

## Designing And Building An Adaptive Online Quiz System As Extension Of Content Management System

Arief Hidayat  
Department of Information System  
STMIK PROVISI  
Semarang, Indonesia  
Email : [rifmillenia@gmail.com](mailto:rifmillenia@gmail.com)

Bayu Surarso and Aris Sugiharto  
Department of Information System  
Postgraduate Program,  
Diponegoro University  
Semarang, Indonesia  
Email : [aris.sugiharto@undip.ac.id](mailto:aris.sugiharto@undip.ac.id)  
Email : [bayus@undip.ac.id](mailto:bayus@undip.ac.id)

**Abstract**—This paper discusses a web-based quiz system with adaptive features which are added. This paper focuses on the major components of adaptive features and techniques to implement the adaptive component. Adaptive quiz system consists of three main components: student model, domain model and adaptation model. The student model describes the student's knowledge, and the domain model is the domain of student teaching, while the adaptation model consists of a set of rules that define the user action. This adaptive quiz system becomes a system of student assessment based on skills, knowledge and preferences of each learner.

**Keywords** : Online Quiz; Adaptive; Student Model; Domain Model; Adaptation Model

### I. INTRODUCTION

Assessment is often being used to measure the student performance [1]. Alotaiby and Chen [2] describes assessment as one of the major component that help student in learning. Quiz, which serves as a type of assessment [3] is the most widely used and well-developed assessment method in higher education [4].

Although online quizzes provide many advantages, perhaps the most beneficial value of online quiz is that it allows student to take quiz at anytime and place, without any restriction. However, by using the web as a medium to take quiz does not really add a significant value to the student's learning process. The new revolution in quiz needs to address an important issue of enhancing the students learning process, rather than only act as a medium of the quiz revolution technology. It is postulated that one of the main problem with online quiz, is the lack of a significant value called 'Personalization'. Without personalization, the system treats all the students in the same manner. Personalization which required the system to adapt to the student's need automatically is called 'Adaptive' [5]. With adaptive capability the system decides which option is the best for the user based on their user model. Adaptive systems keep on track the user's pattern activity and try adjusting the interface

or content that is suitable for different user with different skills, knowledge and preferences [6].

Adaptive is often confused with adaptable. Adaptable allow the user to control the adjustments [6] by allowing the user to customize the system according to his or her own needs [7]. Whereas adaptive is a feature used to measure the learners current level of domain competence [7]. A system is called adaptive if it is able to change its own attributes automatically to suit to the user's needs [8].

Today the creation and management of a website will be further facilitated by the framework Content Management System (CMS). Joomla core program functionality can be added by installing the extension of the CMS application is appropriate. The application can be components, modules or mambots.

This paper will discuss the design and construction of an online quiz system to accommodate an assessment system based on ability, knowledge and preferences of each learner, which can be used as an extension of Content Management System

### II. COMPONENT OF ADAPTIVE SYSTEM

Benyon and Murray's [9], have introduced three main components of adaptive (based on the architecture of adaptive systems) as listed below:

- User model – represents who is being taught (e.g: students, learners)
- Domain model – represents the domain being taught (the subject matter)
- Adaptation model – represents how to teach the user

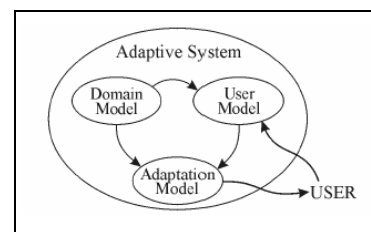


FIGURE 1. MODULES OF AN ADAPTIVE SYSTEM [10]

Figure 1 shows the relationship between the three components of adaptive at which all adaptation is done through the user model. Adaptation is solely depends on the quality of information stored in the user model. Thus, it requires the user's information to be updated accordingly in order to get user's actual level of knowledge [10].

#### A. Domain Model

Generally, domain model is described as below:

- “a framework for representation of the user's domain knowledge” [11].
- represents knowledge about the teaching domain or knowledge representation of the student model [12].
- contains the knowledge to be transmitted to the student [13].

