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การพัฒนารูปแบบการเรียนการสอนวิทยาศาสตร์ที่เน้นวิธีการสอนโดยใช้บริบทเพื่อส่งเสริมความเข้าใจมโนมติและการคิดวิเคราะห์

The Development of Science Instructional Model Emphasizing Contextual Approach to Enhance Conceptual Understanding and Analytical Thinking

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บทคัดย่อ

การศึกษานี้มุ่งที่จะพัฒนารูปแบบการเรียนการสอนวิทยาศาสตร์ที่เน้นวิธีการสอนโดยใช้บริบทเพื่อส่งเสริมความเข้าใจมโนมติและการคิดวิเคราะห์สำหรับนักเรียนระดับมัธยมศึกษาตอนต้น รูปแบบการเรียนการสอนวิทยาศาสตร์นี้เรียกว่า FEACA Model ประกอบด้วย 5 ขั้นตอนของการเรียนรู้ดังนี้ มุ่งความสนใจ, สำรวจตรวจสอบ, วิเคราะห์ข้อมูล, พัฒนาแนวความคิด, และประยุกต์ใช้ การวิจัยในครั้งนี้เป็นการวิจัยเชิงกึ่งทดลอง ดำเนินการตามแบบแผนการวิจัยแบบ pretest-posttest non-equivalent control group design กลุ่มตัวอย่างคือนักเรียนชั้นมัธยมศึกษาปีที่ 3 จำนวน 2 ห้องเรียน ห้องเรียนหนึ่งเป็นกลุ่มทดลองซึ่งสอนด้วย FEACA Model และอีกห้องเรียนเป็นกลุ่มควบคุมซึ่งสอนด้วยการเรียนการสอนแบบปกติ เครื่องมือวิจัยประกอบด้วยแบบทดสอบวัดความเข้าใจมโนมติซึ่งเป็นข้อสอบแบบปรนัยจำนวน 30 ข้อและแบบทดสอบวัดการคิดวิเคราะห์ซึ่งเป็นข้อสอบแบบปรนัยจำนวน 25 ข้อ เพื่อวัดความเข้าใจมโนมติและการคิดวิเคราะห์ก่อนและหลังทำการทดลอง ผลการวิจัยพบว่า FEACA Model ส่งเสริมความเข้าใจมโนมติและการคิดวิเคราะห์ของนักเรียนได้ดีกว่าการเรียนการสอนแบบปกติอย่างมีนัยสำคัญ

คำสำคัญ: รูปแบบการเรียนการสอนวิทยาศาสตร์, วิธีการสอนโดยใช้บริบท, ความเข้าใจมโนมติ, การคิดวิเคราะห์

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Abstract

The purpose of this study was to develop the science instructional model emphasizing contextual approach in order to enhance conceptual understanding and analytical thinking for lower secondary school students. This science instructional model consisted of 5 steps of learning namely 1) Focusing (F), 2) Exploring (E), 3) Analyzing (A), 4) Conceptual Developing (C), and 5) Applying (A) which has been called FEACA Model. A quasi-experimental research, pretest-posttest non-equivalent control group design, was used for evaluating the effectiveness of the model. The samples were two classrooms of the ninth-grade students. One classroom was serving as an experimental group taught with the FEACA Model whereas the other was serving as a control group taught with the traditional instruction. Research instruments consisted of the conceptual understanding test which was 30 items of multiple choice questions, and the analytical thinking test which was 25 items of multiple choice questions. They were used to assess students' conceptual understanding and analytical thinking before and after the treatment. The findings suggested that the FEACA Model was significantly better for promoting both students' conceptual understanding and analytical thinking compared with the traditional instruction.

Keywords: Science Instructional Model, Contextual Approach, Conceptual Understanding, Analytical Thinking

Introduction

Science has been accepted to have an extremely influence on people and societies throughout the world. The countries advancing in science and technology can become the world's leaders in every aspect. Consequently, many countries, including Thailand, put the main goals of national educational policy on the promotion of science conceptual understanding as well as conduct many researches for developing science curriculum that best fit to all students. It is arguable that the science curriculum still lack of the connection between science concepts and the real world or everyday life, which is interesting for students. Hence the real life or familiar situations could promote students' learning in science (Yasushi, 2009).

