System framework for an intelligent question bank and examination system

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System Framework for an Intelligent Question Bank and Examination System

S. Janpla and P. Wanapiron

***Abstract*—This documentary research purposed to design the System Framework for an intelligent question bank and examination system. It was divided into three periods: (1) the synthesis for functions in the question bank system; (2) design of the system framework for an intelligent question bank and examination system; (3) to evaluate the appropriateness of the system framework for an intelligent question bank and examination system. A content analysis was applied to analyze the data. The results found that:**

1. The question bank system consisted of five modules: 1. User Management, 2. Question Management, 3. Examination Management, 4. Evaluation Management and 5. Scoring Management.

2. The system framework of the question bank system consisted of three parts: 1. Relevant persons for the question bank system: teachers, students, and administrators; 2. Framework of the question bank system consisted of five main modules and 15 sub-modules: 1. User Management: 1.1 Login, 1.2 Edit Profiles, 1.3 Set Permission. 2. Question Management: 2.1 Item Management, 2.2 Setting Item, 2.3 Classification Machine Learning. 3. Examination Management: 3.1 Setting Examination, 3.2 Monitoring Examination, 3.3 Select Item Machine Learning. 4. Evaluation Management: 4.1 Evaluation Examination, 4.2 Suggestions, 4.3 Prediction Machine Learning. 5. Scoring Management: 5.1 View Scores, 5.2 View Item Statistics, 5.3 Export Scores and 3.NUMBER? Cloud Computing.

3. The evaluation of the appropriateness of the intelligent question bank system and examination system was checked by five experts regarding the question bank system and machine learning. Statistics used in this research were the mean and standard deviation. The results found that the rate of this framework was in "the most appropriate" (overall mean was 4.70 and S.D. was 0.50.).

***Index Terms*—Artificial intelligence, framework, question bank system, machine learning.**

I. Introduction

Nowadays, ICT and communication have rapidly developed and there are many communication networks, such as the Internet network in the house, mobile phones, and the workplace, as well as networks for education in fiber optics, LAN, wireless LAN and 3G or 4G mobile phones, through which everyone can access to the news, ICT and communication. Information Technology has become to play a vital role in life, especially for education. ICT has become the necessary resource, which the teacher needs to acknowledge modern news because the teacher is a facilitator to develop students so that they can have the skills to search from several resources then applies them to their daily life. ICT is in a part of the learning activities, which enhance the access to resources for the students. It is also a way to connect teachers and students. They can hand in homework to teachers by using the Internet, do the online examination, which the teacher can check and then give feedback to them. It is another way for teachers and students to communicate. Moreover, Thailand applies electronics to education, such as e-learning, e-library and e-testing. In conclusion, ICT and communication are necessary to learn. Everybody can acknowledge the news in order to expand the world of learning.

Whether learning processes will accomplish learning, depends on the assessment and evaluation processes. Both of them need to work with objectives, contents, and instruments for education. These processes purpose to notice the progress of learners and their learning efficiency. As a result, testing is an important instrument to identify them.

There are varieties of education assessment and evaluation instruments. Mostly, the teacher always uses these instruments, such as choosing certain answer tests: the True-False test, Matching Test, Multiple Choice Test and completion or short answer test. Each teacher needs to create the tests to assess and evaluate their students' proficiency. Most of them will be concerned with the validity of content and objectives. However, they do not tend to analyze the tests to choose some good test items to assess and evaluate the students' proficiency.

The question bank system will choose the test items, which are checked in quality to create the question bank system in order to be the repository for examination. Some test items will be collected, and then will be chosen to be in the text. Next, this system will use its scoring result to improve the examination and it collects test items. The question bank system can reduce the duration to produce test items. As a result, it is an advantage for education: for example, there are some good test items, which enhance their standard and reliability. Artificial intelligence will separate test items in many categories according to their difficulty. Moreover, it can choose test items to create tests according to learning objectives.

