

Concepts of an interactive adaptive learning system architecture design in an active learning environment through a cloud learning ecosystem

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ABSTRACT: The architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem is the design on the concept of connectivism learning theory, in which the learners have to work together in the active learning environment via social cloud available on the Internet, leading to cooperative learning through a cloud learning ecosystem. This system consists of six main elements, i.e. 1) stakeholders; 2) cloud learning ecosystem; 3) interactive learning; 4) database; 5) adaptive learning components within the system. The latter consists of five modules, i.e. 1) domain knowledge; 2) pedagogical module; 3) student model; 4) expert model; 5) communication model; and 6) active learning environment. The swim lane diagram of activity in the interactive learning on a cloud learning ecosystem was used. With this, the researcher synthesised the architecture from the five steps of creative problem solving combined with a cloud learning ecosystem, so that the learners, both individually and in group, could create interactive learning in an active learning environment, while sharing knowledge and undertaking activities together.

Keywords: Interactive adaptive learning system, active learning environment, cloud learning ecosystem

INTRODUCTION

Today's learning faces two challenges. The first challenge comes from a change of perception about learning itself, and the second comes from the presence of information and telecommunication technologies that continue to show tremendous growth. Hence, according to this view, learning should provide the opportunity for students to construct their own knowledge actively. Meanwhile, the rapid advancement of information and telecommunication technology offering new easiness in learning enables the shift of learning orientation from outside-guided to self-managed, and from knowledge as a possession to knowledge as a construction. This technology plays an important role in renewing the concept of justification that initially focuses on learning as merely a presentation of various forms of knowledge into learning as guidance to be able to carry out the exploration of socio-cultural rich knowledge [1].

National ICT policy framework 2011-2020 (ICT 2020) has established strategies and measures to promote the application of information and communication technology to provide Thai citizens with knowledge and intelligence, the Thai economy with sustainable growth, and Thai society with equality. In addition, the Ministry of Education has the main strategy to enrich the population of the country by using information and communication technology as a tool or as a main component in the instructional process or by combining it with the instructional models that match with the contexts of learners [2].

According to the national education plan 2017-2036, the target framework and the directions of education in Thailand have been established in a way that the emphasis will be placed on the Thai people having access to opportunities and equality of efficient education, development of effective instructional management, development of high-performance workforce that can satisfy the demands of the labour market and development of the country [3].

The objective thereof is to minimise the inequality of educational opportunities, while increasing the said opportunities of higher education, so that the learners can have lifelong learning based on flexibility, accessibility, efficiency and the ability to pick up knowledge about instructional management through an Internet network [4]. This corresponds with the basic learning principle saying that the learners who expect to be successful in learning have to search for information from Internet services and correspond with others via e-mail, in chatrooms and on Web boards. This will enable the learners to have more chances to express their opinions, which is the main feature of learning that can satisfy the differences of individuals and differences of learning potential among different learners [5].

Active learning is a process of learning management in which the learners do some activities and use their thinking process about the said activities [6].

This is a kind of learning activity management based on two basic hypotheses: 1) learning is a natural effort of humans; and 2) everyone has their own ways of learning [7]. Therefore, the role of learners will be changed from being receivers to becoming co-creators [8] by means of active learning environment. The learners can search for information from the Internet or services and correspond with others via e-mail, in chatrooms and on Web boards. This method enables the learners to create their own knowledge and organise their learning by themselves and encourages them to participate in the instructional process and create mutual interactions at the same time. This is regarded as a learning method that can respond to learning 4.0 (*Thailand 4.0* is a high-tech strategy of the Thailand government).

The cloud ecosystem is an ecosystem that applies cloud computing, in which there are many resources for learning on the Internet, e.g. social media, to encourage the learners to have collaborative learning via cloud technology [9] based on cooperative learning in the connectivism learning theory. As to this theory, the learners are divided into groups in which they have to work together [10]. This is to create collaborative working and learning within the groups via social media available on the Internet, leading to a cloud learning ecosystem.

The study of previous research shows that social media are highly popular amongst university students. Facebook and YouTube are at the top of the list. According to the results of the survey reported by Tokovarov et al, the most frequent applications of social media are communication and file sharing, along with the use of social media as a source of additional knowledge [11]. However, learning in groups is quite a rare application of social media. In accordance with the opinions of the respondents, the most important advantages of social portals are the convenience and easy access via mobile applications. The distracting feature of social media and unreliable information are reported as being the major disadvantages of using social media in education [11].

