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Development of an E-learning Model Based on the Meaningful Learning Process through a Constructivist Theory for Teaching Science to Secondary School Students

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ABSTRACT

This study aimed to design meaningful learning based on the constructivist theory for instructional management through the e-learning lessons. In the learning management method, "web" is used as device by the secondary students for learning science and also strategy of the constructivists group was applied to help students to be able to link the former to the present knowledge. Students participate in learning and understand how to integrate their knowledge for daily living. They can help with solving the science learning problem and with decreasing scientific misconceptions. The method is able to inspire students with positive attitude towards learning, able to develop learning by nature or throughout their potential, and able to enhance their meaningful learning creation through personal experience, whereby they can learn efficiently.

Keyword : E-learning model, Meaningful learning process, Constructivist theory.

1. Introduction

Information technology is able to produce linkages of data which contain all things for learning endlessly and to create widespread knowledge to occur at every degree of education formal, non-formal, and personalized (Marcus, Bowles S., 2004). As we all know, the most enormous computer system in the world is the internet. One of the important roles of the internet is to provide knowledge at all times, places, and social classes. That makes education open wide and spread out in every social class. Learning exchanges, then, occur and information is accessible very fast throughout the world, resulting in learning society (Adams, A.D., 1997). The effective and efficient e-learning leads a change into a novel approach to learning in the world of cybernetics and information technology. To obtain such learning, all the resources in the internet system are designed systematically for creating the instructional system that supports and enhances meaningful learning using the webs system that can be conducive to learning at any place and any time as needed by everyone who wants to have independent learning by themselves. Interactions with students are provided and they can have cooperative learning based upon the learner-centered approach to new knowledge and understanding of self-creation. By such a method, the learning process can be linked to daily living by active learning (Barron, E. and Karen Silvers, 1996).

E-learning is a kind of giving education using a web as tool for learning, an application of the constructivists group's instructional strategy and cooperative learning using the individuals' learning characteristic, such as web-based instruction, web-based interactive learning environment, WWW-based education, and web-based multimedia presentation. E-learning can help teachers and students free from a class-schedule organization problem (David H. Jonassen and others, 2003). Students are a controller of their own learning. Learning occurs at the learners' own pace. The learning has a role to play as an investigator and a data survey maker in cooperative learning and interactions. The learners start to do, not just to receive information and they are centered, able to learn everywhere at home or the work place and able to link the information to a group of people who have a different career and/or ethnic without geographical, distance, and duration obstacles. This brings to a change in the learning society (Barron, E. and Karen Silvers, 1996; Piaget J., 1971).

The findings from a report of studying basic educational management assessments in the 2006 academic year conducted by the Office of Nakhon Phanom Educational Service Area 2 revealed that the learning achievements for the science learning substance group among the 4,029 secondary students of the 3rd span of grades, those who achieved the level of 4 comprised 402 students, the level of 3.5, 320 students, the level of 3, 612 students, the level of 2.5, 573 students, the level of 2, 671 students, the level of 1.5, 587 students, the level of 1, 730 students, and the level of 0, 134 students. Of the 3,566 secondary students of the 3rdspan of grades, whose learning achievements of the science learning substance group in academic year 2008 were evaluated at the local level by the Office of Nakhon Phanom Educational Service Area 2, 11.61 % of whom were at the level "good", 34.25 % at the level "fair", and 54.14 % at the level "poor". That reflects the crisis of Thailand's educational quality. Most of them were low-learning achievers, lack aspiration to learn as the important basic competency for people in the society. Thus, the education reforms for development of students are the urgent policy that has to be placed high on the agenda. The Office of Basic Education Committee add the 4thstrategy to hurry up the development of readiness in information technology and communications for management of educational institutions and affiliated work units of learning in the 2009 budget year.