Not only science conceptual understanding but also analytical thinking ability is one of the important skills for scientific literate person. Thai educational policy indicated that the educational institutions should provide students with training in thinking process, confrontation with various situation, and application of knowledge for preventing and solving problems, as well as prepare activities for learners to derive from authentic experience. These correspond with the policy of the Ministry of Education in developing Thai children towards the 21st century. Emphasizing has been placed on knowledge and skills in analytical and creative thinking. Furthermore, one of the learners' key competencies of Thai educational policy is to encourage students in analytical thinking capacity leading to the creation of bodies of knowledge or information for sensible decision making regarding oneself and society (Ministry of Education, 2008).

There was an attempt to promote Thai students' science conceptual understanding and analytical thinking, however, the results indicated that the students' conceptual understanding in science and students' analytical thinking were still not satisfying especially in the lower secondary education which supported with many standard tests both national and international level (IEA, 2008; NIET, 2010; ONESQA, 2008; Phetdee, 2009). For example, the result of the National Institute of Educational Testing Service (Public Organization) (NIETS) on the Ordinary National Educational Test (O-NET) has indicated that the average science score of the ninth-grade students was fewer than 30 percent (NIETS, 2010). This corresponded with the outcome of the International Association for the Evaluation of Education Achievement (IEA) on the Trends in International Mathematics and Science Study (TIMSS) 2007 which reported that the average science scores of the eighth-grade Thai students were lower than the international mean (IEA, 2008). The results of the Office for National Education Standards and Quality Assessment (Public Organization) (ONESQA) have shown that students' analytical thinking in external quality assessment of basic education also did not reach the standard (ONESQA, 2008).

According to constructivist learning theory, learning is an active process which people create their own new understanding and knowledge of the world based on the interaction of what they already know and believe, and the phenomena or ideas which they come into contact. When people encounter something new, they have to reconcile it with their previous ideas or experience and change what they believe or discard the new information (Educational Broadcasting Corporation, 2004). Research suggested that students often succeed in problems in everyday life at which fail in formal setting, and do better at problems expressed in everyday or familiar context rather than an obviously scientific one (Whielegg, & Parry, 1999).

One application of constructivist theory is known as contextual approach. This approach introduces real life context and situation which students facing in their everyday life before the core science content to develop deeper understanding of scientific idea (Whitelegg, & Parry, 1999). The contextual learning is based on the principle that learning is most effective when information is presented with in a framework that familiar to the student (Souders, & Prescott, 1999). This approach is accepted to be an effective way to improve student's conceptual understanding attitude (Jong, 2008), achievement, problem solving, motivation, (Glynn, & Koballa, 2005), application of knowledge, and retention (Choi, & Johnson, 2005).

All the results above pointed that the lower secondary Thai students did not meet both national and international standards in both science conceptual understanding and analytical thinking. They performed below average and poorly as compared with the students in other countries. Therefore learning and teaching of science need to be changed and focus on the improvement of conceptual understanding and analytical thinking by using students' everyday life experience as a tool.

Therefore, the purpose of this study was to develop the science instructional model emphasizing a contextual approach in order to enhance students' conceptual understanding and analytical thinking for the lower secondary school students on force and motion concepts.

The key features of contextual approach and analysis processes of Marzano were used to be a framework for developing the science instructional model which consisted of 5 steps of learning namely Focusing, Exploring, Analyzing, Conceptual Developing, and Applying which has been called FEACA Model.

The Science Instruction Model

The conceptual framework for developing the science instructional model based on the key features of contextual approach and Marzano's analysis processes. The results of analyzing contextual teaching and learning strategies from the literature reviews could be summarized and synthesized into five important features as follows:

1. Students will be engaged with context or real life experience to catch their attention.

2. Students have an opportunity to do hands-on experience for exploring and collecting data.

3. Students develop their conceptual understanding by themselves under the facilitating of a teacher.

4. Students share and communicate their ideas with other students.

5. Students apply their knowledge they have learned in the class to other contexts.

For analytical thinking, Marzano (2001) has divided analysis processes into five types, namely, Matching, Classifying, Error analysis, Generalizing and Specifying.