Cloud technology is a computing technology with a structure of information and communication technology that can extend itself automatically, providing services to a huge number of clients. The operation thereof relies on the numerous resources available on the Internet. Once connected to the Internet, the users can make use of any of the resources in such a huge network, regardless of their origins or places, whether nearby or far away [12].

The adaptive learning system is a system that can accommodate the different learning potentials of each learner, matched with their aptitude, skills and differences. An artificial intelligence technique can be used to adapt the instructional model to match with the differences of individual learners, e.g. learning ability, preferences, learning style, learning goal, etc [13].

In reference to the aforementioned principles and theories, the researcher had an idea to design an interactive adaptive learning system architecture based on an active learning environment through a cloud learning ecosystem as a tool to encourage the learners to create their own knowledge and organise their learning by themselves. This can be regarded as a learning method that can respond to the learning 4.0.

METHODS

This research is a study of the concept in designing an architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem. To do so, the researcher divided the methodology into three phases as shown below.

Phase 1: study, analyse and synthesise the learning ability on the active learning environment, as well as the elements in the cloud learning ecosystem in order to promote the interactive adaptive learning system. The researcher studied the theories, documents and relevant research as follows: 1) study and analyse the theories, documents and relevant research concerning the learning ability on the active learning environment [6-8][14-16], and then synthesise the elements that the learners received from the active learning environment; 2) study the theories, concepts, and techniques about the usage of cloud ecosystem [9] in order to apply them to promote interactive adaptive learning, and set up activities and tools that support cloud learning ecosystem; and 3) study and analyse the theories, concepts, and styles of learning in adaptive learning system [13][17], and then synthesise the interactive learning process that can be applied in combination with cloud learning ecosystem, in order to promote and accommodate different learning potentials of each learner, matching with their aptitude, skills and differences.

Phase 2: prepare the research tools. In this stage the researcher prepared the tools for this research and for its evaluation, as well as the environments that facilitated the instructional process as follows: 1) create the tool to evaluate the suitability of design an architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem, and prepare a swim lane diagram of activity in the interactive adaptive learning. The said tool consists of ranking questions of five levels; and 2) design the elements that the learners received from active learning environment and adaptive learning process, and that can be used with the cloud learning ecosystem; and design a swim lane diagram of activity in the interactive learning and use it to design the elements of the architecture of

an adaptive learning system in an active learning environment through a cloud learning ecosystem, which can promote and accommodate the different learning potentials of each learner, matching with their aptitude, skills and differences.

Phase 3: evaluate the suitability of the design of an architecture of an interactive adaptive learning system on an active learning environment through a cloud learning ecosystem by the experts, and then analyse and summarise the results thereof.

CONCEPT IN INTERACTIVE ADAPTIVE LEARNING SYSTEM ARCHITECTURE DESIGN IN AN ACTIVE LEARNING ENVIRONMENT THROUGH A CLOUD LEARNING ECOSYSTEM

The concept of designing an architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem is on the basis of connectivism learning theory, in which the learners have to work together in the active learning environment via social media available on the Internet, leading to cooperative learning through a cloud learning ecosystem.

The conceptual framework of an architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem is based on the documents, relevant research and in-depth interviews with the experts with years of experiences in designing instruction systems. The basic concept of the architecture of an interactive learning system in an active learning environment through a cloud learning ecosystem stems from the integration of various significant concepts, i.e. instruction system [18-20], connectivism learning theory [10][21], adaptive learning system [14], interactive learning [22-24], active learning environment [6-8] and cloud ecosystem [9]. This concept can be summarised as seen in Figure 1.

