ISSN 2408-1809
Rangsit Journal of Educational Studies, Vol.4, No.2, pp.1-11, July-December 2017

doi: 10.14456/rjes.2017.13

The Study of Learning Achievements and Developmental Scores from Biology Subject of the Tenth Grade Students: The Comparison between the 5E Inquiry Learning Model and the Active Learning Model Employed in Cellular Respiration Topic

Kittikorn Hongyim[1]
Faculty of Education, Rangsit University, Thailand
imkittikorn@gmail.com

Kanokporn Chayaburakul[2]
Faculty of Science, Rangsit University, Thailand
kanokporn.c@rsu.ac.th

Abstract
The action study aims (1) to compare the learning achievements in Biology subject, in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School between the experimental groups using Active Learning Model and 5E Inquiry Learning Model and (2) compare the developmental scores from Biology subject, in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School between the experimental groups one using Active Learning Model and the other, 5E Inquiry Learning Model. The sample of this study is the tenth grade students from two classrooms of Science-Mathematics major, Kanaratbamrung Pathumthani School, Muang District, Pathumthani province. The study was conducted in the first semester, Academic year 2017. The samples were selected by purposive sampling method. In addition, it is necessary to note that both classrooms were under the responsibility of the researcher as a teacher. Four research instruments were (1) the lesson plans of Active Learning Model and 5E Inquiry Learning Model: 6 plans per each model, (2) Student and Teacher Behavioral Observation Form, (3) the Field Note designed to record any phenomenon that may occur during the in-class period and (4) the Learning Achievement Test. The results of the study are (1) the post-learning achievements of the tenth grade students showed that the experimental group using the 5E Inquiry Learning Model (Class 3 students) had higher scores than the experimental group using the Active Learning Model (Class 2 students). The results indicated the statistically significant difference ($p < 0.05$) and (2) the developmental scores of the tenth grade students between the experimental group using the Active Learning Model (Class 2 students), while the experimental group using the 5E Inquiry Learning model (Class 3 students) showed no statistically significant difference ($p > 0.05$).

Keywords: *Active Learning Model, 5E Inquiry Learning Model, Cellular respiration, Secondary school students*

1. Introduction

Science is a study about facts of nature by using scientific processes in inquiring knowledge systematically. It aids humans in developing their thinking processes and problem solving skills. Therefore, everyone needs to study science in order to understand

the nature and the human made technology. Moreover, the knowledge must be applied correctly (Ministry of Education, 2017: 78).

Cellular Respiration is a lesson in Biology subject (Book I), a learning area of science, compiled by the cooperation of the Institute for the Promotion of Teaching Science and Technology (IPST) and Ministry of Education (MOE) (2012: 125-134). The lessons are related to a set of metabolic reactions and processes that convert biochemical energy from nutrients into adenosine triphosphate (ATP). Additionally, it is important primary knowledge for various biological studies in tertiary level (Ross, Tronson and Ritchie, 2008: 163-168).

The Program for International Student Assessment (PISA) found that, in 2015, Thailand was ranked Number 56 from 72 member countries. According to PISA assessment results from 2000 to 2015, Thailand tended to continuously drop its rankings. Consequently, the assessment results clearly indicate that Thai students' efficiency, especially in Science is still weak (Promotion of Teaching Science and Technology and Ministry of Education, 2017: 1-8).

The students' exam results from Biology subject, in the topic of Cellular Respiration in Academic years 2016 and 2017 from Kanaratbamrung Pathumthani School were lower than the standard scores. Moreover, from the experiences in teaching of professional senior teachers at the school, it is found that students have difficulty understanding the content, causing their exam results to a lower level. Additionally, the lessons have voluminous content and students need to comprehend the knowledge and be able to relate all contents together so as to understand the mechanical system of the learned issues (Ragdale and Pedretti, 2004: 621-626).

Active Learning Model is a learning process that allows the learners to be active in inquiring knowledge from classroom activities such as reading, writing, interaction with peers and problem solving. In this way, the learners will be able to construct the knowledge and apply, analyze, synthesize, evaluate or create the learner's efficiency development. Moreover, the model also develops the potential of the learners (Sutin, 2012: 4) in line with the National Education Act of 1999 which also emphasizes the learners' efficiency development (Ministry of Education, 2002: 8).