From the idea and theory as mentioned above, it is evident that the instructional management of the meaningful learning process help students to create broad knowledge increasingly in the subject studied, to link the former to the present knowledge for creating a body of knowledge, to participate in learning till it is understood, and to integrate the knowledge into a daily living. By such a process, students' abilities are developed to be able to solve a problem so that they can develop their right scientific conceptions, and they can decrease their misconceptions while increase positive attitude

toward science as well as their learning achievements (Papert, Mindstorms S., 1993). An approach to educational management on the principle that everyone is able to learn and self-develop and that the learners are most important should be realized. The educational management process has to be followed for supporting the students' development by nature and the fulfillment of their potential with meaningful learning of what being learned through their experience. That makes the students learn efficiently, leading them to develop according to their potential and the intentions of education reforms. This author perceives the learning importance and tries to find a way to promote students' learning creation by helping them with learning from modern media which conduce to self-learning at anywhere, anytime, and which provide correspondence and interactions with the lessons, teachers, and even the students themselves. The students are able to learn from various sources of learning without limits on the world wide webs (WWW) that are able to increase knowledge which will result in students' learning achievement as well as meaningful learning (Kwon, So Young, 2006; Chen, Baiyun, 2007; Bross, April J., 2008).

2. Background

2.1 Meaningful learning process

Meaningful learning (Ausubel, David, 1963), is a way which the students use to subsume their own previous knowledge into that which follows or that which already exists in their cognitive structure. Ausubel gives the definition of meaningful learning as learning which students get from what their teacher explains and which they listen to with understanding until students can see the relationship between what they learn and structure of cognitive domain being kept in memory and available for forthcoming application. Ausubel's theory indicates that the theory per se has an objective to explain about cognitive domain. Ausubel's theory is that which finds a principle to describe the learning called "meaningful verbal learning", especially the linkage of the knowledge appearing in the text used at school to the knowledge previously retained in students' brain in cognitive structure. The teaching by this way can be called the information giving method through words. The objective of Ausubel's theory is merely to describe cognitive learning. Learning can be classified into 4 types: (1) meaningful reception learning, (2) rote reception learning, (3) meaningful discovery learning, and (4) rote discovery learning. The technique that helps students learn meaningfully from a teacher's teaching or description using the Advance Organizer is that which creates a linkage between the previous knowledge to the new information or concepts being learned. Through this technique, students can learn meaningfully without rote learning. The general principle to be used is to organize and arrange information for students to learn into categories. The frame and principle in general are presented before learning the new topic. The lessons are divided into important topics and those topics are informed to students about the new concepts to learn (Ausubel, David, 1978). Vygotsky's principle and method of teaching called teacher assisted teaching or "scaffolding" can help students work successfully according to the targets planned. According to Vygotsky, the teacher realizes the assistance from the zone of proximal development with emphasis on the importance of culture, society, and environment which have an effect on intelligence (Vygotsky, L., 1978).