Since the user knowledge is often referred as a subset of expert knowledge, the user knowledge is also said as a subset of domain knowledge. In other words, the user knowledge is an overlay over the domain knowledge [12].

One method commonly used to represent domain model is Semantic Network, Semantic Networks are excellent knowledge representation structures” [14]. It consists of a set of nodes and a set of links. Node is used to represent the concept or the real-world objects and link is used to represent the semantic relationship between the concept and the objects. According to Feng et al. [15], semantic network model consists of four components: a set of nodes, a set of directed edges or links, a set of labels, and a set of constraints.

#### B. User Model

According to Koch [16], user model is information about user. “Without the user model, the system could not distinguish between the different users and would treat all users in the same manner” [10]. Users are different in many ways such as having different background, experiences, knowledge, preferences, interests and etc. Thus, user model is needed for a system to make a selection of responses to individualize and personalize the user [16].

One common method for developing a user model or student model, namely the overlay model and the stereotypes. Overlay model presents the user's knowledge as a subset of the system's knowledge. Overlay is the most frequently technique used for modeling student [17] and it is often used to measure the knowledge level of students [18].

The problem to initialize individual user model or group modeling is often solved by implementing stereotypes technique [19]. A stereotype is actually a powerful technique [19] and it is widely used in user modeling [20]. A stereotype is made up of common attributes of users group which is normally describes the users interest [12]. Each stereotype has its own

predefined properties, and the user which is assigned to those stereotypes inherits its properties [12].

#### C. Adaptation Model

The adaptation model defines the following in the system [21]:

- What can be adapted
- When to be adapted
- How it is to be adapted

Therefore, to answer “What can be adapted”, the adaptation model may consist of information as below [22]:

- which questions should be considered easy or hard,
- grades to interpret the learners knowledge,
- how many questions are necessary to estimate the learner's knowledge with confidence, and
- how is the learner's performance going to affect the learner model such as try attempt, student request for hints.

To answer “When to be adapted” and “How to be updated”, it requires the adaptation to perform additional processing. In other words, the adaptation cannot be done, by storing and retrieving events or data directly from database [23]. Therefore, the adaptation model consists of a set of rules that defines the user action and also the trigger action which define the results from the user action, which later on need to be updated in the user model [24].

### III. RESULT AND DISCUSSION

#### A. Domain Model of Adaptive Online Quiz System

Domain Model represents the subject being taught, domain model is used to provide the structure of the implementation of the adaptive online quiz system. Domain knowledge is developed based on the subject being taught to student such as Introduction of Information Technology, Operating Systems, Data Structure, and soon. The adaptive online quiz system support all kinds of subject from the semester. Each of the subjects for the particular semester such as Introduction of Information Technology for semester 1, Operating System for semester 2, and Data Structure for semester 4 is considered as different domain knowledge. As such, the adaptive online quiz system allows many domain knowledge to be created in the system.

The structure of the domain knowledge is created based on the structure of student's book (subject) for the college. However, in order to support for all types of structure of the college's domain knowledge, this research defines the generic structure as follows as shown in Figure 2:

- Semesters in the college, refers to odd or even.
- For each of the semesters, it may consist of at least one or many subjects.

- For each subject it may consist of at least one or many chapters

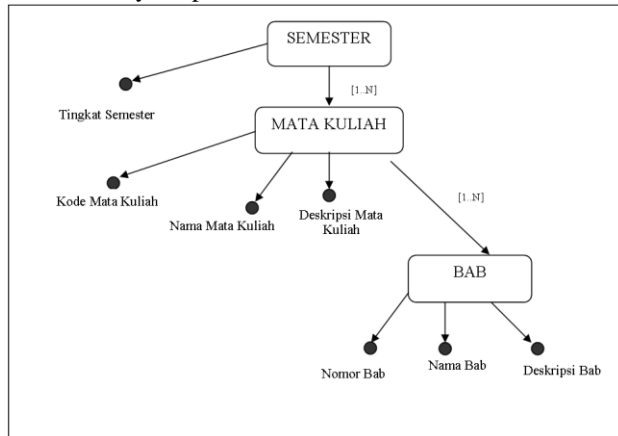


FIGURE 2. SEMANTIC NETWORK FOR THE ADAPTIVE ONLINE QUIZ SYSTEM

The implementation of domain model has been transformed into use cases. As a result, there are three main use cases being identified to develop the domain model, which are: ‘maintain semesters’, ‘maintain subjects’, and ‘maintain chapters’.