At present, both the Active Learning Model and the5E Inquiry Learning Model are widely used in teaching and learning. The 5E Inquiry Learning Model consists of 5 processes: 1) Engagement 2) Exploration 3) Explanation 4) Elaboration and 5) Evaluation. The teachers who apply these methods need to encourage the students to think by themselves. Additionally, the teachers or instructors also need to create the activities that allow the students to connect previous experiences with the new ones. The students are to use the learning processes and the scientific skills to inquire the knowledge. The Elaboration process is also an essential process that facilitates the students in applying the learned knowledge in problem solving in their daily life. In addition, the learning processes can lead the students to examine and search for knowledge continuously. They can also develop their high level of critical thinking and creativity (Kanjanarakpong, 2006).

According to the previous studies and various problems found in Cellular Respiration, it is interesting to compare the student learning achievements brought about by the two learning models namely, the 5E Inquiry Learning Model and the Active Learning Model in the topic. The study focuses on the tenth grade students. Hence, this

study aims to investigate which model is more appropriate for teaching biology and could also be applied to other subjects.

2. Objectives of the Study

1. To compare the learning achievements in biology in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School between the two experimental groups using Active Learning Model and 5E Inquiry Learning Model.

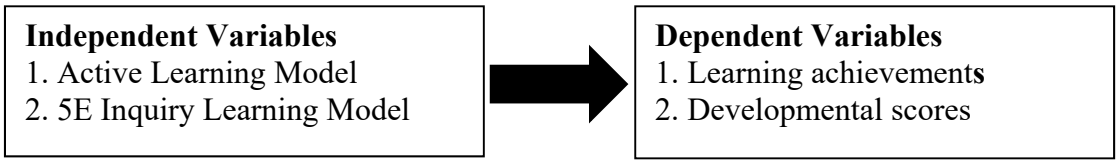
2. To compare the developmental scores in biology, in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School between the two experimental groups using the Active Learning Model and the 5E Inquiry Learning Model.

3. Hypothesis of the Study

1 . In Biology subject, in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School, the Active Learning Model is more effective than the 5E Inquiry Learning Model in learning achievements.

2 . In Biology subject, in the topic of Cellular Respiration of the tenth grade students from Kanaratbamrung Pathumthani School, the Active Learning Model is more effective than the 5E Inquiry Learning Model in developmental scores.

4. Scope of the Study



5. Research Methodology

1. Population and samples

The tenth grade students from two classrooms of Science-Mathematics major, Kanaratbamrung Pathumthani School, Muang District, Pathumthani province were the population group of the study conducted in the first semester, Academic year 2017.

2. Samples

The tenth grade students from two classrooms of Science-Mathematics major, Kanaratbamrung Pathumthani School, Muang District, Pathumthani province. The study was conducted in the first semester, Academic year 2017. The samples were selected by purposive sampling method. In addition, it is necessary to note that both classrooms were under the responsibility of the researcher as a teacher.

3. Variables in the study

Independent variables

1. Active Learning model
2. 5E Inquiry Learning model

Dependent variables

1. Learning achievements
2. Developmental scores

4. Content used in teaching

The content used in the study was taken from the academic curriculum referring to the Basic Education Curriculum 2008, Science branch, high school level, main point 1, Organisms and Living, Cellular Respiration chapter.

5. Period of the study

The study was conducted from May to December 2017 and the data was collected during the first semester, Academic year 2017, from 1st of July 2017 to 1st of August 2017. The overall time of the study was 16 sessions: 55 minutes per session.

6. Instrumental Construction

1. Lesson plans of the Active Learning Model and 5E Inquiry Learning Model: 6 plans per each model. The researcher followed the steps of constructing the instruments as follows: -

1.1 The researcher studied the theories, teaching approaches and previous studies related to the lesson plans. The lesson plans were designed for both learning models, Active Learning and 5E Inquiry Learning for teaching Biology, in the topic of Cellular Respiration.

1.2 The researcher designed the lesson plans based on the Active Learning Model and the 5E Inquiry Learning Model. The lesson plans consisted of the main content, indexes, learning contents, learning objectives, learning materials, organization of learning approaches, media for accessing sources of knowledge and evaluation criteria. Then, all materials were proposed to the thesis advisor and the experts for further approval.