The two main ideas, contextual approach and Marzano's analysis processes were used to develop the science instructional model. This model presented science teaching steps by using real life context and situation in everyday life for developing students' scientific conceptual understanding and analytical thinking. The model was called FEACA Model and composed of five steps as follows:

Step 1: Focusing

The purposes of this step are to catch students' attention and diagnose their prior knowledge by engaging them with real life context. At this step, the everyday life situation will be presented as a starting point in order to recall student's experiences related to that situation and check their prior knowledge about the concept they will learn in the class. Teacher encourages students to think by asking a question related to that situation. Students answer the question and compare similarities and differences of their own answers with their friends' answers as well as organize those answers into meaningful categories. Students communicate what they get by sharing with their peers. At the end of the step the answers will not be verified right or wrong, but it will be the problem for investigated in the next step.

Step 2: Exploring

The purpose of this step is to give students an opportunity to investigate through hands-on and mind-on exploration which built upon the everyday life situation from the first step. At this step, the students will be separated into small groups and do experiment or activity for exploring the answer of the questions developed in first step. The teacher acts as a facilitator helping the students if they meet any problems and checks whether the students obtain all necessary information for using in the next step.

Step 3: Analyzing

The purpose of this step is to give students an opportunity to analyze data and construct knowledge by their own under the facilitating of a teacher. At this step, the students find the relationship of information from their observation by answering the questions and summarizing what they get for constructing their own knowledge. The students communicate their understanding by sharing with the whole class.

Step 4: Conceptual Developing

The purpose of this step is to construct correct conceptual understanding about that topic under the facilitating of a teacher. At this step, the students discuss the conclusion from the previous step and re-shape their understanding under the facilitating of the teacher. Furthermore, the students study more about the topic from documents and relate the concepts they have learned with situation in the first step. The roles of the teacher are to help the students to construct scientific conceptual understanding and correct all misconception.

Step 5: Applying

The purpose of this step is to apply scientific concept to new contexts. At this step, the students in each group apply conceptual understanding they have learned in the class to new contexts or real life situations and share with the whole class. The students also need to give the reason to explain the reasonableness of information. The students in other groups evaluate validity of that application and identify any errors in reasoning that have been presented.

Research Questions

The research questions of this study were as follows:

1. Does the FEACA Model enhance students' conceptual understanding better than the traditional instruction?

2. Does the FEACA Model enhance students' analytical thinking better than the traditional instruction?

Research Objectives

In this study, the main purposes were as follows:

1. To develop and implement the science instructional model emphasizing contextual approach for the lower secondary school students.

2. To make a comparison between conceptual understanding of the students who learn through the FEACA Model and that of the students who learn through the traditional instruction.

3. To make a comparison between analytical thinking of the students who learn through the FEACA Model and that of the students who learn through the traditional instruction.

Research Hypotheses

For studying the effectiveness of the FEACA Model, the following hypotheses were tested:

H1: Students' conceptual understanding posttest mean scores of the experimental group were higher than the pretest mean scores with a statistically significant difference.

H2: Students' conceptual understanding posttest mean scores of the experimental group were higher than that of the control group with a statistically significant difference.

H3: Students' analytical thinking posttest mean scores of the experimental group were higher than the pretest mean scores with a statistically significant difference.

H4: Students' analytical thinking posttest mean scores of the experimental group were higher than that of the control group with a statistically significant difference.

Research Design

This study was a quasi-experimental research, the Pretest-posttest Non-equivalent Control Group Design. Teaching with the FEACA Model was used as the experimental group, and teaching with the tradition instruction was used as the control group and both groups were served as the independent variables, while the results of students' conceptual understanding and analytical thinking were served as the dependent variables (see Table 1).

Table 1: The Pretest-Posttest Non-equivalent Control Group Design

	Pretest	Treatment	Posttest
E	T_1	X	T_2
C	T_1	~X	T_2

The symbols indicate as follows:

E is experimental group

C is control group

T1 is pretest

X is teaching with the FEACA model

~X is teaching with the traditional instruction

T2 is posttest

Research Method

Population

The populations of this study were the lower secondary school students who were studying in the first semester of 2011 academic year in Uthaithani province, Thailand.