#### B. Student Model of Adaptive Online Quiz System

User model represents the system belief about the user in which it describes the user’s knowledge. For user model is referring to the student model. Student model describes the student knowledge of the domain model. With student model, the system treats different manner for each student. Student model contains all information that the system knows about the students. In order to develop the student model, there are two kinds of information required which is static and dynamic information. Static information may contain the student profile such as student name, address, identification number, gender, student semester and contact number. The dynamic information may contain the information about the user interaction with the system such as student current level of difficulty knowledge and student history level of difficulty knowledge, date of quiz taken, score of the quiz and the subject of quiz taken. To capture the static and dynamic information, the Overlay Model and Stereotype techniques have been chosen.

Student knowledge is described through the domain knowledge, using an overlay model. In Qualitative measurement of Overlay Model, the user’s knowledge weighted is measured based on the concept-value as a set of pairs. The content or topic of the domain knowledge is considered as a ‘Concept’ and the result of each student’s achievement of the chapter is considered as a ‘Value’. For each of the ‘Concept’, this research allows more than one ‘Difficulty Level’ to be created, but researcher use only the difficulty level 1 to 3, the higher difficulty level means the higher the

questions’ difficulty, is determined by the teacher. Figure 3 shows Student Overlay Model for the adaptive online quiz system.

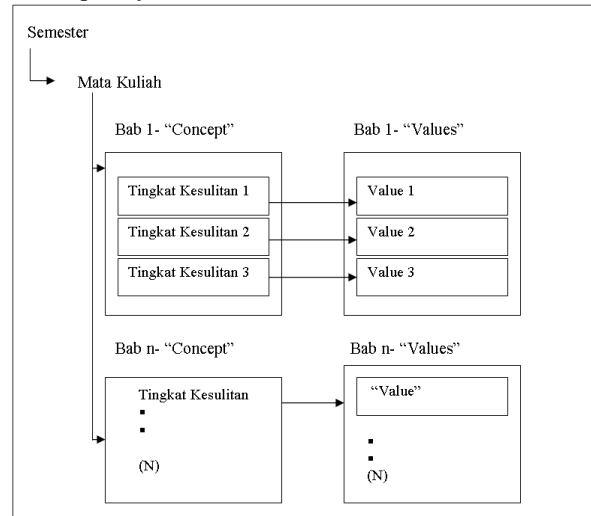


FIGURE 3. STUDENT OVERLAY MODEL FOR THE ADAPTIVE ONLINE QUIZ SYSTEM.

For the adaptive online quiz system, this research uses stereotype for grouping student based on the common criteria of the student’s model. There are two types of information need to be captured in order to apply the stereotypes technique:

- The system must know the student’s the information, attribute or property to capture the stereotypes.
- What scenario, events or behavior that reflects the stereotypes.

In order to implement stereotype technique, the attribute to capture stereotypes are defined as below:

- 1) *The student’s semester*
- 2) *The subject taken by the student*
- 3) *The latest level of difficulty domain knowledge (including chapter and difficulty level)*
  - a) *If the student is the first time user of the quiz, the latest level of domain knowledge is defined by pre test.*
  - b) *Else, the latest level of student knowledge is referred to the last taken quiz*
- 4) *The student score in the latest difficulty level of domain knowledge*

Based on the attribute captured, the teacher is required to set the condition rules that reflect particular stereotypes. The groups of the stereotype for the students change depending on the score they got. They may fall under a beginner’s group for the first time access quiz and later move on to advanced group student after taking more quizzes. For instance, a semester 1 student who takes Introduction of Information

Technology and gets 70, the system searches the rules that match the conditions. For example,

- if the student's score fall in the range of 1 to 49, the student is considered as a beginner
- if the student's score fall in the range of 50 to 74, the student is considered as intermediate student
- if the student score above 75, the student is considered as an advanced student.