Artificial intelligence (AI) is a technology, which imitates many skills of human wisdom to a computer, such as being experts. Nowadays, there are few experts in specific things. Artificial intelligence can solve this problem. Moreover, this intelligence is necessary to daily life. People use instruments and applications, which are based on AI principles, such as household equipment: automatic vacuum cleaners, lawnmowers and applications on Smart phones, the Internet,

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autonomous cars, robots and abilities for decision-making and solving problems, which are equal to humans' proficiency. Their main core is called machine learning that is like the brain of AI.

Machine learning is defined as applying the computer to imitate students' learning by using learning algorithms of machine learning, in order to predict the results a decision to continue the processes. Computers can acknowledge the situation, which is based on learning. The accuracy rate of the decision is suitable. The prediction of the result and decision will be better according to the new resources.

Creating a question bank system to use in the evaluation of the results needs to be developed. Good test items will be designed according to objectives, which are reliable and flexible. In particular, this system can adjust and choose the items from objectives. Furthermore, it can also analyze students from each question and improve the test to be suitable to each student. After the test, it will give the students' strength and weakness.

A framework is a way to develop an ICT system by a logical design, which will identify the overall connected system to analyze the sub functions and other details. An intelligent question bank system will illustrate the idea to develop the system, which combines the question bank system and machine learning to create an intelligent question bank system.

Learning process evaluation is an important step because it can access learners' efficiency clearly in order to access learners' capacity as well as learning result. Evaluation is an instrument to develop learners. Scoring will show qualitative data about learners' achievement and it can compare to the other learners in order to evaluate achievement and give advice effectively. As a result, evaluation is a basis for educational decision such as curriculum evaluation, learners' efficiency evaluation and teaching processes evaluation. Knowing about learners' fault in their examination will prepare teachers to correct their fault. In addition, examination is an educational determination to test learners' capacity. However, creating exam database is time consuming in each semester. Therefore, intelligent question bank is a new and important approach which can design, manage and evaluate learners' achievement because of the rapid development of computer and internet. Intelligent question bank will support learners' evaluation so this system will help examination to become effective.

To solve the previous problem, machine learning in question management will apply to intelligent question bank and examination system to classify the examination item automatically. Bloom's Taxonomy of Learning Domains, including Cognitive Domain Remembering; Understanding; Applying; Analyzing; Evaluation and Creating, is used in classifying steps. This classifying step supports teacher to prepare the examination and teacher can determine to choose the items in each group or to set the match system to select the items automatically in order to enhance the efficiency of learners' evaluation. In module: examination management uses machine learning system to choose the appropriate items to test students. If teacher decides the machine learning system to choose items automatically, the system will select the items according to 6 groups of Bloom's Taxonomy and it also analyzes the learners' answers automatically what group do they answer the most correctly and the least correctly. In module: Evaluation management will use machine learning system to predict result and suggest recommendation. When learners finish their examination, this system will give suggestion by analyzing from learners' answer. They can know what lesson they have to improve. As a result, the researchers present system framework for an intelligent question bank and examination system in order to be the approach to develop the system.

II. Literature Review

A. Question Bank System

The question bank system is the set of test items, which are created according to the statistical data from students' scoring results, in order to be the instruments to evaluate specific factors. It is also flexible, and can be adjusted to the examination to reduce the duration during the test. Moreover, it can choose some reliable test items to create some sub-test items, in order to apply to the test on computer or paper version [1]-[3].

B. Artificial Intelligence Technology

Artificial intelligence technology is the imitation of human wisdom in the computer, in many functions, such as mental ability, reasoning, understanding, imagination, perception, recognition, creativity, and emotion. This technology programs the computer to do as humans can do. In this case, the computer can be the expert because there are few specific experts. This technology will solve this problem effectively. [4], [5].

C. Machine Learning

Machine learning is defined as applying a computer to imitate human learning by using a learning algorithm of machine learning to predict the result, or to continue the decision. The computer can acknowledge the actual situation in order to decide effectively. Prediction of the result will be better according to the new data. Learning algorithms can be divided according to learning processes into four types: supervised learning, unsupervised learning, semi-supervised learning and reinforcement learning [6], [7].

