THE DEVELOPMENT OF STEM EDUCATION LEARNING ACTIVITY SUPPLEMENTED WITH THE FORMATIVE ASSESSMENT FOR ENHANCING THE STUDENTS' UNDERSTANDING OF WIND ENERGY AND THE ABILITY IN INVENTING THE WIND TURBINE

BOONLIANG CHORDNORK
Ban Hua Bung School, Udonthani School
moopun2009@gmail.com

INTRODUCTION

The issues of the wind, wind energy and the transformation of the wind energy into electricity were included in the science course no.5 under the Basic Education Core Curriculum B.E. 2551 (2008). Also, the objective of developing the students' performance was determined in the section of human development of the 12th Plan of the National Economic and Social Development Board (NESDB) whose focus was on the development of skills important in the 21st century.

Since this national purpose was crucial, it was necessary for the teacher to develop the learning process that could be applied in the students' real life, rather than the study that focused on only lessons and tests. As a result, the STEM Education supported the learning from the real practice and the ability in significantly applying their knowledge in solving the real problems.

In the meantime, according to the study on the process of engineering design based on STEM concept, it was summarized that the students developed their higher skills in inquiring, in linking their knowledge and in creative thinking. (Passorn Tidma, 2015: Nongnuch Ektrakul, 2015). Moreover, it was found that the learning through cooperation and the formative assessment during the study affected the students to improve their work. The students were able to learn what they were doing, the problems they were facing, what they should do next or which kind of problems they had to solve. This enabled them to learn what they should improve. With the trend of studying the renewable energy, the study on wind and wind energy were significant issue. Apart from understanding what the wind was, how it was developed, its advantage and its drawbacks, the study on applying the wind energy as the renewable energy was necessary and may affect the use of other energies in human activities.

OBJECTIVES

The objective of this research was to evaluate the understanding of the 7th Grade students on the wind energy and their ability in inventing the wind turbine.

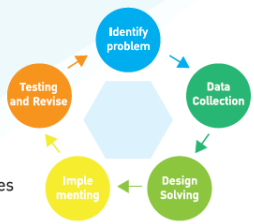
METHOD

The quantitative method (Cohen et al., 2011; Crewell, 2012) based on the Interpretive Paradigm were used to design the research, data collection and data analysis in order to explain the perspectives, concepts, experience and profound understanding of the students in learning the Wind Energy and in inventing the wind turbine. The intervention was conducted in the 1st semester of 2017 academic year in Hua Buang School located outside the municipality area of Udon Thani Province. The target group was 24 students of the 7th Grade that were selected by the method of Homogeneous Sampling (Creswell, 2012: 207).

RESEARCH TOOLS, DATA COLLECTION AND DATA ANALYSIS

The research tools used for data collection were the multiple choices test, the open-ended questionnaires and the observation form. The data collection was shown in picture.

1. Teaching and learning in classroom as well as conducting the engineering design process base on STEM education supplemented with formative assessment.
2. Using the observation form for evaluating students' understanding of the wind energy and the invention of the wind turbine.
3. Post-test by using the open-ended questionnaires
4. Post – test by using the multiple choice



The data were analyzed by the frequency and the combination of documentary interpretation (Erickson, 1986). Data analysis was showed below:

1) Preparing the data and transcribe verbatim,
2) Reading the data and repeat reading the data,
3) Data coding and reduction,
4) Conceptual categories, and
5) Thematizing and Interpret

OUTCOMES

The research outcomes could be concluded in three sections. First, the average score evaluated the students' understanding in learning the topic of Wind and Wind Energy. Second, the students' explanation about the wind energy, their design of wind turbine, their working plan based on STEM and the questions raised in the class reflected their understanding. Third, the students were able to invent the wind turbine. In this regards, each section was shown as follows:

Table 1 : The average score to evaluate the understanding of the 7th Grade students in terms of Wind, Wind Energy and the invention of the wind turbine.

Full score	Percent of standard (75%)	Post test		Standard Deliverage (S.D.)	No. of Students Passed (N)	Percent of Students Passed (%)
		Average score	Percent (%)			
20	15	15.75	78.75	2.25	20	83.33

Table 2 : The table of multiple frequency referred to 10 questions and the students' examples in understand and interpret the content.