2. The Student and Teacher Behavioral Observation Form was developed for recording the in-class behavior of the students and the teachers. The researcher's assistant was responsible for keeping the record of what was going on while the researcher was teaching.

3. The Field Note was designed to record any phenomenon that may occur during the in-class period. It aimed not only to collect the comments or impression of the students, but also any unsuitable behaviors or conflicts that might occur due to the presence of the researcher. Thus, the field note was expected to yield additional data.

4. The Learning Achievement Test for Biology, in the topic of Cellular Respiration was planned following the steps below:-

4.1 The researcher studied the standard educational documents, indexes and the school curriculum as well as the scientific tests, the criteria for actual assessment and evaluation.

4.2 The researcher created the four-choice objective test consisting of 60 items. The test was based on the learning objectives and the assessment criteria which only 40 items out of 60 items of the test were used for the actual test. The reason was to prevent any errors that might occur. Thus, creating 60 items and using only 40 articles was believed to be sufficient.

4.3 The test then was proposed to the thesis advisor and the experts for further approval. The specialists in assessment and evaluation including an assessment expert, a content expert, a teaching expert and a media expert to verify the concordance of the tests and the learning objectives, or so called Index of item Objective Congruence (IOC) (Laobensa, 2016). The commentators checked the suitability of the test time and the correctness of the questions and choices. The results of IOC were recorded in details. After that, the test was piloted with eleventh grade students from Kanaratbamrung,

Pathumthani School, during the first semester, Academic year 2017. Those students had learned about Cellular Respiration prior to the test. Next, the data was collected from the test scores and then analyzed the item difficulty (P) and discrimination (R) by using a computer program for test reliability. The items had a difficulty point between 0.20-0.80 (Laobensa, 2016) and had a discrimination point between 0.20-1.00 (Laobensa, 2016). The items which were not included in the adjusting criteria were then proposed to the experts one more time and the approved items were then used with the real sampling groups.

7. Data Analysis

7.1 The data obtained were then compared to identify the results from achievement scores from Biology, in the topic of Cellular Respiration between the two groups of the tenth grade students from Kanaratbamrung Pathumthani School. One experimental group employed the Active Learning Model and the other, the 5E Inquiry Learning Model. The data collected were analyzed by using statistical analysis. The comparison in the same group sample was done by using T-test for Dependent Sample statistic and the comparison of the different group samples was done by using T-test for Independent Sample.

7.2 The developmental scores from Biology, in the topic of Cellular Respiration of the two experimental groups of tenth grade students from Kanaratbamrung Pathumthani School, using different learning models, were compared. The data were analyzed by using statistical analysis, T-test for Independent Sample.

8. Results and Discussion

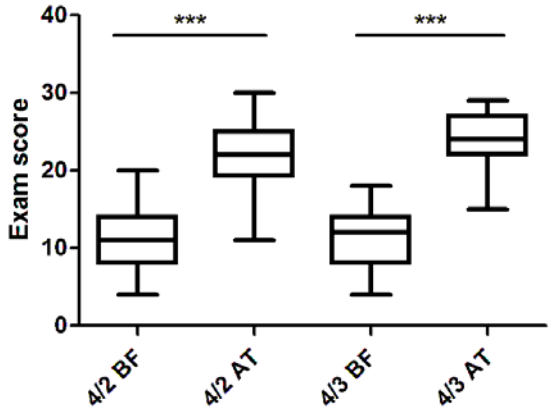


Fig. 1 shows the comparison of pre- and post-learning achievements of the tenth grade students between the Active Learning Model Group (Class 2) and the 5E Inquiry Learning Group (Class 3). *** p = 0.0001

Table 1 shows the comparison of pre- and post-learning achievements using the Active Learning Model of the tenth grade students (Class 2).

Samples (N=40)	**Full score**	$\bar{x}$	**S.D.**	**t**	**p**
Before	40	11.00	4.17	14.42	0.0001***
After	40	21.63	4.35		

*** Significant difference .0001

From the table, it is found that the learning achievements of the Active Learning Model group showed statistically significant difference.

