Development of a Constructivist and Connectivist Learning Model for Undergraduates Involving Cloud Technology in Order to Promote the Creation of Innovative Education

Kanokrat Jirasatjanukul, Nuttakan Pakprod, and Julaporn Khammungkul

Abstract—**The objectives of this research are as follows: 1) to analyze the constructivist and connectivist framework involving cloud technology; 2) to develop a constructivist and connectivist learning model involving cloud technology; and 3) to evaluate the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education. The samples consisted of 7 experts in the design of learning models and in the use of information technology and communications who were chosen by purposive sampling and who had at least 5 years' relevant experience. The data were analyzed by mean and standard deviation. The evaluation results revealed that the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education was at the highest level of overall feasibility ($\bar{x}$= 4.68, S.D. = 0.47). The implication of this study points out the feasibility of learning model to allow promotion of learning environment to encourage educational innovation and the development of innovation skills on the part of the students.**

Index Terms—**Constructivism, Connectivism, cloud technology, innovative education.**

I. INTRODUCTION

Initially, the model of education began with "Education 1.0" in which learners primarily follow the instructors' explanations and lectures. The next step was "Education 2.0" focusing on being informed with knowledge with no need to have any creativity. This was followed by "Education 3.0" which is the education model in the era of information technology emphasizing the creation of knowledge. And at present, it is "Education 4.0" in which learners are encouraged to create their own works or innovations. It is regarded as the era of creating innovations and knowledge based on interests of individuals or groups of people who have common motivations. The roles of technology shall vary according to the learners. In other words, learners are considered the source of technological evolution for innovation. Accordingly, [1], [2] Education 4.0 is also expected to promote Thailand 4.0. However, learners in all levels must be promoted and developed in a way that they are well equipped with skills, well prepared and capable of creating innovations.

The education model that promotes and develops innovative skills is that of constructivism because this learning theory allows the learner to build knowledge [3]. Moreover, according to this theory, the learning environment would promote the arrangement of learning environments in various situations, based on a real life context.

The instruction management model that promotes and develops innovation skills is constructivism because the theories of this concept primarily place an emphasis on learners and the construction of knowledge by their own. In addition, constructivism can promote the management of learning environments in different situations of the real-world context. Jonassen (1999) [4] proposed the principles of learning environment design based on constructivism, known as Constructivist Learning Environments (CLEs), focusing on the enhancement of problem-solving abilities based on learning experiences. The objective thereof is to encourage learners to construct knowledge by themselves based on the interpretation of their own experiences so that they are able to solve the problems. Thereby, the essential components in the constructivist learning environments include: 1) problem, question or project as the focus of the environment, which consists of problem context, problem representation or simulation, and problem manipulation space, 2) related cases, 3) information resources, 4) cognitive tools, i.e., problem/task representation tools, static and dynamic knowledge modeling tools, performance support tools, and information gathering tools, 5) conversation and collaborative tools, and 6) social/contextual support. Furthermore, the constructivist learning environments also offer the following instructional activities to support learning, i.e., modeling, coaching, and scaffolding. The learning environments are managed in such a way that learners are provoked to connect different knowledge from different case studies and apply the said knowledge to deal with the problematic situations. Learners are assisted with information resources so that they can understand the problems and suggest possible solutions. The cognitive tools can also help learners interpret and manipulate the problems successfully. In addition, the use of conversation and collaboration to negotiate and construct meaning for the problems, which are considered social support systems, enables learners to acquire learning and apply it in their real life.

Learning not only takes place within an individual [5] but it may also occur either within or outside a person. This concept is, therefore, the origin of connectivism, which is

Kanokrat Jirasatjanukul is with Faculty of Science and Technology, Phetchaburi Rajabhat University, Thailand (e-mail: kanokrat.jir@mail.pbru.ac.th).

Nuttakan Pakprod is with Faculty of Education, Phetchaburi Rajabhat University, Thailand (e-mail: nuttakan.pak@mail.pbru.ac.th).