Sample

The samples in this study were two classrooms of ninth grade students who were mixed ability. They were studying in the first semester of 2011 academic year of a school in Uthaithani province, Thailand. This school was selected from schools using the Basic Education Core Curriculum B.E. 2551 (A.D. 2008) for the ninth-grade students by purposive sampling.

Sampling

After the conceptual understanding test and the analytical thinking test were administered with four classrooms of the ninth-grade students in Nongkhayangwittaya School, Mean and Standard deviation (S.D) of the pretest conceptual understanding scores and the pretest analytical thinking scores of four classrooms were analyzed one-way analysis of variance (One-way ANOVA) by using the F-test. The results have shown that each of the classrooms had no statistically significant difference in both the conceptual understanding and the analytical thinking. After that, the four classrooms were separated into two groups depended on the number of students, group 1: Gr. 9/1 and Gr. 9/2 and group 2: Gr. 9/3 and Gr. 9/4. The second group was selected by using simple random sampling. At last by using simple random sampling, the Gr. 9/4 was selected as the experimental group taught with the FEACA Model where as the Gr. 9/3 was selected as the control group taught with the traditional instruction.

Variables of the Study

The independent variables were the teaching with the FEACA Model for experimental group and the teaching with the traditional instruction for control group.

The dependent variables were the results of teaching in both groups on students' conceptual understanding and analytical thinking.

Content

The contents using in this study were developed based on the national science curriculum standard, Strand 4: Force and Motion, in the Basic Education Core Curriculum B.E. 2551 (A.D. 2008) for the ninth-grade students. The contents consisted of six topics as follows: 1) Acceleration, 2) Action and Reaction, 3) Friction, 4) Moment, 5) Buoyant Force, and 6) Motion of Objects.

Research Instruments

Research instruments for using in this study comprised of three components as follows:

1. The FEACA Model

The FEACA Model was developed from analyzing contextual teaching and learning strategies from the literature reviews integrated with the Marzano's analysis processes. This model consisted of 5 steps of learning namely 1) Focusing (F), 2) Exploring (E), 3) Analyzing (A), 4) Conceptual Developing (C), and 5)Applying (A). The draft FEACA model was evaluated by advisors and five experts to check the validity of the model. After gathering the data, the FEACA Model evaluation forms were analyzed Item of Consistency (IOC). The results of experts' consideration are shown in Table 6.

The results have shown that IOC of almost all items were more than 0.75 which meant the items were strongly congruence, and only one item was 0.60 which meant congruence. In conclusion, there was consistency in every aspect of the FEACA Model. These meant the FEACA Model was appropriate to be the science instructional model for using in the science classroom.

2.The Learning Unit by Using FEACA Model

The learning unit for using in this study was developed based on the five steps of the FEACA Model. The documents involving in the learning unit consisted of teacher's guide and instructional plans.

The teacher's guide was written in order to provide teacher necessary information about the leaning unit and the guidelines for using the FEACA model in the classroom.

The instructional plans were developed based on the FEACA Model. There were six instructional plans used in this study, each of which used for each content. Each instructional plan consisted of instructional sequences, instructional materials, assessment, evaluation, and work sheets for students.

The learning unit was examined the validity by using the Index of Consistency (IOC) (Table 7) and revised according to comments and suggestions of the experts before implementing.

3. The Conceptual Understanding Test

The conceptual understanding test was used to assess students' understanding the main concepts of "Force and Motion". The test composed of 30 items of multiple choice questions, each of which had only one correct answer and three alternative answers that were based upon students' misconceptions about the topics. The content areas covered in the test were: Acceleration, Action and Reaction, Friction, Moment, Buoyant Force, and Motion of Objects, each of which consisted of 5 items. Most of the questions were emphasized on the main concept in force and motion rather than the calculation and all were connected to real life. Some items were adapted from the Force and Motion Conceptual Evaluation (Thornton, & Sokoloff, 1998). The reliability of the test calculated with KR-20 formulations was 0.78. The validity was evaluated by three experts. The Index of Consistency (IOC), the item difficulty (p), and item discrimination (r) of the test ranged between 0.67-1.00, 0.23-0.75, and 0.21-0.63, respectively. The test was revised according to comments and suggestions of the experts before implementing.