According to the results, it can be seen that the Active Learning Model is a learning pattern that can improve the students' learning performance in Cellular Respiration.

The standard deviation (SD) value of pre-learning achievements of the Active Learning Model group is less than the SD value of the post-learning achievements. It indicates that the Active Learning Model suits some learners because the distribution of the SD value in the pre-learning achievements was found to be higher than that of the post-learning achievements.

Table 2 shows the comparison of pre- and post-learning achievements using the 5E Inquiry Learning Model of the tenth grade students (Class 3).

Samples (N=40)	**Full score**	$\bar{x}$	**S.D.**	**t**	**p**
Before	40	11.61	3.51	17.80	0.0001***
After	40	23.88	3.17		

*** Significant difference .0001

From the table, it is found that the learning achievements of the 5E Inquiry Learning Model group showed statistically significant difference.

According to the results, it seems likely that the 5E Inquiry Learning Model is a learning pattern that can improve the students' performance too.

Moreover, the difference of the SD value of pre-learning achievements in 5E Inquiry Learning Model is lower than that of the post-learning achievements. That means the post scores of the learners are not vastly scattered.

The distribution of the pre-scores of is lower than that of the post scores. It indicates that the 5E Inquiry Learning Model can improve most of the students better than the Active Learning Model.

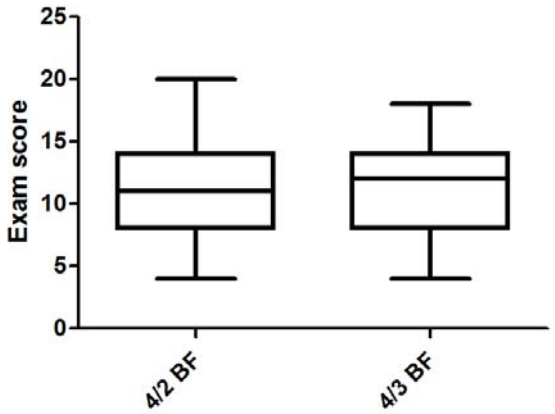


Fig. 2 shows the comparison of pre-learning achievements of the tenth grade students between the Active Learning Model group (Class 2) and the 5E Inquiry Learning Model group (Class 3) that showed no statistically significant difference ($p > 0.05$)..

Table 3 shows the comparison of pre- and post-learning achievements of the tenth grade students from both Class 2 and Class 3.

Samples (N=40)	**Full score**	$\bar{x}$	**S.D.**	**p**
Class 2	40	11.00	4.17	0.5096^{ns}
Class 3	40	11.61	3.5	

ns = non-significant difference
AL= Active Learning Model group
5E = 5E Inquiry Learning Model group

From the table, the results showed no significant difference ($p > 0.05$) in the learning achievements of both groups before employing the learning models: the Active Learning Model and the 5E Inquiry Learning Model,

The pre-learning achievements of both Class 2 and Class 3 are not significant different and the mean value is close at 11.00 and 11.61 respectively. It seems likely that the both classes have equal basic knowledge of Cellular Respiration. Additionally, it shows no significant difference.

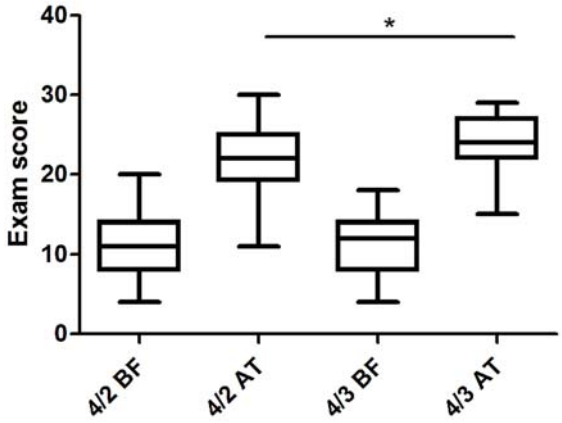


Fig. 3 shows the comparison of post-learning achievements of the tenth grade students between the Active Learning Model group (Class 2) and the 5E Inquiry Learning group (Class 3). * p = 0.05

Table 4 shows the comparison of pre- and post-learning achievements of the tenth grade students using Active Learning Model (Class 2) and the 5E Inquiry Learning Model (Class 3).