D. Related Works

Ref. [8] developed an adaptive assessment system to compose serial test sheets using item response theory. They presented approach to show the quality of examination items by creating examination which could be used according to criteria in e-learning system. It required formative assessment, so the examination could be the challenge for students. Deciding appropriate examination items was important for producing questionnaire in many criteria such as difficulty degree, discrimination degree, frequency of opening the examination, choosing examination behavior, evaluation and finishing the examination. It depended on item response theory and education theory.

Researchers presented adaptive assessment system to produce examination database. This approach could enhance the efficiency of choosing the items in series according to the multiple criteria. Using computer-assisted testing system would reduce the barrier of creating examination and

improve the quality of evaluation which was the important part and new trend of education. Multiple assessment criteria were the formula of serial test sheets and approach to create serial test for continuous evaluation according to multiple criteria. Qualification of examination items in item bank system could be adapted and changed dynamically by considering to the students' learning

Ref. [9] developed intelligent examination system to support teacher's reflection measurement of learners' guided feedback. It purposed to present Intelligent Examination Framework (I-EXAM) which will give suggestion to learners immediately during multiple choices examination. Teacher could notice learners' doing examination and evaluate their efficiency by using Visual Suggestion Refinement Tool (VSRT) This tool used Data Mining Techniques which facilitated teachers to analyze the overall view to specific detail of learners' activities. It could enhance efficiency of idea and give suggestion according to learners' demand. Examining the processes and analyzing learners' behavior by using data mining and visualization techniques to support teachers in web-based educational system.

Visual Suggestion Refinement Tool (VSRT) would suggest and advice to teachers; for example, this item is too easy, this item is too difficult. Giving feedback might not be effective. Some learners misunderstood. As a result, VSRT could facilitate teachers to know problems then improve. They could use these suggestions then record to the e-learning database in order to improve and add more feedbacks or change the feedback to be more specific or improve content in e-learning by changing the steps of activities.

I-EXAM would help teachers to know learners' behavior during online examination by monitoring data via diagnostic visual tool. Teachers could analyze the overall view into the detail of learners' activities. Moreover, they could evaluate giving feedbacks during examination by using Data Mining Techniques.

Ref. [10] developed integration of machine learning approach in item bank test system which was the process of categorizing examination items by using automatic Support Vector Machine. Categorizing examination items according to Bloom taxonomy needed to create the model from training data and test data in order to evaluate the accuracy of categorizing the items.

This research used the efficiency of machine learning module and the previous item bank system in order to integrate to web-based learning management system, intelligent tutoring system and the other systems which had the elements of online evaluation to learners' achievement. Learners could apply this module because e-learning system could change into specific learning. As a result, Bloom Taxonomy was important to the examination for cognitive level of learners.

According [11], an Adaptive Web-Based Intelligent Tutoring System is used for analysis student's programming skill by using Mastery Learning, Logistic Regression and rule-based techniques. The models were conduct to classify and suggest student's learning for each student according to student's performance.

III. Research Processes

The research processes were divided into three periods according to research objectives.

The first period was to analyze the functions of the question bank system by learning data about analyzing the functions of the question bank system. The researcher studied some documents then performed the content analysis and synthesis of 13 related research works from 2012-2017.

TABLE I: Synthesis of the Modules of the Question Bank System

Module of the question bank system	01-Prashant K Gupta, 2012 [12]	02-Kavitha Rajamani, 2013 [8]	03-Essam Kosba, 2013 [9]	04-Peng Lu, 2014 [13]	05-Piya Thirapanmethee, 2014 [14]	06-Mei-Hui Wang, 2014 [15]	07-Eman Khater, 2015 [16]	08-Yan Cong, 2015 [17]	09-Nongnuch Ketui, 2016 [18]	10-Anbuselvan, 2016 [10]	11-Jun JI, 2016 [19]	12-S .O .Kuyoro, 2016 [20]	13-Michael Ajinaja, 2017 [21]
User Management	✓			✓	✓		✓	✓	✓		✓	✓	✓
Course Management	✓									✓		✓	✓
Question Management	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Examination Management	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
Evaluation Management	✓	✓	✓	✓	✓	✓	✓		✓				
Analysis Management		✓			✓	✓	✓		✓				
Scoring Management	✓	✓	✓				✓	✓	✓		✓	✓	✓
Answer Storage Module	✓		✓		✓								
Suggestion Module			✓										
Test Paper Generator								✓		✓			
Item or Question Generator		✓								✓			
System Management							✓	✓			✓		
Intelligent or Adaptive Test			✓				✓	✓		✓			

According to Table I, we found that the question bank system consisted of five modules: user management, question management, examination management, evaluation management and scoring management.