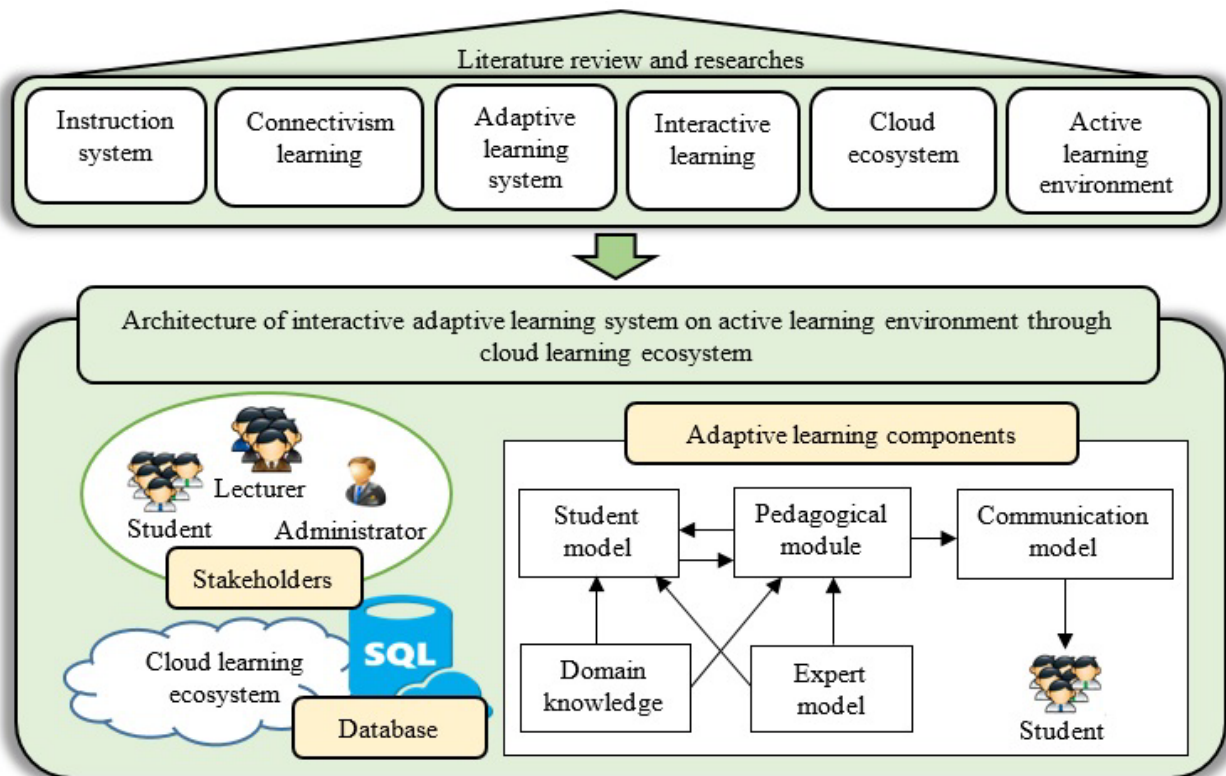


Figure 1: Conceptual framework an architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem.

The concept of an interactive adaptive learning system architecture design on an active learning environment through a cloud learning ecosystem is on based mainly on connectivism learning theory, in which the learners have to work together in the active learning environment via social media.

The interactive adaptive learning system that was developed must be capable of changing or adapting the styles and processes of learning to support and match with the potential of individual learners. Moreover, the appropriate cloud learning ecosystem must be prepared for the learners, so that they can create interactive learning on the active learning environment, while sharing knowledge and undertaking activities together, both individually and in group.

The objectives of an interactive adaptive learning system are: 1) to be capable of adapting styles, contents and tests in accordance with the aptitude, skills and different learning potential of individual learners; thereby, the adaptation has to be made on the basis of learning ability, preferences, learning style and learning goal, etc; 2) to encourage the learners to have an active learning environment with the aid of tools that can support and promote learning and undertaking

activities in cloud technology; and 3) to be capable of applying a cloud learning ecosystem to promote adaptive learning and collaborative activities of the learners.