Julaporn Khammungkul is with Independent Researcher, Thailand (e-mail: julapornk@gmail.com).

considered a learning theory in the digital age [6], [7]. Siemens (2004) [8] illustrated that learning is a process that occurs within nebulous environments of shifting core elements. He also added that learning that occurs outside an individual focuses on connecting specialized information and knowledge, which shall enable us to learn more once compared to our current state of knowing. Thus, connectivism is a theory that can support the knowledge subjected to changes on a daily basis due to the learning of new information. Since technology is changing all the time, individuals need to learn and adapt their ways of life in compliant to the changing society. Not only that, it is necessary for them to possess knowledge and literacy of digital age. This is corresponding to the current learning which is always connected to the knowledge outside available through the internet network systems, e.g., google, Wikipedia, blogger, WordPress, Facebook, twitter, YouTube, etc. [9] Learners shall create new knowledge by themselves when connecting to the desired sources of knowledge and managing the relationship of the said connected knowledge[10]. Thus, learning shall occur when knowledge is processed by means of data connection and data input. [11]

In the research of Ruamkaew, Simmatun and Samavardhanae (2016) [12], connectivism was employed to develop the open learning model for enhancing the creativity of undergraduate students. The research proposed six steps of learning process, i.e., 1) problem – solving situation, 2) connect node, 3) self-monitor, 4) create and construct, 5) evaluation, and 6) share. The results of this research indicated that the propriety and congruency of the learning model based on connectivism for enhancing the creativity are at high level and very high level, respectively. Therefore, connectivism is considered another theory that is suitable to be used in the development of a learning model through cloud technology for undergraduate students to promote the creation of educational innovation.

Nowadays, cloud computing is very popular because users do not need to install a program on a personal computer to process information. [13] In cloud computing, a lot of information will be sent to be processed on the cloud server for analysis. The answer is returned quickly which reduces the expense on investment into information technology on the part of an organization. Moreover, cloud processing allows users to use and access resources at the same time, which makes data storage and access more efficient. [14]

The challenge of creating a learning media innovation today is that of creating a learning media that is easily accessible. The learners and teacher do not have to be at the same geographical place. Learners can search for relevant information quickly through the online Learning Management System (LMS) [15]. There are many kinds of learning media, and users can readily access various learning sources. The system will help process the data so that learners can obtain information correctly and quickly. Cloud technology, the internet, and open source software, can lead to learning innovation as mentioned above [16].

Therefore, in order to promote the skill of creating innovation and applying this knowledge to real life in such a way that it could be used for occupational purposes in the future, the researcher studied the constructivist and connectivist learning model involving cloud technology for students in the field of mathematics. The aim was to promote the creation of educational innovation to focus students on the need to study the relationship between problem and knowledge in the creation of innovation, such that it can be used in real life. In addition, such a learning approach can be used to upgrade the educational process through the use of educational innovation for online learning.

II. OBJECTIVES OF THE RESEARCH

To analyze the constructivist and connectivist framework involving cloud technology for undergraduates as a means of promoting innovative education.
1) To develop a constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.
2) To evaluate the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education

III. SCOPE OF THE RESEARCH

A. Population and Sample Group

The sample group consisted of 7 experts in the design of learning models and in the use of information technology and communications who were chosen by purposive sampling and who had at least 5 years' relevant experience. They were used in the evaluation of the learning model.

B. Studied Variables

1) The independent variable is the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.
2) The dependent variable is the evaluation of the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.

IV. METHODOLOGY

The design of a constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education involves the following process:
1) A study and review of the relevant literature and research on educational innovation in terms of constructivism and connectivism, and the use of cloud technology, followed by an analysis of the conceptual framework.
2) The creation of a concept framework consisting of the creation of an innovative skill constructivist and connectivist learning environment incorporating the use of cloud technology.
3) Using the conceptual framework to design a constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.
4) The creation of a questionnaire to evaluate the feasibility

of the model. The aim is to evaluate the consistency of the questions and then to make improvements in order to use the questionnaire in the next procedure.