The second period was the design of the system framework for an intelligent question bank and the examination system.

This system was designed by using machine learning. It also applied logical design to get the suitable intelligent question bank system framework. This framework combined some ideas of the framework program development of the question bank system and machine learning.

The third period was to evaluate the appropriateness of the system framework for an intelligent question bank and examination system, which were the processes used to evaluate the appropriateness by using experts in the question bank system and machine learning for the intelligent question bank system for five experts.

IV. Results

A. The First Period: The Result of Synthesis the Module of the Question Bank System

Applying research works to synthesize the module of the question bank system is shown in Table I.

B. The Second Period: System Framework for an Intelligent Question Bank and Examination System

The system framework for an intelligent question bank and examination system can be divided into 3 parts: 1) Relevant persons for the question bank system; 2) Question bank system framework; 3) Cloud computing, as shown in Fig. 1.

TABLE II: Relevant Persons for Intelligent Question Bank System

Relevant persons for question bank system	Responsibility
1. Teachers	-design the test -improve the test -view the statistics data of the test -determine the examination of the test
2. Students	-do online test which is created from question bank system -check the result of the test -check the suggestion from the test
3.System administrators	-manage user accounts -determine users 'permission -manage the other works

1) Relevant persons for the question bank system

Relevant persons for the question bank system consisted of three groups, such as teachers, students, and system administrators. Each group had different responsibilities as shown in Table II.

2) Question bank system framework

Question bank system framework consisted of main modules and sub-modules as shown in Table III.

3) Cloud computing

Cloud computing is a computer system or computer resource service, as well as using a processing unit, memory unit, storage unit and online system for the user UNCLEAR. This evaluation can reduce the difficulty in the installation, monitoring of system, and can reduce the time and budgets in creating computer and network systems. This system uses resources by using the Internet network. It is the processing method according to users' demand. Users can identify the demand for Cloud computing system software. Later, software will require the resource management system according to users' demand. Anyway, this system can increase and decrease the amount of resource, as well as offer the service according to the users' demand. They can access the system data by using the Internet and manage resources in the network. If the users' demand increases, they can buy additional services to enhance the efficiency of the system. They do not upgrade the system and computer. It can reduce the budget and difficulty in management and system monitoring [22]. Applying an intelligent question bank and examination system to Cloud computing can reduce the budget, time, and difficulty in IT management because users do not need to buy hardware, software, software updates, which are expensive and have long-time maintenance. When the demand increases, for example, the number of user's increases, the evaluation will be better. If we want to increase the storage space, it is easy to add and extend your Cloud resources.

Fig. 1 is shown the system framework which consisted of these detailed by following:

Peoples: Administrators are able to manage the overall system. Their responsibilities are to determine the right to users such as upload users and teacher, to determine the access of students, teachers, maintain system, monitoring system, backup system and database to this system.

The duties of teachers are to manage, insert, delete, improve and arrange the test. They can specify the test and choosing the items of test as teachers wish.

TABLE III: Main Modules and sub-Modules of Question Bank System

Main modules	Sub modules	Responsibility
1.User Management	1.1 Login	Users accessing the system need to add correct username, password, and they need to sign up before login to the system.
	1.2 Edit Profiles	Users can edit their profiles, such as changing the password, email, profile picture.
	1.3 Set Permission	Set permission to each type of user, such as: student, teacher or administrator
2.Question Management	2.1 Item Management	Manage test items: add, delete and correct
	2.2 Setting Item	Set items, such as grouping items, evaluation rate, evaluation objectives
	2.3 Machine Learning	Apply machine learning to group test items automatically.
3 Examination Management	3.1 Setting Examination	Set the date, time for the starting and finishing points of the test.
	3.2 Monitoring Examination	Monitor examination, for example, the system will check students who are doing or finishing the test.
	3.3 Machine Learning	Apply machine learning to choose suitable test item for the examination.
4 Evaluation Management	4.1 Evaluation Examination	Write reports and evaluate the examination, such as duration of the test, number of examiners and score of the test.
	4.2 Suggestions	Give advice about the result to students for their strengths and weaknessse
	4.3 Machine Learning	Apply machine learning to predict the result of the test and give advice.
5.Scoring Management	5.1 View Score	Students can view their score.
	5.2 View Item Statistic	View the statistics of each item: correct, wrong, statistic and difficulty.
	5.3 Export Score	Export examiner's name and score from the system.