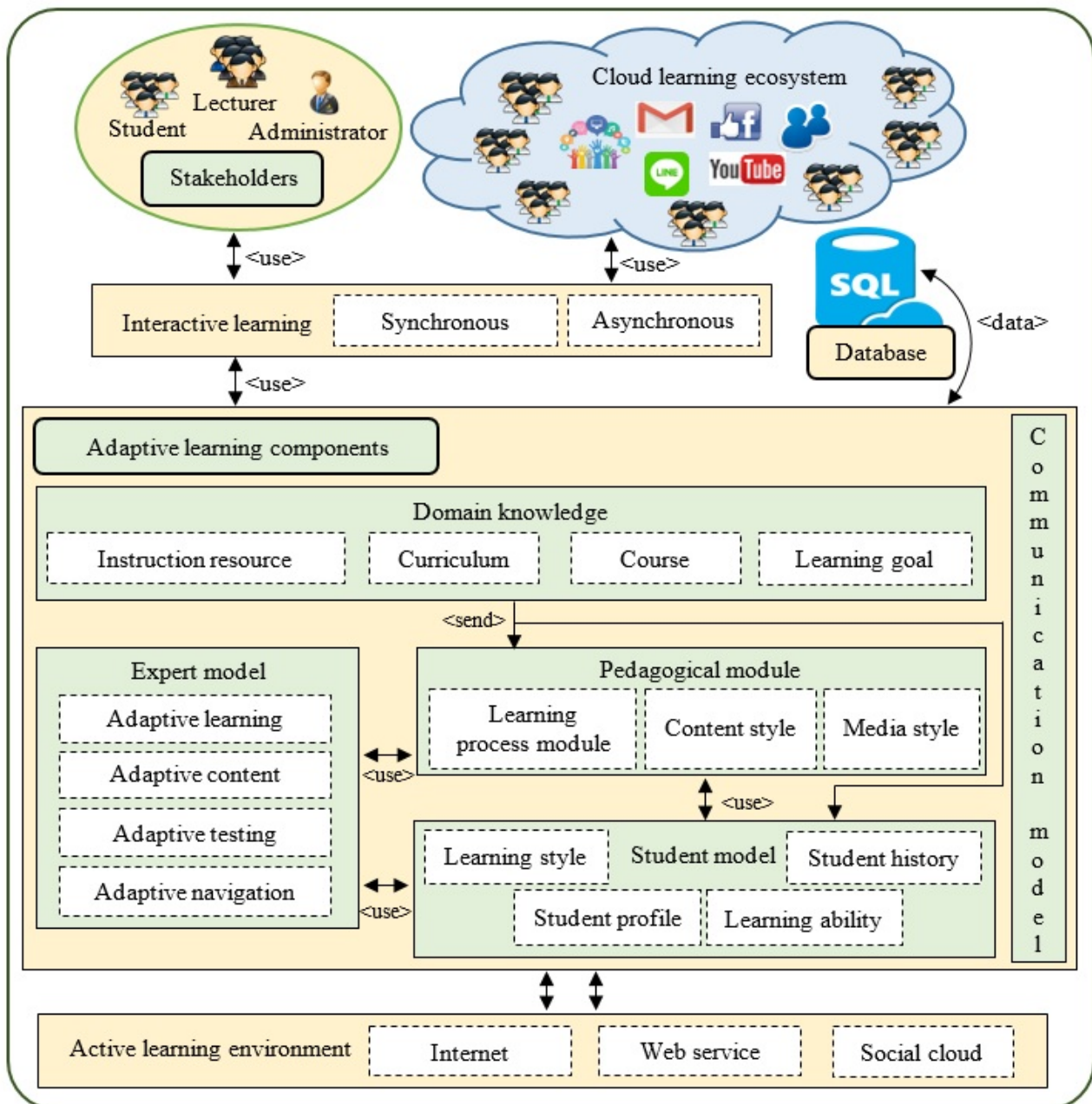


Figure 2: Architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem.

According to Figure 2, the architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem consists of 6 main elements, i.e. 1) stakeholders; 2) cloud learning ecosystem; 3) interactive learning; 4) database; 5) adaptive learning components; and 6) active learning environment. Each of the elements above can be described as follows.

1. Stakeholders are the persons involved in the use of this interactive adaptive learning system, for instance, administrators, lecturers and students. At the first access to this system, the stakeholders must log in to the system to show their identities. Different stakeholders have different authorised access to the system.
2. The cloud learning ecosystem is a cloud ecosystem where there are tools and resources to promote a variety of learning styles, e.g. social media, YouTube, line, email, Web boards, chat rooms, etc. The said tools are provided to promote and accommodate the different learning potentials of each learner, matching with their aptitude, skills and differences, in the form of cooperative learning, in which the learners do activities in a small group of about three to five persons under the connectivism learning theory.
3. Interactive learning is an interactive adaptive learning system that was developed to accommodate the interactive learning between learner and learner, learner and lecturer, and learner/lecturer and learning media. The system must also accommodate the access by multiple users, both synchronous and asynchronous.