5) Giving the model and the questionnaire to the 7 experts for evaluation.

6) Analyzing and concluding the evaluation results by analyzing the means and standard deviation.

7) Improving the model in accordance with the suggestions of the experts.

V. RESEARCH RESULTS

A. The Synthesis of the Results in Terms of the Concept Framework of the Constructivist and Connectivist Learning Model Involving Cloud Technology for Undergraduates As a Means of Promoting Innovative Education

The research framework is as follows:

The input consists of 21st Century learning skills on the development of innovative skills, constructivism, connectivism and cloud technology.

The process includes the constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.

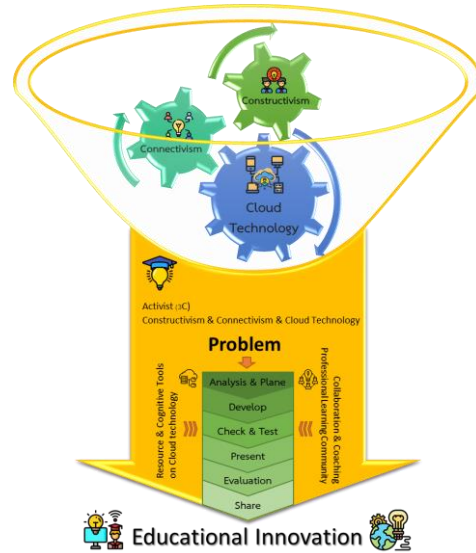The output includes educational innovation media which can be used online.
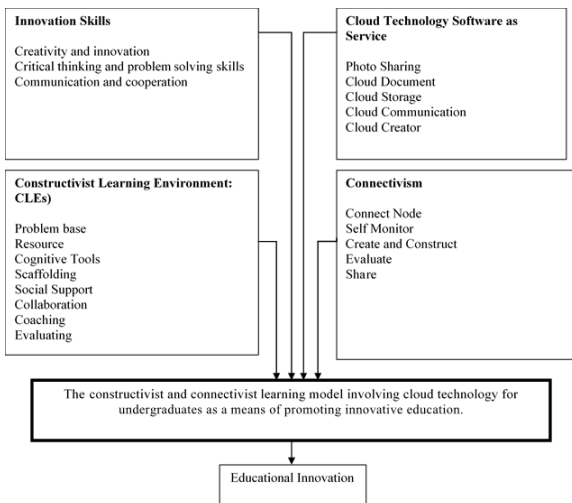

Fig. 1. The conceptual framework of the research project with regard to a constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education.

B. The Result of Developing a Constructivist and Connectivist Learning Model Involving Cloud Technology for Undergraduates As a Means of Promoting Innovative Education

Based on the figure above, the process could be explained as follows:

1) Problem: The teacher specifies the problem.

2) Analysis & Plane: After the learners have been informed of the problem, they plan and design a response by working together with the support of cloud technology. The teacher acts as a coach providing recommendations and advice.

3) Development: After the planning and designing process, the result is developed into a piece of work by using cloud technology in order to develop the innovation.

4) Check & Test: The work is inspected and tested for validity.

5) Present: The work of each group is presented in order to exchange knowledge and generate more creativity as a result of seeing the work of colleagues.

6) Evaluation: The work is improved and evaluated.

7) Share: The final work is shared.

Fig. 2. Instructional model.