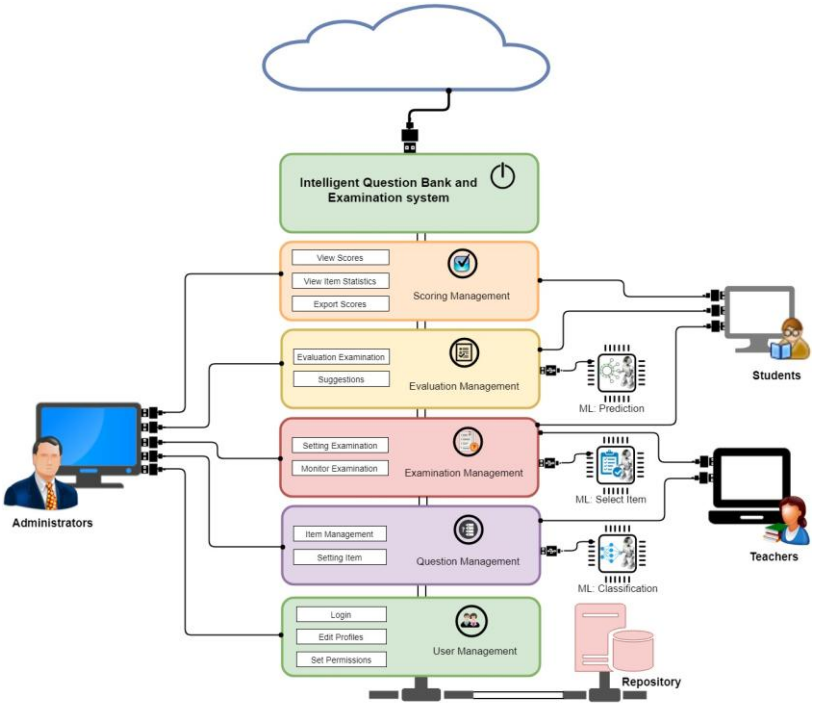

Fig. 1. System framework for an intelligent question bank and examination system.

Students can access according to the right which administrator determines. When they finish the test, they will know the result, evaluation and suggestion from the system.

Web-based application: Web-based application consists of 5 main modules: User Management, Question Management, Examination Management, Evaluation Management and Scoring Management. The detail will be shown in Table III.

Repository: Repository is database of the system such as Users Profiles, Item or Question, Answer and Scoring, Result from evaluation and Setting of system.

Cloud Computing: Web-based application is on Cloud Computing which is the Infrastructure as a Service (IaaS). It has processing unit, memory unit, storage unit and flexible network system which can be modified and expanded the structure according the demanding of users. Moreover, it can reduce the difficulty of maintenance because the overall system will be in cloud computing in order to be able to support to the amount of test data and tester which are increased rapidly.

Machine Learning: Machine Learning- Classification is the determination of question by Support Vector Machine automatically. It will be applied to Question Management Module to classify the kinds of test items according to Bloom taxonomy, so model is created by using training data and test data in order to evaluate the accuracy of test item classification.

Machine Learning-Select item Choosing the appropriate test items is important to the producing questionnaire which has many criteria such as difficulty degrees, discrimination degrees, weigh distribution of the related theories, frequency of choosing test items, choosing test items behavior, evaluation and finishing test. They depend on item response theory and educational theory. As a result, researchers will present ML approach to choose test item according to the criteria and access students' achievement from choosing the correct answer.

