the effort contributes to offer learning content in advance so that learners are better prepared to learn right after course enrolment until completion. Furthermore the effort significant to create the interest to engage active participation from tutors or learners by giving recognition or acknowledgement that their postings will be retain for future learning or discussion and might be recommended by other learners as best reflect their understanding. Future efforts for continuous learning enhancement support can deliver the system in a way that matches the preferred learning style of the learners by varying the sequentialization of content elements or in a way that matches diverse teaching strategies such as game base learning, simulation, role playing and case study.

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