The implementation of student model has been transformed into use cases. As a result, there are three main use cases being identified to develop the student model, which are: 'maintain student profile', 'student take quiz', and 'student history result quiz'.

### C. Adaptation Model of Adaptive Online Quiz System

For adaptation model, this research applies the IF-THEN rules. It takes the rules form of IF<condition> THEN<action> rules, whereby

- <condition> is referred to the student's knowledge level from the student model
- <action> is referred to the result change in student's knowledge level that reflects to the next level of the difficulty of the domain knowledge. The next level can be, whether the student move to the higher level, stay in the same level or move to the lower level of the domain knowledge

The <condition> and <action> are the rules defined by the teacher. The <condition> and <action> works in pair. For each <condition>, it has only one <action>. Based on this <condition>, the system search for the matched <action>. The <condition> is determined by the student's latest result (scores), together with the latest chapter and the difficulty level of the domain knowledge. Whereas the <action> is used to determine the next recommended difficulty level and chapter of the domain knowledge based on the certain range of score define by the teacher. Figure 4 shows example of adaptive rule.

Rule Name: Rule 1	
Conditions:	<ol style="list-style-type: none"> <li>1. When student is at level ____</li> <li>2. When student has score ____</li> <li>3. When student has knowledge level ____ at the topic ____</li> </ol>
Actions:	<ol style="list-style-type: none"> <li>4. Set the knowledge for section topic's ____</li> <li>5. Move to section ____</li> <li>6. Move to level ____</li> </ol>
Description:	<ol style="list-style-type: none"> <li>7. When a student has score between 80-100 and</li> <li>8. When a student is at level 3</li> </ol>
THEN	<ol style="list-style-type: none"> <li>9. Move to Section XYZ – question</li> </ol>
Trigger Point	<ol style="list-style-type: none"> <li>10. Trigger point is: Introduction (section) questions no 1</li> </ol>

FIGURE 4. EXAMPLE OF ADAPTIVE RULE

The implementation of adaptation model has been transformed into use cases. As a result, there are

eight main use cases being identified to develop the adaptation model, which are: 'quiz configuration', 'maintain difficulty level', 'maintain question', 'display current and next difficulty level', 'perform quiz', 'perform feedback', 'select questions', and 'maintain rules'.

### D. Implementation of the Adaptive Online Quiz System

The adaptive online quiz system started when the student successfully login to the system and subsequently take a quiz by clicking on the Take Quiz' hyperlink. Next, the student is required to choose the subject that he or she wants to take the quiz and click on the button 'Current Difficulty Level' to know their latest level of the selected domain knowledge. At the same time, the system displays the next recommended difficulty level of knowledge for the student to take. The next recommended level is displayed based on the rules defined by the teacher. Upon accepting the level and clicking the button 'Take Quiz', the system displays a set of questions according to the recommended level. Student is required to answer all questions displayed. After submitting the answers by clicking the 'Submit' button, the system does the following process:

- validates the student answer with the correct answer
- calculate the student's scores
- based on student score, time and the current difficulty level, get the next recommended difficulty level of domain knowledge based on the rules defined by the teacher
- saves the student's record in the database
- Provides the student feedback information such as score, total correct answer, total wrong answer, and so on as shown on figure 5.

<b>Kuis</b>	
Hasil dari kuis yang telah dikerjakan :	
Bab	: Bab 1 - Pengenalan Komputer
Level	: Level 1
Jawaban Benar	: 5
Jawaban Salah	: 5
Nilai	: 50
Soal yang terjawab salah :	
No.	Pertanyaan
1	Kecepatan pemrosesan komputer mainframe lebih tinggi dibandingkan mikrokomputer Jawaban Benar : Salah
2	Pemrosesan adalah manipulasi berupa perubahan data oleh komputer menjadi informasi Jawaban Benar : Benar
3	_____ adalah mesin elektronik yang menerima data lalu memrosesnya menjadi informasi Jawaban Benar : komputer
4	_____ adalah jaringan yang meliputi seluruh dunia yang menghubungkan ribuan jaringan lebih kecil. Jawaban Benar : internet
5	Teknologi _____ menggabungkan komputasi dan komunikasi berkecepatan tinggi Jawaban Benar : informasi

FIGURE 5. THE FEEDBACK SCREEN

Next, if the student decides to take another quiz, the same process above is repeated. The process would only end, if the student reaches the highest level defined

by teacher or the student logs out from the system Figure 6 shows latest recommended difficulty level of student knowledge screen.