4. Database is a section that stores the data of learners, lecturers and administrators.
5. Adaptive learning components are the main elements of this interactive adaptive learning system that can promote and accommodate the different learning potentials of each learner, matching with their aptitude, skills and differences. In this part, the researcher synthesised an adaptive learning process based on the principles of intelligent tutoring system, using the learning technique of artificial intelligence. The system consists of five modules as below:
 - 5.1 domain knowledge is a module that stores data and information about teachings, which will be selected to teach the learners;
 - 5.2 the pedagogical module is used to store the information about teaching, for instance. This module has to be defined by the lecturers by analysing the data in knowledge base and sending them to the student module;
 - 5.3 the student model is a module that stores data and information about learners. These data have to be analysed in order to select the learning styles, contents, tests and guidelines that are suitable to all learners. Therefore, the student module is considered to be a significant element of adaptive learning system, because it can be applied to establish the learning process and adaptive learning that can support and accommodate learners;
 - 5.4 the expert model is a section that stores the roles or styles of the system that can be adapted to match with the different learning ability of learners by means of artificial intelligence techniques. The expert module includes four adaptive styles, i.e. 1) adaptive learning refers to the adaptation and selection of learning processes that are appropriate to the learners with different ability; 2) adaptive content refers to the adaptation of contents, so that the said contents or the styles of contents match with the different ability of learners; 3) adaptive testing is an adaptation that focuses on selection of tests, questions or examination available in the database, so that the tests can be suitable to the learners with different ability; and 4) adaptive navigation is a navigation style that the learners can adjust according to their learning ability;
 - 5.5 the communication model is provided to define the styles of interaction between learners and adaptive learning system, whereby the system must be able to receive feedback information from learners, monitor the learning behaviours of learners and store the learning history.
- 6) The active learning environment is a preparation of the environment that encourages learners to have practical active learning by taking any actions and making use of media available on the Internet for the benefits of learning and undertaking activities. The said media include Internet, Web service, social cloud, etc. This module shall support the elements of adaptive learning.

ACTIVITY IN THE INTERACTIVE LEARNING ON A CLOUD LEARNING ECOSYSTEM AND SWIM LANE DIAGRAM

Students' learning activity is marked by an increase in participation while acquiring knowledge. This activity lasts and runs naturally; it is comfortable and encourages curiosity. The desirable learning condition is a non-boring learning situation, because the students are actively involved in sharing in a learning experience and defining problems derived from a course discussion, so that each of them can evaluate the nature of the learning [25].

The majority of the learning process takes place in groups or teams. The idea is to have students work in small groups in order to address the presented case. By collaborating, students see other problem-solving strategies being used, they discuss the case using their collective information, and they need to take responsibility for their own learning, as well as their classmates [26].

The swim lane diagram of activity in the interactive learning in a cloud learning ecosystem, which the researcher synthesised from the five steps of creative problem solving of Torrance [27] and the research of Chatwattana and Piriyasurawong [28] combined with a cloud learning ecosystem so that the learners, both individually and in group, can create interactive learning on the active learning environment, while sharing knowledge and undertaking activities together as seen in Figure 3 (see the Appendix).

RESULTS

In this study on a concept study in an interactive adaptive learning system architecture design on a active learning environment through a cloud learning ecosystem, the researcher asked experts to evaluate the suitability of the architecture and the swim lane diagram of activity in the interactive learning on a cloud learning ecosystem. These experts were specialists in the fields of computer, information and communication technology for education, and education technology, with at least five years of experience in undertaking research and teaching in the said fields.

Section 1: results of suitability evaluation on the design of architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem. The results are described in the following paragraphs:

- Results of suitability evaluation on the design of architecture of an interactive adaptive learning system (overall elements) are summarised in Table 1.

Table 1: Results of suitability evaluation on the design of architecture (overall elements).

| Items for evaluation | Suitability | | Level of suitability |
|---|-------------|------|----------------------|
| | \bar{x} | SD | |
| 1. The system architecture corresponds with the objectives of research. | 5.00 | 0.00 | highest |
| 2. Elements of architecture. | 5.00 | 0.00 | highest |
| 3. The order of elements in architecture of interactive adaptive learning system is obvious and coherent. | 4.86 | 0.38 | highest |
| 4. Each element is related to one another. | 4.86 | 0.38 | highest |
| 5. The order of elements in system architecture is appropriate and easy to understand. | 4.53 | 0.53 | highest |
| 6. Overall elements in system architecture are complete and cover all demands. | 5.00 | 0.00 | highest |
| Overall average suitability | 4.88 | 0.33 | highest |

According to Table 1, it was found that the result of suitability evaluation on the design of architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem (overall elements) is at the highest level ($\bar{x} = 4.88$, $SD = 0.33$).