2.2 Constructivist theory/constructivism

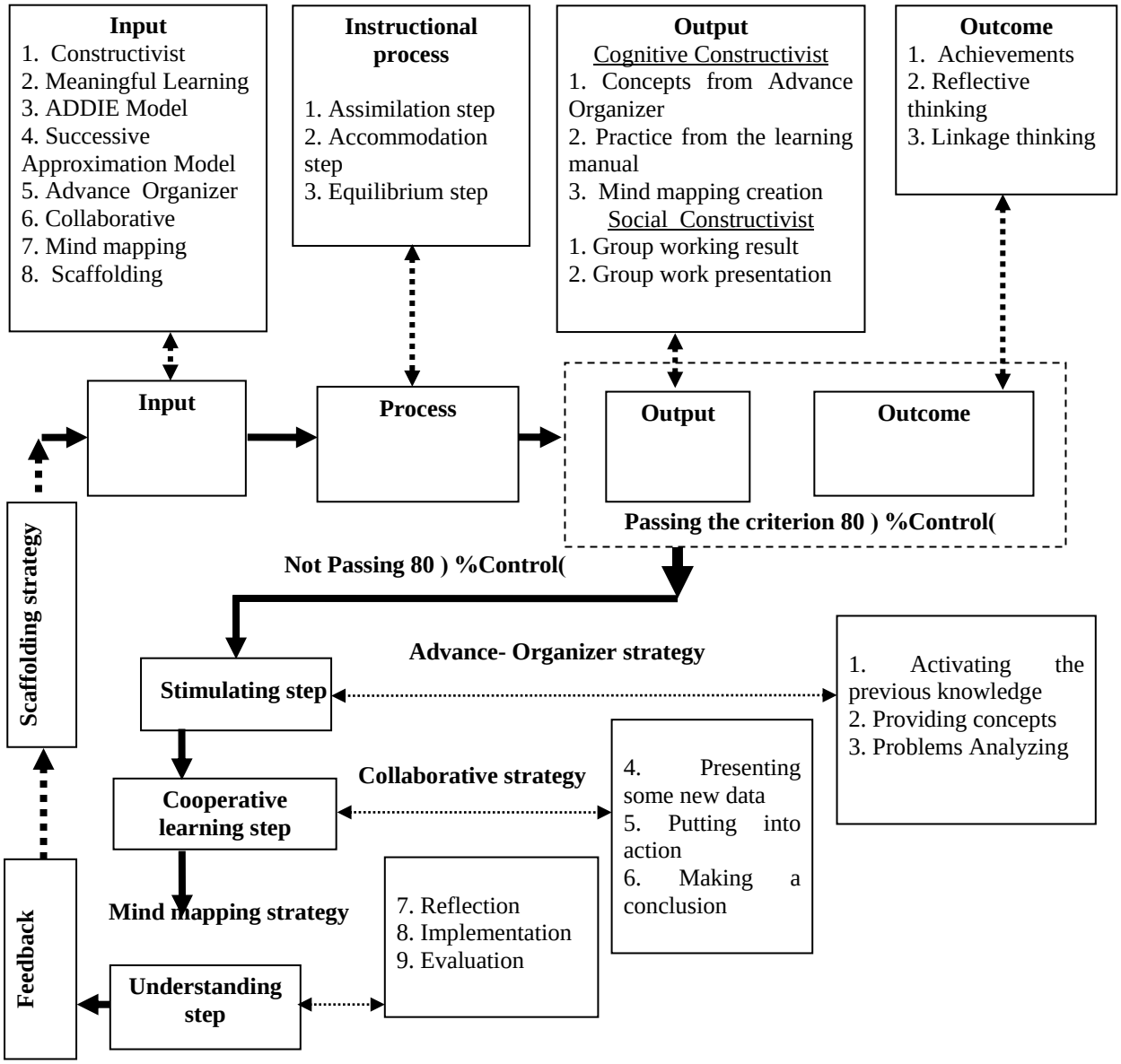
The ideas about the principles of five attributes of meaningful learning by David H. Jonassen and others are those for designing learning environment based on the constructivist theory. The five attributes emphasize a design of authentic learning activity for students' cooperative learning through the context of social construction. The five attributes also emphasize learning exchanges among students by letting them have an opportunity to converse with each other and present various ideas to each other and by letting them choose data reasonably for reaching a collaborative conclusion which leads to meaningful learning. Also, the instructional technology application is a supporter of five

attributes of meaningful learning (David H. Jonassen and others, 2003). Those five attributes are: (1) meaningful learning is active: manipulative/observant, (2) meaningful learning is constructive: articulate/reflective, (3) meaningful learning is intentional: reflective/regulatory, (4) meaningful learning is authentic: complex/contextualized, (5) meaningful learning is cooperative: collaborative/conversational. Learning activity as expressed by combining these five attributes together yields meaningful learning from interactions which result in reflective learning. It is learning which is much more than merely the personalized learning. There is a plenty of various learning technologies which support meaningful learning.

3. Principles of the Model Design

The study employed a structured questionnaire for collecting data from a panel of 21 experts in Thailand, whose doctorates concerning educational management, work experience and academic work proved a qualification for them to judge for the appropriate model. To reach a consensus among the experts, the criterion for the average score according to their opinion on five attributes of meaningful learning (David H. Jonassen and others, 2003), is set at between the high and the highest levels (means = 3.50-5.00). The inputs for the model include Advance Organizer (Ausubel, David, 1978), scaffolding (Vygotsky, L., 1978), e-learning presented in sequences based on the successive approximation model (Allen, W. Michael, 2006), and Basic Education Curriculum (B.E. 2551). The related theories and principles were considered for the design like: five attributes of meaningful learning, meaningful learning using the principle of linkage between previous and new information (subordinate learning) together with the ever-learned principle (combinatorial learning) [3], the principle of designing an instructional management system based on the ADDIE Model (Allen, W. Michael, 2006), the design of learning for being presented in sequence or linear presentation based on the Successive Approximation Model, the conceptual layout or Advance Organizer (Ausubel, David, 1978), cooperative learning (Johnson, D.W. & Johnson, R.T., 1994), reflective thinking through mind mapping, and scaffolding or teacher-assisted-teaching (Figure 1).