Samples (N=40)	**Full score**	$\bar{x}$	**S.D.**	**t**	**p**
AL group	40	21.63	4.35	2.64	0.0101*
5E group	40	23.88	3.17		

* Significant difference .05

AL= Active Learning Model group
5E = 5E Inquiry Learning Model group

From the table, in terms of the learning achievements, it was found that the scores of the two groups showed statistically significant difference after the groups had been exposed to two different learning models: the Active Learning Model and the 5E Inquiry Learning Model.

As for the mean value of both sample groups, the results show that the mean value of Class 2 by the Active Learning Model is 21.63, while that of Class 3, treated by the 5E Inquiry Learning Model, is 23.88. The mean value of Class 3 is statistically higher than that of Class 2 ($p < 0.05$). That means the learning achievements after using the 5E Inquiry Learning Model is better than those after using the Active Learning Model. Moreover, the enhancement and learner supporting in the 5E Inquiry Learning Pattern is better than those of the Active Learning Model.

In the comparison of the SD value of the post-learning achievements of both groups, it was found that the SD value of Class 3 is lower than that of Class 2. The result confirms that the 5E Inquiry Learning Pattern is greater than the Active Learning Pattern.

The results reject the hypothesis of the study. It can be assumed that the the 5E Inquiry Learning Model allows more opportunities for the learners to think by themselves, to observe, to inquire the knowledge by asking questions and to search for the solutions or construct new knowledge through their thinking processes and action processes by using scientific methods as a tool (The Institute for the Promotion of Teaching Science and Technology (IPST), 2014). Additionally, Class 3 students had already had better basic learning than Class 2 students, so it could also be one of the factors that caused the achievement results to be higher. The findings were in line with the previous study of Suphap Sitthisak (2014) in which he compared the academic achievements in Physics subject and the students' attitudes towards Science of Grade 10 students using the 5E Inquiry Learning Cycle and the 4 MAT Learning Cycle. The results revealed that the students using the 5E Inquiry Learning Cycle had better academic achievements than the students using the 4 MAT Learning Cycle which showed the statistical significance at .05 level.

Table 5 shows the comparison of developmental scores of the tenth grade students using the Active Learning Model (Class 2) and the 5E Inquiry Learning Model (Class 3)

Samples (N=40)	$\bar{x}$	**S.D.**	**t**	**p**
AL (Class 2)	10.63	4.60	1.63	0.1062^{ns}
5E (Class 3)	2.27	4.33		

ns = non-significant difference

From the table, it is found that after using two different learning models: the Active Learning Model and the 5E Inquiry Learning Model, the developmental scores showed no significant difference ($p > 0.05$).

The developmental score is the post-test score deducted by the pre-test score. After that, both developmental values is compared by statistics. From the outcomes, the students who got high scores in the pre-test also scored high in the post-test. That caused the developmental score to be low, while some learners who got low pre-test scores could score higher in the post-test. That made their developmental values high. The results

reveal that the developmental score of both the 5E Inquiry Learning Model and the Active Learning Model groups is not significant difference ($p > 0.05$).

According to the statistic results, the developmental scores of the 5E Inquiry Learning model and those of the Active learning model are not significant different because both of the learning patterns can enhance the potential of the students in the same way. Additionally, the findings correlate with what was found in the study of Rotjanakunnatam, Santiboon and Chayaburakul (2014), Developing the Conceptual Instructional Design with the Inquiry-Based Instruction Model of Secondary Students at the 10^{th} Grade Level on Digestion System and Cellular Degradation Issue. The results indicate that a number of students have wrong conceptual ideas but they could not improve their understanding on the topic.

The results reject the hypothesis of the study since both learning models are equally efficient in enhancing the achievements of the students in learning biology in the topic of Cellular Respiration.

Results of the Study

1. The post learning achievements of the tenth grade students showed that the experimental group using the 5E Inquiry Learning Model (Class 3 students) had higher scores than the experimental group using the Active Learning Model (Class 2 students). The results indicated the statistically significant difference ($p < 0.05$).