Machine Learning – prediction and suggestion will give suggestion to students immediately during the test. Teacher can observe and supervise students' doing test then evaluate students' proficiency by using Data Mining Techniques which can analyze from overall view to specific detail of students' activities. Later, it can give suggestion according to students' demand. Teacher will see problem then improve, add more detail in Web-based application or change the sequence of activities and record to database of Web-based application

C. The Third Period: The Evaluation of the Appropriateness of the Intelligent Question Bank System by Using Machine Learning

In the analysis of the appropriateness of the intelligent question bank system by using machine learning, the descriptive statistics used in the research were mean and standard deviation. The evaluation criterion was a rating scale, which was divided into five ratings, according to Likert's scale [23] as follows:

5 meant the most appropriate
4 meant more appropriate
3 meant fairly appropriate
2 meant less appropriate
1 meant the least appropriate

The criteria were created to arrange the rate of appropriateness of experts as follows:

Mean 4.50 -5.00 meant the most appropriate
Mean 3.50-4.49 meant more appropriate
Mean 2.50-3.49 meant fairly appropriate
Mean 1.50-2.49 meant less appropriate
Mean 1.00-1.49 meant the least appropriate

For the appropriateness evaluation of experts regarding the intelligent bank system by using machine learning, the researcher asked five experts to evaluate. The results are

shown in Table IV.

TABLE IV: EVALUATION RESULT OF THE APPROPRIATE SYSTEM FRAMEWORK FOR AN INTELLIGENT QUESTION BANK AND EXAMINATION SYSTEM

Description	Result		Rating
	$\overline{X}$	S.D.	
1.Principle in this research for system framework for an intelligent question bank and examination system	4.60	0.55	The most appropriate
2 .System framework for an intelligent question bank and examination system			
2.1 Relevant persons for intelligent question bank system			
2.1.1 Teacher	4.60	0.55	The most appropriate
2.1.2 Students	4.80	0.45	The most appropriate
2.1.3 Administrators	4.80	0.45	The most appropriate
2.2 Modules of intelligent question bank and examination system			
2.2.1 User Management	4.80	0.45	The most appropriate
2.2.2 Question Management	4.80	0.45	The most appropriate
2.2.3 Examination Management	4.60	0.55	The most appropriate
2.2.4 Evaluation Management	4.60	0.55	The most appropriate
2.2.5 Scoring Management	4.60	0.55	The most appropriate
3 .Cloud Computing	4.80	0.45	The most appropriate
4 . Intelligent question bank and examination system can apply to daily life	4.60	0.55	The most appropriate
Overall Score	**4.70**	**0.50**	**The most appropriate**

According to Table IV, we found that the overall appropriateness was in the rating "the most appropriate" the mean was 4.70 and the standard deviation was 0.5. The result was reliable. As a result, the experts' opinion was in the rating "the most appropriate".

V. CONCLUSION AND DISCUSSION

This was a documentary research and there were three periods of research: the synthesis module of the question bank system and designing the intelligent question bank and the examination system. A content analysis was used in analyzing the data. The results showed that:

1) The question bank system consisted of five modules, such as the User Management Module, Question Management Module, Examination Module, Evaluation Management and Scoring Management Module.
2) The intelligent question bank and examination system can be divided into three parts: 1. Relevant persons for the intelligent question bank system; 2. Intelligent question bank system; 3. Cloud computing framework, which consisted of 5 modules, which were consistent with the research works of [13], [15], [17] then they were analyzed and designed according to ICT program designing. The researcher designed the sub-modules of each main module and applied machine learning to three modules, such as the examination management module, question management module, evaluation management modules. The question management module could arrange the categories of examination automatically according to the evaluation rates, which related to research work of [18]. The examination management module could choose the suitable test items for examiners and the evaluation processes, which were related to the research works of [15]. The evaluation module could evaluate the result automatically then give the feedback to examiner, which related to the research works of [9].
3) The evaluation of the appropriateness of the intelligent question bank and examination system was checked by five experts regarding the question bank system and machine learning. The statistics used in this research were the mean and standard deviation. The results found that the rate of this framework was in "the most appropriate" (overall mean was 4.70 and S.D. was 0.50.)

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