Figure 1: The e-learning model based on the meaningful learning process through a constructivist theory



4. Experiment

4.1 Participants

4.1.1 Population

The population comprised 309 students of the first year secondary level in the schools under the supervision of the Office of Nakhon Phanom Educational Service Area 2

4.1.2 Sample Group

Thirty students at the secondary level purposively selected from those who were enrolled at Ban Kha Phithayakhom under the supervision of the Office of Nakhon Phanom Educational Service Area 2 were investigated for the efficiency of the e-learning model based on the meaningful learning process through a constructivist theory.

4.2 Methods of Assessment

The author assessed the cognitive constructivist outputs from these: (1) concepts from a conceptual layout, practices from a learning manual, mind mapping creation in the social constructivist aspect, group work performance, and group work presentation; while the outcomes were assessed from these: (1) learning achievements, (2) reflective thinking, and (3) linkage thinking. The method of assessment was specified following the idea of Borg and Gall into 4 stages as follows: (Borg, R. Walter and Damien Meredith Gall, 1979)

1. Stage 1: Study of background. A survey was conducted for investigating the problems and needs of teachers and secondary students to manage the instructional process in the science learning substance group. The procedure was carried out using a questionnaire to ask their problems and needs in instructional management through the e-learning model based on the meaningful learning process using a constructivist theory, and to ask for some suggestions.

2. Stage 2: Construction of the Model. This author created an e-learning model based upon the meaningful learning through a constructivist theory and then sent it to be examined by experts for 2 rounds, first round by 21 experts.

3. Stage 3: Study of the Model's efficiency and effectiveness. The Model was implemented through 30 first year secondary students on the basis of one to one testing, small group testing, and field testing by 7 content units covering 21 hours (Figure 2).

Figure 2: An illustration of e-learning presentation for meaningful learning in the science learning substance group

Methodology. The author operated as follows.

3.1 Holding a workshop to plan cooperative instruction management for allotting a calendar of carrying on tasks among these people: educational supervisors, this author, the first year secondary level teachers in the science learning substance group, and the sample of students participated in this study.

3.2 Operating the plan according to the participatory allotted calendar of carrying on the instructional process based on the e-learning model constructed by this author.

3.3 Evaluating the instructional management process and holding a seminar for measuring satisfaction with participation between the teacher and students.

4.3 Results of the Study

4.3.1 A study of problems and needs of students and teachers in instructional management in the science learning substance group based on the meaningful learning through a constructivist theory.

Table 1: Results of analyzing problems and needs of students and teachers in the science learning substance group at the first year secondary level

No.	Particulars	Levels of opinion			
		Students		Teachers	
		Problem	Need	Problem	Need
1.	The Basic Education Curriculum (B.E. 2551)	Medium	Medium	Medium	High
2.	Science Instruction Management	Medium	High	Medium	High
3.	Cooperative Learning	Medium	High	Medium	High
4.	Conceptual Layout Construction	Medium	High	Medium	High
5.	Helping Students	Medium	High	Medium	High
Total		**Medium**	**High**	**Medium**	**High**

4.3.2 An assessment of appropriateness of the e-learning model by the experts based on the meaningful learning process through a constructivist theory developed by this author. The results of evaluation are presented in Table 2.

Table 2: Opinion of experts on the meaningful learning model

No.	Particulars	Opinion		
		$\overline{X}$	S.D.	Level
1.	Principle of Five Attributes of Meaningful Learning	4.66	0.46	Highest
2.	Principle of Conceptual Layout) Advance Organizer)	4.61	0.47	Highest
3.	Principle of Assisting Students) Scaffolding)	4.66	0.56	Highest
4.	Principle of Developing E-learning	4.52	0.55	Highest
5.	Basic Education Curriculum (B.E. 2551)	4.57	0.63	Highest
6.	Principle of Science Instruction Management	4.53	0.64	Highest
7.	Principle of Designing the Instructional Management Model	4.58	0.62	Highest
8.	Principle of Designing the Scientific Process Skill Teaching	4.63	0.61	Highest
9.	Principle of the Cooperative Learning Model by Johnson & Johnson	4.56	0.67	Highest
10.	The Main and Secondary Components and Their Relationships with the Meaningful Learning Process	4.71	0.45	Highest
Total		**4.61**	**0.57**	**Highest**