- Results of suitability evaluation on the design of architecture of an interactive adaptive learning system (individual elements) are summarised in Table 2.

Table 2: Results of suitability evaluation on the design of architecture (individual elements).

| Items for evaluation | Suitability | | Level of suitability |
|--|-------------|------|----------------------|
| | \bar{x} | SD | |
| 1. Stakeholders | 5.00 | 0.00 | highest |
| 2. Cloud learning ecosystem | 4.86 | 0.36 | highest |
| 3. Interactive learning | 5.00 | 0.00 | highest |
| 4. Database | 5.00 | 0.00 | highest |
| 5. Adaptive learning components | 4.89 | 0.31 | highest |
| 6. Active learning environment | 5.00 | 0.00 | highest |
| 7. Application of learning system architecture | 4.80 | 0.47 | highest |
| Overall average suitability | 4.91 | 0.30 | highest |

According to Table 2, it was found that the result of suitability evaluation on the design of architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem (individual elements) is at the highest level ($\bar{x} = 4.91$, $SD = 0.30$).

Section 2: results of suitability evaluation on the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem. The results are described in the following paragraphs:

- Results of suitability evaluation on the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem (overall elements) are summarised in Table 3.

Table 3: Results of suitability evaluation on the design of a swim lane diagram (overall elements).

| Items for evaluation | Suitability | | Level of suitability |
|--|-------------|------|----------------------|
| | \bar{x} | SD | |
| 1. The swim lane diagram of activity corresponds with the objectives of research. | 5.00 | 0.00 | highest |
| 2. Stages of swim lane diagram of activity. | 5.00 | 0.00 | highest |
| 3. The order of elements in swim lane diagram of activity is obvious and coherent. | 4.86 | 0.38 | highest |
| 4. Each element is related to one another. | 4.86 | 0.38 | highest |
| 5. The order of elements in swim lane diagram of activity is appropriate and easy to understand. | 4.86 | 0.38 | highest |
| 6. Overall elements in swim lane diagram of activity are complete and cover all demands. | 5.00 | 0.00 | highest |
| Overall average suitability | 4.93 | 0.26 | highest |

Referring to Table 3, it was found that the result of suitability evaluation on the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem (overall elements) is at the highest level (\bar{x} = 4.93, SD = 0.26).

- Results of suitability evaluation on the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem (individual elements) are summarised in Table 4.

Table 4: Results of suitability evaluation on the design of a swim lane diagram (individual elements).

| Items for evaluation | Suitability | | Level of suitability |
|---|-------------|------|----------------------|
| | \bar{x} | SD | |
| 1. Stakeholders | 4.90 | 0.44 | highest |
| 2. Preparation process | 4.93 | 0.32 | highest |
| 3. Learning process | 4.93 | 0.26 | highest |
| 4. Cloud learning ecosystem | 5.00 | 0.00 | highest |
| 5. Application of swim lane diagram of activity | 4.79 | 0.50 | highest |
| Overall average suitability | 4.91 | 0.33 | highest |

Referring to Table 4, it was found that the result of suitability evaluation on the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem (individual elements) is at the highest level (\bar{x} = 4.91, SD = 0.33).

CONCLUSIONS

This research is a study of the results from the concepts in an interactive adaptive learning system architecture design on an active learning environment through a cloud learning ecosystem. It is also concerned with a study of the results from the design of a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem. The concepts of design of architecture of an interactive adaptive learning system are based on connectivism learning theory, in which the learners must work together in the active learning environment on the Internet.

The interactive adaptive learning system that was developed must be capable of changing or adapting the styles and processes of learning in order to support and match with the potential of individual learners. Moreover, the appropriate cloud learning ecosystem must be prepared for the learners, so that the learners, both individually and in group, can create interactive learning on the active learning environment, while sharing knowledge and undertaking activities together. The conclusion can be made as follows:

- The architecture of an interactive adaptive learning system in an active learning environment through a cloud learning ecosystem consists of six main elements, i.e. 1) stakeholders; 2) cloud learning ecosystem; 3) interactive learning; 4) database; 5) adaptive learning components; and 6) active learning environment.
- The researcher synthesised a swim lane diagram of activity in the interactive learning on a cloud learning ecosystem from the five steps of creative problem solving include: 1) find data and clarify creative problem; 2) realise creative problem; 3) search for concepts of creative problem solving; 4) find out creative problem solving steps; and 5) accept creative problem solving steps.

