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To cite this article: P Hendradi *et al* 2019 *J. Phys.: Conf. Ser.* **1196** 012038

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Cloud Computing-Based E-Learning System Architecture in Education 4.0

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Abstract--- E-learning architecture based on Cloud Computing is an implementation of the E-learning System by utilizing the benefits of Cloud Computing. Furthermore, the E-learning system will experience a change with the emergence of the Education 4.0 era which is an adaptation of the development of Industry 4.0. Therefore the writer try to review the architecture of the e-learning system based on cloud computing in relation to Education 4.0 era. In this paper, the authors propose a concept of cloud computing-based e-learning system architecture at Education 4.0. The aim is to produce architecture that can be used as a guideline in developing cloud computing-based e-learning systems that answer the needs of Education 4.0. For this reason, in this paper, the author reviews the papers that review the architecture of cloud-based e-learning systems and also papers on Education 4.0.

1. Introduction

Development of Cloud Computing in e-learning systems from web-based, known as the traditional e-learning system to adopt cloud computing services and models. Significant changes are the power needs that must be provided by the organizers and users of the e-learning system. By utilizing the advantages of Cloud Computing, the use of power will be more effective and efficient [1].

Next is Education 4.0, which is the adoption of the Industry 4.0 era, which is based on seven aspects which are evolution in the world of education [2]. The use of technology is no longer a recommended tool but is a necessity because based on data from the Indonesian Internet Service Providers Association (APJII) information technology penetration in society is quite high [3].

From the explanation above, the writer will try to review the architecture of e-learning system based on cloud computing in relation to Education 4.0 era. The purpose of this study is to produce proposed cloud-based e-learning system architecture at Education 4.0.

This paper will be divided into four parts. The first part is about the background and the issues that are the goal. The second part of the review and presentation of relevant papers in the form of related work and literature studies. Furthermore, the third section which contains the discussion and discussion that produces the architectural proposal and the final part is the conclusion.

2. Related Work

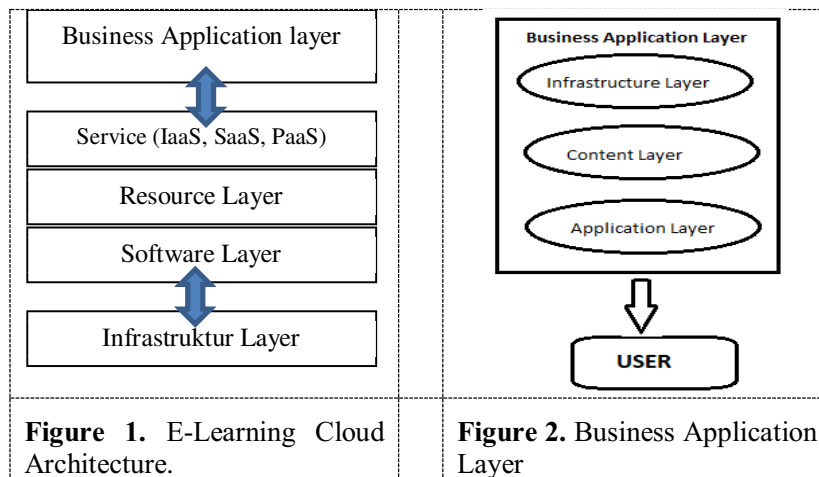
2.1 Cloud-based E-learning architecture

However, the E-learning system will not be able to replace the function of the teacher, but as a supplement in a learning. Permanent teachers who manage classes and develop cloud-based E-learning systems. Cloud-



based E-learning system is the migration of cloud computing technology into e-learning. All the benefits of Cloud Computing are used to improve e-learning's performance. Architecture Cloud-based E-learning systems are divided into five layers: Layer Infrastructure, Software Layer, Resource Management Layer, Service layer and Application Business Layer[4].

On a paper with the theme E-learning System based on Cloud Computing: A Review, explains that the part that distinguishes between Cloud-based E-learning Systems and other Systems in the Business Application Layer in addition to the other four layers [1].



Of these five layers, the Application layer is often referred to as the Business Application layer, which is the layer that differentiates it from other systems in implementing cloud computing[1]. This layer contains three more layers, namely the Infrastructure layer, Content Layer and Application Layer. Layer infrastructure is a pool of Cloud E-learning resources, while in Content Layer contains content from e-learning such as web file systems, web services, database systems and so on. And in the Application Layer contains services from the E-Learning System.