4.3.3 A study of the efficiency of the e-learning model based on the meaningful learning process through a constructivist theory (Table 3)

Table 3: The efficiencies of the process and learning based on the e-learning model through the meaningful learning process

No. of Students	**Process Efficiency (E_1))score of 60)**		**Learning Efficiency (E_2))score of 40)**	
	Average score	**Percentage**	**Average Score**	**Percentage**
30	50.03	86.72	34.47	86.17

Table 3 shows that the efficiency of the e-learning model based on the meaningful learning through a constructivist theory as constructed by this author has an index of 86.72/86.17.

4.3.4 The learning achievements gained before and after learning through the e-learning model based on the meaningful learning process (Table 4)

Table 4: Learning achievement scores gained pre-test and post-test

Samples	**Students No.**	**Sum**	**Average Score) total =40)**	**Percentage**
Pre-test Post-test	30 30	784 1,034	26.13 34.47	65.33 86.17

Table 4 showed that the average score gained pre-test 26.13 or 65.33 % and the average score after learning is 34.47 or 86.17 from the full score of 40.

4.3.5 The index of the effectiveness of development of the e-learning model based on the meaningful learning process through a constructivist theory showed the value of 0.6009. Thus, it denotes students' increasing learning up to 60.09 %, which is higher than the acceptable criterion of effectiveness index of 0.50 or 50 %.

4.3.6 The comparison of learning achievements gained pre-test and post-test learning from the e-learning model based on the meaningful learning process through a constructivist theory (Table 5)

Table 5: Comparison of learning achievements pre-test and post-test the treatment

Achievement Scores	**N**	$\bar{X}$	**S.D.**	**t-test**	**P**
Pre-test Post-test	30 30	26.13 34.47	4.18 2.26	21.34*	.000

Table 5 shows that the mean posttest score of the students learning by using the designed method is higher than their mean pretest scores with the significance level of .05. This means that the students have better knowledge after learning by using the model.

Table 6: An assessment of reflective thinking, linkage thinking, and learning cooperation

Reflective Thinking		**Linkage Thinking**		**Learning Cooperation**	
Detail	**Quality Level**	**Detail**	**Quality Level**	**Detail**	**Quality Level**
.1Ask a	Highest	1. Observe	Highest	1. Participate	Highest

question				in Planning	
.2Self-ask 3.Link the thought ahead/as expected/to the present experience	Highest Highest	2. Explain 3. Listen	Highest Highest	2. Behave oneself based on duty	Highest
		4. Link the Relationship	Highest		
		5. Criticize	Highest	3. Cooperate in working	Highest
.4Assess	Highest	6. Collect data	Highest		
.5Analyze	Highest	7. Present knowledge	Highest	4. Express ideas	Highest
6. State a hypothesis	Highest	8. Show data quality	Highest		
.7Seek and consider a suitable alternative	Highest	9. Conclude accurately and correctly according to data evidence	Highest	5. Admit others' idea	Highest
		10. Responsible for the work assigned	Highest	6. Participate in activity constantly	Highest

5. Conclusions

5.1 The e-learning model based on the meaningful learning process through a constructivist theory comprises the following: 1) Stimulation Step: (1) reviewing the previous knowledge, (2) filling up with the concepts, (3) inserting of the problem; 2) Participation in Learning Step: (1) studying new data, (2) various experiments, (3) participative conclusion making; 3) Knowing and Understanding Step: (1) having reflective thinking about knowledge, (2) applying the knowledge in daily living, (3) determining or assessing the value of knowledge.

5.2 The efficiencies of process and learning were 86.72 and 86.17 respectively, and the index of effectiveness was 0.6009. The students had a significantly higher learning achievement after learning than that before learning at the .05 level.

5.3 The assessment of reflective thinking, linkage thinking, or learning cooperation as a whole was at the highest level.

In conclusion, the e-learning model helps students to be able to create knowledge by linking the previous with the new knowledge, and able to participate in learning until they understand it and bring it to integrate with daily living application. The Model is able to help with solving a problem given in scientific learning, able to decrease scientific misconceptions which will result in a positive attitude towards learning. By application of the Model, students are able to have a higher learning achievement. So, the Model is recommended for use in learning management at the secondary level in Thailand.

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