C. Evaluation of the Constructivist and Connectivist Learning Model Involving Cloud Technology for Undergraduates As a Means of Promoting Innovative Education

TABLE I: THE EVALUATION OF THE INSTRUCTIONAL MODEL

Evaluation items	$\bar{x}$	S.D.	Feasibility level
The learning model in the research is feasible for building educational innovation.	4.86	0.38	highest
Constructivism is feasible for building educational innovation.	4.71	0.49	highest
Connectivism is feasible for building educational innovation.	5.00	0.00	highest
Cloud technology is feasible for building educational innovation.	4.57	0.53	highest
The learning model component is feasible.	4.86	0.38	highest
The learning model component is relevant.	4.71	0.49	highest
The context analysis process is feasible.	4.71	0.49	highest
The learning activity process is feasible.	4.71	0.49	highest
Each step of the learning activity process is relevant and consistent.	4.86	0.38	most
The learning activity process is feasible and can be used in real learning.	4.43	0.53	high

Evaluation items	$\bar{x}$	S.D.	Feasibility level
The learning activity process is feasible and can create innovative skills.	4.43	0.53	high
The learning activity process is feasible and can create educational innovation.	4.29	0.49	high
Total	4.68	0.47	highest

From the table above, it is clear that the form displays the highest level of overall feasibility. The evaluation result which displayed the highest score was connectivism. This indicates that is feasible in terms of helping promote educational innovation. In addition, the learning model developed in this research is feasible to help promote the development of educational innovation. Similarly, the learning model component is feasible, and each step of the learning activity is relevant and consistent.

VI. CONCLUSION AND DISCUSSION

The development of a constructivist and connectivist learning model involving cloud technology for undergraduates as a means of promoting innovative education as displayed in this research involved constructivism, connectivism and cloud technology. It could be said that it is a 3C teaching activity leading to learning activity to encourage innovation education in the form of a teaching medium that could be used online as follows: 1) the teacher specifies a problem 2) after the learns have been informed of the problem, they would plan and design a response by working together with the support of cloud technology. The teacher would be a coach providing advice. 3) After planning and designing, the response would be developed as a piece of work using cloud technology in order to develop the innovation. 4) The work is inspected and verified in terms of validity. 5) The work of each group is presented in order to exchange knowledge and generate more creativity as a result of seeing the work of colleagues. 6) The work is improved and evaluated. 7) The final work is shared.

In arranging the activity for the creation of innovation, cloud technology would be used as a tool for the [13], [14]. The teacher would act as a coach by providing advice and by making it convenient for the students to learn by constructivism and connectivism.[17] In so doing, it would encourage creativity on the part of the students in terms of being innovative [18] Moreover, based on the evaluation of the model by 7 experts in terms of feasibility, it is clear that the model was found to be acceptable and feasible, and could be used in a learning environment to encourage educational innovation and the development of innovation skills on the part of the students.

CONFLICT OF INTEREST

The author declares no conflict of interest.

AUTHOR CONTRIBUTIONS

All author listed have significantly contributed to the development and the writing of this article.

REFERENCES

[1] C. Jones and P. Pimdee, "Innovative ideas: Thailand 4.0 and the fourth industrial revolution," *Asian International Journal of Social Sciences*, vol. 17, no.1, pp. 4-35, 2017.

[2] L. A. Aiemsri, S. Ardwichai, P. Sinlarat, and N. Chan-Urai, "Developing indicators of creative and productive leadership for basic education school administrators," *Educational Research and Reviews*, vol. 15, no. 5,pp. 261-271, 2020.

[3] S. S. Anagün, "Teachers' perceptions about the relationship between 21st century skills and managing constructivist learning environments," *International Journal of Instruction*, vol. 11, no. 4, pp. 825-840, 2018.

[4] D. H. Jonassen, "Designing constructivist learning environments," *Instructional Design Theories and Models: A New Paradigm of Instructional Theory*, vol. II, pp. 215-239, Mahwah, NJ: Lawrence Erlbaum Associates, 1999.

[5] N. Jeerungsuwan, "Development of AAA model for blended learning based on the philosophy of sufficiency economy," *Major: King Mongkut's University of Technology North Bangkok*, 2007.

[6] G. Siemens, "Connectivism: Creating a learning ecology in distributed environments," *Didactics of Microlearning. Concepts, Discourses and Examples*, pp. 53-68, 2007.

[7] J. G. S. Goldie, "Connectivism: A knowledge learning theory for the digital age?" *Medical Teacher*, vol. 38, no. 10, pp. 1064-1069, 2016.