FIGURE 6. LATEST RECOMMENDED DIFFICULTY LEVEL OF STUDENT KNOWLEDGE SCREEN

#### IV. CONCLUSION

By implementing Adaptive Questions technique, a dynamic sequence of questions is generated depending on the student's responses. In other words, the student answer determines the next series of the questions. The process to determine which questions to trigger next, is setup by the teacher. Therefore, adaptive questions techniques are a highly structured quiz, setup by the teacher which implements the concept of IF <condition> THEN <action> rules. In addition there are three main model involved in order to implement the adaptive quiz which are student model, domain model and adaptation model. Student model is a model that keep all the student information, domain model is a knowledge representation of the student model and the adaptation model is a model that consists of a set of rules that defines the user action and triggers that defined the results from the user action which later on need to be updated in the student model.

The researcher recommends the addition of the features of this adaptive quiz system to improve the functionality of this system such as adding support for questions or answers in the form of drawings or special symbols, student result history should be presented in graphical for easier interpretation, and support to load a batch of questions instead entering the question one by one.

#### REFERENCES

- [1] Quinn, D.; & Reid, I. 2003. *Using Innovative Online Quizzes to Assist Learning*. <http://ausweb.scu.edu.au/aw03/papers/quinn/paper.html>. Retrieved 27 April 2010.
- [2] Alotaiby, F.T.; & Chen, J. X. 2005. *Generic Summative Assessment Functional Model*. IEEE.
- [3] QuestionMark; & League. 2004. *An Assessment Framework for the Community College*. <http://www.league.org/publication/whitepapers/files/0804.pdf>. Retrieved 27 April 2010.
- [4] Brusilovsky, P. 2003. *Developing Adaptive Educational Hypermedia Systems: from Design to Authoring Tools*. <http://www2.sis.pitt.edu/~peterb/papers/KluwerAuthBook.pdf>. Retrieved 6 April 2010.
- [5] Santally, M. I.; & Senteni, A. 2005. *Adaptation Models for Personalization in Web-based Learning Environments*. <http://72.14.235.104/search?q=cache:0lBXmKxULEwJ:pppjj.us.m.my/mojit/articles/pdf/April05/01-Santally-revised-typeset.pdf+adaptation+santally+models&hl=en&ct=clnk&cd=1&gl=my>. Retrieved 12 Mei 2010.
- [6] Kules, B. 2000. *User Modeling for Adaptive and Adaptable Software Systems*. <http://www.otal.umd.edu/UUGuide/wmk/>. Retrieved 25 April 2010.
- [7] Cheng, Q. & Kinshuk. 2004. *Application of Adaptivity in Quiz Systems*. [http://www.col.org/pcf3/Papers/PDFs/Cheng\\_Kinshuk.pdf](http://www.col.org/pcf3/Papers/PDFs/Cheng_Kinshuk.pdf). Retrieved 26 April 2010.
- [8] Weibelzahl, S. 2002. *Evaluation of Adaptive Systems*. [http://www.idemployee.id.tue.nl/g.w.m.rauterberg/amme/weibelzahl\(2002\).pdf](http://www.idemployee.id.tue.nl/g.w.m.rauterberg/amme/weibelzahl(2002).pdf). Retrieved 24 April 2010.
- [9] Benyon, D. R. and Murray, D. M. 1993. *Adaptive systems; from intelligent tutoring to autonomous agents*. Knowledge-Based Systems, 6(4), 197–219.