2. The developmental scores of the tenth grade students between the experimental group using the Active Learning Model (Class 2 students) and the experimental group using 5E Inquiry Learning Model (Class 3 students) showed no statistically significant difference ($p > 0.05$).

9. Suggestions

The researcher offers some suggestions from this study for further research as follows:-

Suggestion for implementation of the research models

Active Learning is an activity-dominated learning approach, thus clear instructions should be given prior to doing the activities so that the students will clearly understand the steps.

Suggestion for future study

The comparison between the use of the Active Learning Model and the 5E Inquiry Learning Model should be repeated to reassure the results of this study.

10. The Authors

Kittikorn Hongyim is a graduate student in the M.A. Program in Teaching Science at the Faculty of Education, Rangsit University, Thailand. His current research is in the area of science education with a focus on biology at the secondary school level.

Kanokporn Chayaburakul has a Ph.D. in anatomy from Mahidol University. At present, she is an Assistant Professor in the Faculty of Science, Rangsit University, Thailand. She is currently Head of the of Anatomy Unit, Faculty of Science, Rangsit university. Moreover, she has been the Director of International Medicine (India) of Rangsit University.

11. Acknowledgements

My great appreciation goes to Asst. Prof. Dr. Kanokporn Chayaburakul in Department of Medical Sciences, Faculty of Science, Rangsit University, my major advisor in this research and Miss Vanida Wattanatum for her research support. Special thanks are for Grade 11 students a total of 404 students at Kanaratbamrung Pathumthani School, who kindly and willingly cooperated with the researcher. My gratitude also goes to the Institute for the Promotion of Teaching Science and Technology (IPST) for fully funding this study.

12. References

Bloom, B. S. (1956). Taxonomy of Educational Objectives. The classification of educational goals-Handbook I: Cognitive Domain. New York: McKay.Deakin University.

Kemmis, S., & McTaggart, R. (Eds.). (1988). The action research reader. Geelong, Victoria: Deakin University Press.

Ministry of Education. (2002). National Education Act of 1999. Bangkok: Kurusapa Printing Ladphrao.

Ministry of Education. Basic Education Curriculum 2008. (Online). Retrieved from http://math.ipst.ac.th/wp-content/uploads/2015/PDF/Curriculum%202551.pdf, June 24, 2017.

Phuket Rajabhat University. (2014). The 5 th International Conference of Science Educators and Teachers, June 6, 2016, Phuket Rajabhat University.

Wikian P. (nd). Multimedia Technology. (Online). Retrieved from https://krupiyadanai. wordpress.com/computer4, July 23, 2017.

Promotion of Teaching Science and Technology and Ministry of Education. (2012). Additional Biology 1 Science branch. Bangkok: OTEP.

Promotion of Teaching Science and Technology and Ministry of Education. Study conclusion PISA 2015. (Online). Retrieved from https://drive.google.com/file/d/0BwqFSkq5b7zScUJOOV9ldUNfTlk/view, July 7, 2017.

Promotion of Teaching Science and Technology. Learning pattern that develop high level thinking. (Online). Retrieved from http://biology.ipst.ac.th/?p=688, July 7, 2017.

Ragsdale. F. R. and K. M. Pedretti. (2006). Making the Rate: Enzyme Dynamics Using Pop-It Beads. The American Biology Teacher, 9, 621-626.

Ragsdale. F. R. and K. M. Pedretti. (2006). Making the Rate: Enzyme Dynamics Using Pop-It Beads. The American Biology Teacher, 9, 621-626.

Ross, P. M. and et al. (2008). Increasing Conceptual Understanding of Glycolysis & the Krebs Cycle Using Role-play. The American Biology Teacher, 3, 163-168.

Kanjanarakpong, S. (2006). Manual of thinking skill assessment. Bangkok: Thanarksorn.

Sitthisak. S. (nd).The comparison of academic achievement toward physics learning and scientific attitude of student-grade 10 between inquiry learning cycle 5Es and the 4 MAT learning cycle. (Online). Retrieved from http://newtdc.thailis.or.th/docview.aspx?tdcid=17665, June 9, 2017.

Sutin, T. (2012). Active Learning…Learning Actively. Bangkok: PBL WU Newsletter.