[8] G. Siemens. "Connectivism: A learning theory for the digital age," *International Journal of Instructional Technology and Distance Learning*, vol. 2, no. 1, 2004.

[9] S. Sithi and S. Sopeerak, "The web-based instruction model based on connectivism learning theory to enhance problem-solving skill in information and communications technology of higher education students," *The Far Eastern University Galeway to Entrepreneurship*, vol. 8, no. 2, pp. 102-112, 2014.

[10] R. Kop and A. Hill, "Connectivism: Learning theory of the future or vestige of the past?" *The International Review of Research in Open and Distributed Learning*, vol. 9, no. 3, 2008.

[11] N. Songsom, P. Nilsook, and P. Wannapiroon, "The student relationship management system process via the internet of things," *TEM Journal*, vol. 8, no. 4, pp. 1426-1432, 2019.

[12] K. Ruamkaew, P. Simmatun, and K. Samavardhanae. "Open learning model base on connectivism for enhancing the undergraduate students' creative thinking," *Prae-wa Kalasin Journal of Kalasin University*, vol. 3, no. 1, pp. 45-63, 2016.

[13] M. T. Baldassarre, D. Caivano, G. Dimauro, E. Gentile, and G. Visaggio, "Cloud computing for education: A systematic mapping study," *IEEE Transactions on Education*, vol. 61, no. 3, pp. 234-244, 2018.

[14] C. Kangvaravoot, P. Wannapiroon, and P. Nilsook, "Ideas marathon learning with cloud technology," *The Sixth TCU International e-Learning Conference 2015*, pp. 93-97.

[15] M. Anshari, Y. Alas, M. H. S. A. Hamid, and M. Smith, "Learning management system 2.0: Higher education," *Handbook of Research on Engaging Digital Natives in Higher Education Settings*, pp. 265-279. IGI Global, 2016

[16] I. Y. Andrushchak and V. P. Martsenyuk, "Innovative features of use cloud technology," *Комп'ютерно-інтегровані технології: освіта, наука, виробництво*, pp. 10-14, 2017

[17] E. Trnova and J. Trna, "Connectivism and teacher constructivism in science and technology education focusing on inquiry-based science education," *Conexão Ciência*, vol. 12, no. 2., pp. 69-75, 2017

[18] W. Chujitarom, "Digital storytelling through teamwork gamification model to encourage innovative computer art," *TEM Journal*, vol. 9, no. 2, pp. 560-565, 2020.

Kanokrat Jirasatjankul earned a Ph.D. Department of Information and Communication Technology for Education, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. Her works as a teacher in the Faculty of Science and Technology, Phetchaburi Rajabhat University (PBRU). Her research expertise in computer education, information and

communication technology for education, computer science in the human-computer interaction and Latent Semantic Analysis (LSA).

Nuttakan Pakprod earned a Ph.D. Department of Information and Communication Technology for Education, faculty of Technical Education, King Mongkut's University of Technology North Bangkok (KMUTNB), Thailand. Her works as a teacher in the Faculty of Education, Phetchaburi Rajabhat University (PBRU). Her research experience in many positions such as the Electronic Book, Computer Graphic Design, Information and Communication Technology for Education.

Julaporn Khammungkul earned a bachelor of science (computer science) from Ubon Ratchathani University in Ubon Ratchathani, Thailand in 2006. After finishing at Ubon Ratchathani, she completed a master of science degree in computer science at Thammasat University, Bangkok, Thailand in 2010. She earned a doctor of philosophy degree in applied behavioral science research (M.S./Ph.D.) from Behavioral Science Research Institute at Srinakharinwirot University, Bangkok, Thailand in 2020. Currently, she is an independent researcher in the field of computer science and behavioral science. Her research interests focus on individual differences in human-computer interaction, program development and evaluation, and behavioral science in the context of education and learning, to enhance quality of education and promote knowledge creation or innovation.