Whereas in another paper with the theme of Cloud Computing: A New Business Paradigm for E-learning, it also divides architecture into five layers with the Business Application layer as a layer opening with other cloud implementations. But in it, it is divided into five parts, namely content creation, content delivery, education platform, teaching evaluation, and education management[5]. In another paper with the theme An E-learning Architecture-based System on Cloud Computing, also with five layers with the Business Application Layer as well as the important layers, dividing into six parts, Content Production, Content Delivery, Collaboration, Virtualization, Assessment and Management[4]. Reviewing the three themes above is the resume in table form:

Table 1. Detail Business App Layer

Riahi, Ghazal [1] Three layers	Laisheng, et al. [5] Five parts	Masud, et al [4] Six parts
Content layer	Content Creation Content Delivery Education Platform	Content Production Content Delivery
Infrastructure Layer		Virtualization
Application Layer	Education Management Teaching Evaluation	Management Assessment Collaboration

From the table above using colors can be grouped into three groups, namely by referring to the three layers in the Business Application Layer of the Riahi paper, namely the Layer Infrastructure, Content Layer and Application Layer.

2.2 Education 4.0

E-learning system is the third revolution in education which involves all forms of learning using electronic media and digital media in its delivery and distribution. In the implementation of the Massive Open Online Course (MOOC) developing E-Learning system which is a means of learning and web-based learning offered by various universities in the world, both those who are graphic or licensed.

While the paper with the theme Education 4.0 for Tall Thin Engineer in a Data Driven Society explains the evolution in the world of education which is currently known as Education 4.0. In this paper it is explained that Education 4.0 is an adaptation of Industry 4.0 which is loaded with automation and sensors and leads to Internet of Thing (IoT) [2].

Next is the role of Artificial Intelligent (AI) plays an important role in the fourth education revolution called Education 4.0. that is marked by blended learning and seven AI features namely [2]; Adaptability to the individual knowledge level, Chabot’s for define topics, Machine Learning, Game based learning, Communities of practice, Learning analytics, Mobile connectivity, E-Assessments. Beside that are seven aspects in Education 4.0, namely: Personalization, gamification, mobile connectivity, adaptability, Learning Analytics-Method, Intelligent teletutors and E-Assessment.

In addition, there is another definition of Education 4.0 by Dematrini [6] who stated that Education 4.0 is a feature of Education 3.0 which is supplemented by an emphasis on AI, that is an increase in features of 6 attributes in Education, namely: Teacher, content delivery, learning process, learning organization, student and mean. From the above two papers, the relation is proposed as follows:

Table 2. Profile and seven feature

Demartini et al [6]	Ciolacu, et al [2]
Profile	Seven feature
Teacher	Intelligent teletutors
Content Delivery	mobile connectivity
Learning process	adaptability, gamification
learning organization	E-Assessment
student	Personalization
means	Learning Analytics-Method

From the table above shows, the relationship between Education 4.0's attribute profile and its features or can also describe what features are contained in Education 4.0. By reviewing the five papers above it can be assumed that there is a link between the profit model of the e-learning system, seven aspects of Education 4.0. and profile of Education 4.0.

2.3 Adoption Cloud Computing In Education X.0

There are six things that must be considered in adopting Cloud computing in the education system[7]: functionality, platform, contract, user experience and accessibility, technical issues and costs.

The concept of cloud computing adoption in the E-learning System consists of five independent factors derived from the combination of Diffusion of Innovation (DOI) and Technology Accepted Model (TAM) theories. These factors are associated with two dependent variables "Intent to adopt cloud computing" and "Actual usage of cloud computing". These factors are: Usability Factor, Innovation Factor, Economic Factor, Technological Factor and Contextual Factor[8]. Of the five factors, Usability which contains Usefulness and Ease to Use are many factors that arise in the adoption of cloud in education[9].

3. Discussion

From the above explanation in the third evolution of education called E-learning era, actually consists of two types, namely when the E-Learning System on the web is often referred to as Traditional E-Learning and when the E-Learning System is based on Cloud Computing. For traditional E-learning, most of the resources are provided by institutions, while cloud-based e-learning is a part of resources using cloud service facilities so that it can increase effectiveness and efficiency[10].

In this discussion, the architectural design of the Cloud-based E-learning System is proposed to refer to the development of Education 4.0. namely by considering the five layers of Cloud E-learning Architecture and attributes Education 4.0 profile.

3.1 Teacher

Teacher in Education 4.0 becomes a Leader Collaborative knowledge creation with supported by AI-based learning portal. This means that the teacher's position is to lead a forum to learn together and exchange experiences using the cloud as a resource provider equipped with AI.

The Chatbot application is one example of an AI application. The role of chatbot can take the form of Tutor, teacher communication, Question & Answer and natural conversation [11].

3.2 Content Delivery

Speaking of content delivery, we will also talk about Open Education Resource - OER in harmony with the cloud, which is an AI-based resource provider. That is a system that can adapt to individuals who are often termed adaptive learning [12].

Adaptive systems in education have concepts similar to the concept of 'recommender system'. Likewise on 'assessment' where Computer-Aided Assessment is often known as e-assessment [13]. In the common architecture of cloud-based e-learning systems, the location of content-delivery in cloud management systems is connected to the service layer and accessed by users via the internet [14].

Discussion on Content Delivery and Software will recognize the term Software Defined Mobile Social Network (SDMS) which is the development of Software Defined Network (SDN) where users in e-learning not only get content but can exchange content in certain social network environments[15].