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BIOGRAPHY



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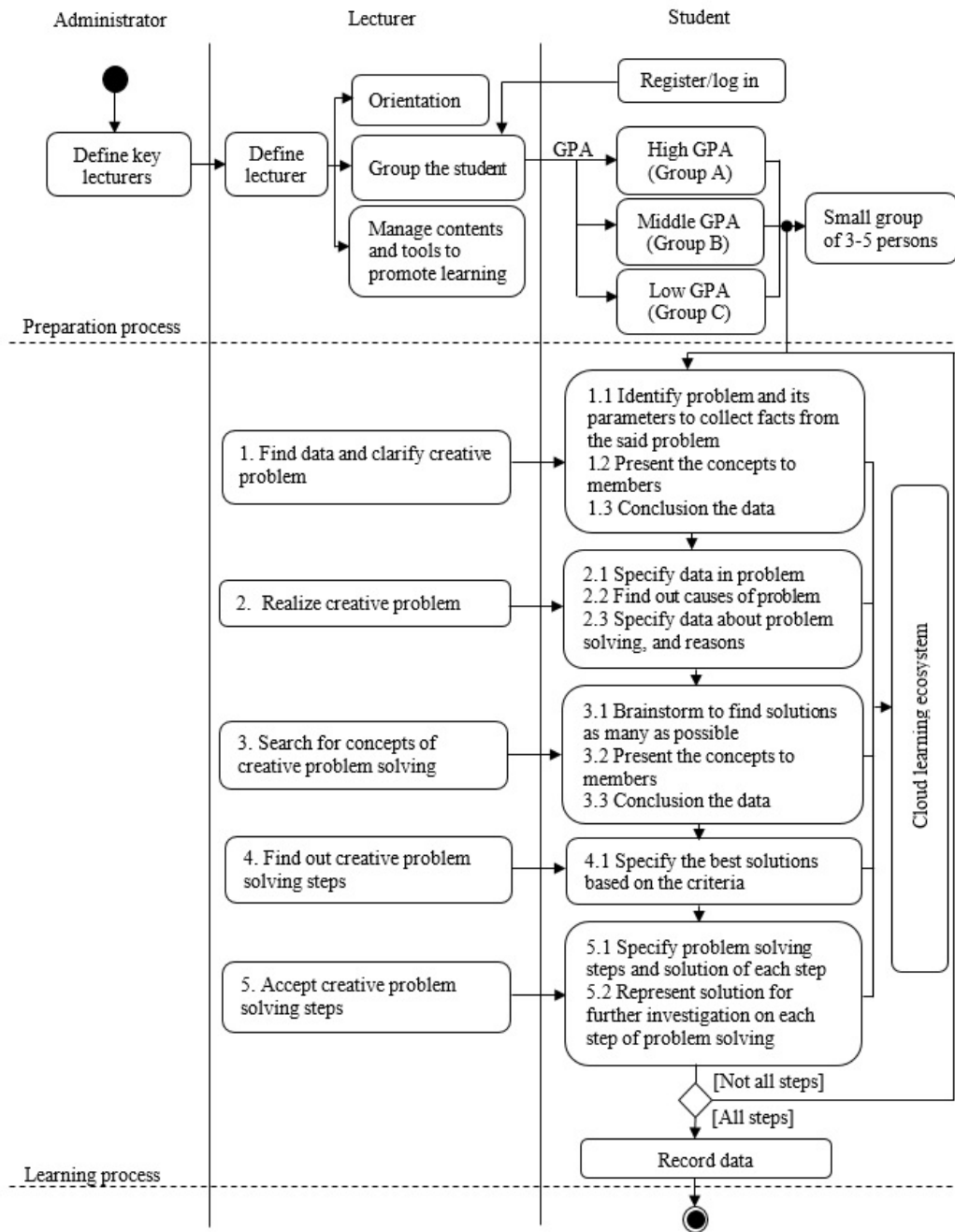


Figure 3: Swim lane diagram of activity in the interactive learning on a cloud learning ecosystem.