Question No.	Details Found	Frequency	Topic for Interpretation
1, 2, 9	The wind in motion or kinetic energy caused the wind turbine to spin or mechanical energy. This latter energy was used to transform into the electricity.	14	Understanding in scientific concept
1, 2, 9	The energy from sun was transformed into the wind energy. Then, the motor converted the mechanical energy to the electricity.	10	Science misconception
5, 10	Electricity generator and the presentation of inventing the wind turbine	10	Understanding in technology
1, 4, 7, 8	The design of the windmill's propeller in terms of its best position: to face wind or to be perpendicular.	22	Understanding in engineering
3, 6	The calculation of the length, the width, the number of propellers, the similar shape and equal size of each windmill's propeller.	17	Understanding in mathematics

Table 3 : The test of the effectiveness of the wind turbine

Test No.	Problems found during the test	Fixing Method	Electricity (mA)
1	The turbine moved slowly and swayed because the propellers were not attached firmly with the core.	The turbine moved slowly and swayed because the propellers were not attached firmly with the core.	.....3.48.....
2	The propellers were too big and were positioned in different direction. This caused them to flap around.	The propellers were too big and were positioned in different direction. This caused them to flap around.	.....5.67.....
3	The core was stuck. The propelier core did not attach firmly.	The core was stuck. The propelier core did not attach firmly.	.....10.60.....

Table 4 : The assessment of the wind turbine invented by the students

Group No	Planning and Time			Balance			Design of Linking Point			Material's Cost Effectiveness			Quantity of Electricity			Creative Thinking			Total (18)	Assessment Result	
	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1	3	2	1		Pass	Fail
1		2		3				2			2				1		2		12	✓	
2	3			3			3				2		3			3			17	✓	
3		2			2		3					1		2			2		13	✓	
4	3			3			3			3			3				2		14	✓	
5		2			2			2			2		3			3			14	✓	
6	3			3				2		3			3			3			14	✓	

Criteria: Good – 14-18 scores, more than 80%, Fair – 10-14 scores, more than 60%, To improve – 0-9 scores, around 0-59%

Conclusion and discussion

1. Regarding the formative assessment after studying the Wind, the Wind Energy and the Invention of Wind Turbine based on STEM activities, it was concluded that the average score was 78.75%. Twenty students reached the higher score than the average score of 75%. This was accounted for 83.33% of total students. This was because the formative assessment was the real assessment that encouraged the students to reflect their view in activity simultaneously. Also, the questions asked during the session of designing the invention and the session of testing the effectiveness of the wind turbine in generating electricity attracted the students' attention and inspired them to improve their wind turbine to spin faster. This research was related to the self-assessment guideline and the research of Passorn Tidma, 2015: Nongnuch Ektrakul, 2015. The latter research highlighted the reflection that showed the improvement, the guideline and the goal for achievement.

2. According to the STEM activities, the students were found to have the most profound understanding in engineering. This was because the invention of the wind turbine highlighted the processes of design and invention. The knowledge in mathematics was applied for calculating the invention. Also, the knowledge in science in terms of using the evidence was utilized to prove that how much the wind turbine was able to generate the electricity. This was the confirmation of answer that took place naturally. (Vasquez et al, 2013). Concerning the misconception on the transformation of energy, the techniques of formative assessment, such as, create analog, POE Probes, Friendly Talk Probes and so on (Keeley Page, 2008) may have to be applied in order to inspire the students to share their views or to reflect their concepts.

3. The effectiveness in inventing the wind turbine relied on a number of factors, such as, the design, the planning, the time management, the analysis of invention component (the core of propellers, the linking point, the spinning point, etc.). To work on this invention efficiently, it was required to know how and to have experience in using equipments, such as, scissors, cutter, screwdriver, etc; and in selecting the material and the structure of the propellers & its position. These details were categorized in the part of engineering design which was a component of STEM activities.

References

- Creswell, J. W. (2012). Educational research: planning, conducting, and evaluating quantitative and qualitative research. (4th ed.). Boston, Pearson Education.
- Cohen, L., Manion, L., & Morrision, K. (2011). Research methods in education. (7th ed.). New York: Routledge.
- Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock. Handbook of Research on Teaching. (3rd ed.), New York: Macmillan.
- Keeley, P. (2008). Science formative assessment. Thousand Oaks, CA: Sage.
- Passorn Tidma (2015). The Development of Creative Thinking in Studying Human Body By Applying STEM Engineering Design for the 8th Grade Students. Thesis, Science Study, Naresuan University.

Recommendations

1) The researcher was aware that this research did not include the study of different genders (male/female) that may affect the inventing capacity or interest in doing invention. Therefore, the future research may highlight the study of gender factor whether it affected the ability in inventing and how.
2) The future research should concentrate in studying the opinions of students in different levels and in supporting the students to solve problems in situations. The study should be reasonable and cost-effectiveness as well as be able to reach final outcomes. Also, it should be studied regularly or taking 2-3 years for research in order to study the students' skill development in solving problem. The formative assessment or the assessment in the real situation should be applied by science teachers as a guideline for student development.
3) The opportunity in doing the real experiment with real tools and real situation resulted the students to be able to test the variables in studying science. This truly enhanced the students' learning. This opportunity could be seen from the Chevron Enjoy Science Project.