3.3 Learning Process

The use of social networking in the learning process is increasingly widespread and has no limits. In the adaptive learning process, AI portal support can be set according to the learning process when in real time. In producing adaptive learning, the system uses Learning Analysis (LA) which results from the Education Data Mining (EDM) method[16].

LA applications can use Virtual Learning Environment (VLEs) which are widely available, such as features provided in the Learning Management System (LMS) and Content Management System (CMS). In addition, the LA Application can also be prepared by a system independently by the institution.

3.4 Learning organization.

Learning organization (LO) is an organization that helps individual learning also develop themselves[17]. Institutional affiliation in education 4.0 is irrelevant, because learning organizations can be cloud-based providers by implementing AI applications. This provider will adjust to the needs, national, regional and institutional boundaries [6][2].

LO in cloud computing can be in the form of Learning Management System (LMS) applications both in the form of commercial platforms, free public platforms and own (private) platforms[18]. From this, it can be concluded that LO is a Service layer and Application Business Layer in Cloud-Based E-learning Architecture.

3.5 Student

The student position is as one of the main stakeholders, namely as one who has an interest in the e-learning system. Of the many benefits and affordances to students are in 'Support for mobile learning' and 'Cost savings in software' [19]. Support for mobile learning for students is allowing easy access by using mobile devices owned by students. While the cost saving in software makes students free from payment for software licenses and free to use them at home. For "Support for mobile learning" in the cloud-based e-learning system architecture is infrastructure while "cost saving in software" is on the application.

From the discussion above the author tries to connect between rows and columns to track the relationship. Based on Cloud-based E-learning Architecture [1][4] that the application column is an important layer of cloud-based e-learning, so it is Closely related to Education 4.0 attribute[6]. For the relevance of the application column with the six attributes of Education 4.0 can be explained in the following table:

Table 3. Proposed Table Relation E-Learning Cloud Layer dan Education 4.0

Education 4.0 (attribute)[6]	E-Learning Cloud Layer [1][4]				
	Infrastructure	Software	Resource	Service	Application
Teacher					[11]
Content Delivery		[15]		[14]	[12][13]
Learning Process					[16]
Learning Organization				[18] [6] [2]	[18]
Student	[19]				[19]

From the above discussion, considering the architecture of Cloud-based e-learning systems, in the Education 4.0 era, the cloud-based e-learning system architecture is proposed as follows:

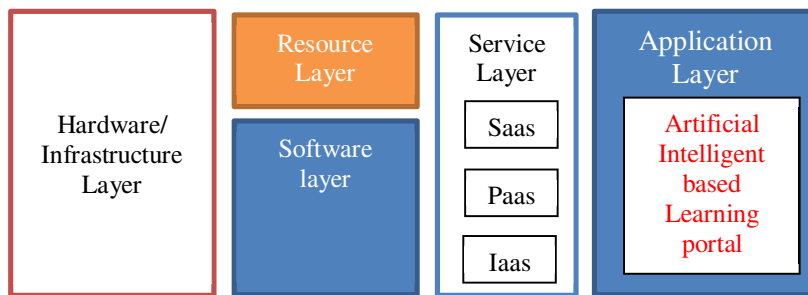


Fig. 3 Proposed E-learning Cloud Architecture on Education 4.0

Figure 3 above shows the biggest changes in architecture occurring at the business application layer. Where the role of AI becomes important for the implementation of the cloud-based learning system in education 4.0. For more in-depth layers of business applications are described in Figure 4 below.

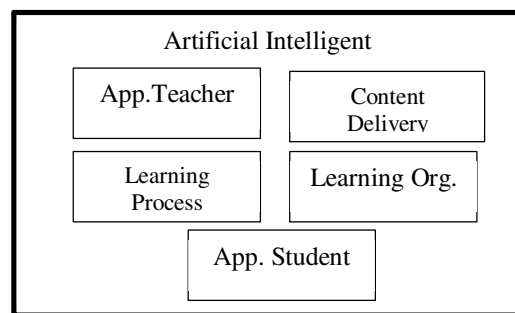


Fig. 4 Detail Business Application Layer

4. Conclusion

Era Education 4.0 has an influence on the cloud computing-based e-learning system architecture, especially in the Business Application Layer. This can be seen by linking between attributes of Education 4.0 and Layer on E-learning System Architecture. So it can be concluded that Cloud-Based E-Learning System Architecture can be developed into Cloud-based E-learning Architecture system in Era Education 4.0 by adjusting Business Application Layer based on Artificial Intelligent.

Acknowledgements

This paper purpose for starting point to the advanced my research about e-learning based on a cloud in Education 4.0. Then this paper could be my Ph.D. proposal in FTMK-UTeM Malaysia. Special support by Prof. Dr. Khanapi Bin Abd Ghani my main supervisor and Dr. Siti Nurul Mahfuzah Mohamad my co-supervisor.

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