- [10] Kavcic, A. 2001. *Enhancing Educational Hypermedia: Personalization through Fuzzy Logic*. <http://72.14.203.104/search?q=cache:XX6MZ9lh1B4J:lgm.fri.uni-lj.si/~alenka/papers/Cost2001.pdf+Enhancing+Educational+Hypermedia:+Personalization+through+Fuzzy+Logic&hl=en&gl=my&ct=clnk&cd=1>. Retrieved 27 April 2010.
- [11] Brusilovsky, P. 2003. *Developing Adaptive Educational Hypermedia Systems: from Design to Authoring Tools*. <http://www2.sis.pitt.edu/~peterb/papers/KluwerAuthBook.pdf>. Retrieved 6 April 2010.
- [12] Kavcic, A. 2000. *The Role of User Models in Adaptive Hypermedia Systems*. IEEE.
- [13] Pena, et al. [Pena, C., Marza, J. & Rosa, J]. 2004. *Curriculum Sequencing for An E-Learning Systems based on Learning Styles*. IEEE.
- [14] Geller, et. al [Geller, J., Perl, Y., Halper, M., Chen, Z. & Gu, H.]. 2002. *Evaluation and Application of a Semantic Network Partition*. IEEE.
- [15] Feng, et al. [Feng, L., Chang, E., Dillon, T.]. 2002. *A Semantic Network-Based Design Methodology for XML Documents*. ACM Transactions on Information Systems.
- [16] Jeremic, et al. [Jeremic, Z., Devedžic, V. & Gasevic, D]. 2004. *An Intelligent Tutoring System for Learning Design Patterns, Proceedings of the Workshop on Adaptive Hypermedia and Collaborative Web-based Systems (AHCW'04) at the 4th International Conference on Web Engineering*.
- [17] Ozdemir, B & Alpaslan, F. N. 2000. *An Intelligent Tutoring System for Student Guidance in Web-based Courses*. IEEE.
- [18] Tsiriga, V. & Virvou, M. 2002. *Initializing the Student Model Using Stereotypes and Machine Learning*. IEEE.
- [19] Elsevier. 2004. *Four Approaches to User Modeling—A Qualitative Research Interview Study of HCI Professionals' Practice*. [http://www.sciencedirect.com/science?\\_ob=ArticleURL&\\_udi=B6V0D-4CG0W02-1&\\_user=152948&\\_coverDate=08%2F31%2F2004&\\_rdoc=1&\\_fmt=&\\_orig=search&\\_sort=d&view=c&\\_acct=C000012678&\\_version=1&\\_urlVersion=0&\\_userid=152948&md5=cf2d3caa6b38260c696a120fbd8f7be4](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V0D-4CG0W02-1&_user=152948&_coverDate=08%2F31%2F2004&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000012678&_version=1&_urlVersion=0&_userid=152948&md5=cf2d3caa6b38260c696a120fbd8f7be4). Retrieved 2 Mei 2010.
- [20] Paramythis, et al. [Paramythis, A., Loidl-Reisinger, S. & Kepler, J.]. 2004. *Adaptive Learning Environments and e-Learning Standards*. The 3rd European Conference on e-Learning presented on 25-26 November 2004.
- [21] Lalos, et al. [Lalos, P., Retalis, S. & Psaroniligkos, Y.]. 2005. *Creating Personalised Quizzes Both to the Learner and to the Access Device Characteristics: the Case of CosyQTI*. A3EH: Third International Workshop on Authoring of Adaptive and Adaptable Educational Hypermedia July 19, 2005 at AIED'05.

- [22] De Vrieze, et al. [De Vrieze, P. T., Van Bommel, P., Van Der Weide, Th.P.]. 2004. *A Generic Engine for User Model Based Adaptation*.  
<http://citeseer.ist.psu.edu/cache/papers/cs/32875/http:zSzzSzwww.cs.kun.nlzSzresearchzSzzSzreportszSzfullzSzNIII-R0423.pdf/devrieze04generic.pdf>. Retrieved 26 April 2010
- [23] De Bra. 2001. *AHA! Adaptive Hypermedia for All, Project Proposal*.  
<http://www.nlnet.nl/project/aha/200106-aha-proposal.html>. Retrieved 26 April 2010.