4. The Analytical Thinking Test

The analytical thinking test was used to assess students' analytical thinking based on Marzano's analytical thinking which comprised of Matching, Classifying, Error Analysis, Generalizing, and Specifying. The test composed of 25 items of multiple choice questions. The reliability of the test calculated with KR-20 formulations was 0.79. The Index of Consistency (IOC), item difficulty (p), and item discrimination (r) of the test ranged between 0.67-1.00, 0.25-0.73, and 0.22-0.70, respectively. The test was revised according to comments and suggestions of the experts before implementing.

Data Collection and Analysis

The learning unit was implemented for 8 weeks. The assessment tools were applied for collecting data before and after implementation in both groups. The dependent samples t-test was performed statistically to find out the difference in pretest and posttest conceptual understanding mean scores, and the difference in pretest and posttest analytical thinking mean scores in experimental group for testing the first and the third hypotheses. Furthermore, the independent samples t-test was performed statistically to find out the difference in conceptual understanding posttest mean scores and analytical thinking posttest mean scores between both groups for testing the second and the fourth hypothesis.

The Results of Hypotheses Testing

This section presents the results of research hypotheses in this study which are as follows:

Results of Testing H1

For the first hypothesis, the results of comparison of students' conceptual understanding mean scores before and after implementation of experimental group are shown in Table 2.

Table 2: The comparisons of the pretest and posttest mean scores on students' conceptual understanding of experimental group

Score	N	Mean	S.D.	Mean of Difference	t	p
Posttest	29	13.517	4.380	6.138	4.600**	.000
Pretest	29	7.379	2.441			

** p < .01

The results of the dependent samples t-test indicated that students' conceptual understanding posttest mean scores were higher than the pretest mean scores at the .01 level of significance. The finding from the analyzed data implied that the FEACA Model was effective to enhance students' conceptual understanding on force and motion concept.

The Results of Testing H2

The second hypothesis focused on the comparisons of the posttest mean scores of students' conceptual understanding between the experimental group and the control group which are shown in Table 3.

Table 3: The comparisons of the posttest mean scores on students' conceptual understanding between experimental group and control group

Score	N	Mean	S.D.	Mean of Difference	t	p
Experimental group	29	13.517	4.380	3.828	2.121**	.000
Control group	29	9.690	2.106			

** p < .01

The results of the independent sample t-test illustrated that students' conceptual understanding posttest mean scores of the experimental group were higher than that of the control group at the .01 level of significance. The finding from the analyzed data implied that the FEACA Model was effective to enhance students' conceptual understanding on force and motion concept better than the traditional instruction.

The Results of Testing H3

The third hypothesis was the comparisons of students' analytical thinking mean scores before and after the implementation on the experimental group which are shown in Table 4.

Table 4 : Comparisons of the pretest and posttest mean scores on students' analytical thinking of experimental group

Score	N	Mean	S.D.	Mean of Difference	t	p
Posttest	29	13.241	4.172	3.103	3.254**	.000
Pretest	29	10.138	3.125			

** $p < .01$

The results of the dependent samples t-test indicated that students' analytical thinking posttest mean scores were higher than the pretest mean scores at the .01 level of significance. The finding from the analyzed data implied that the FEACA Model was effective to enhance students' analytical thinking for the lower secondary school students.

The Results of Testing H4

For the last hypothesis, the results of comparison of students' analytical thinking mean scores between experimental group and control group are shown in Table 5.

Table 5 : Comparisons of the posttest mean scores on students' analytical thinking between experimental group and control group.

Score	N	Mean	S.D.	Mean of Difference	t	p
Experimental group	29	13.241	4.172	2.448	1.227*	.000
Control group	29	10.793	3.385			

* $p < .05$

The results of the independent sample t-test illustrated that students' analytical thinking posttest mean scores of the experimental group were higher than that of the control group at the .05 level of significance. The finding from the analyzed data implied that the FEACA Model was effective to enhance students' analytical thinking better than the traditional instruction.

The results of this study showed that the FEACA Model developed by researchers were significantly effective to enhance conceptual understanding and analytical thinking of the lower secondary students better than the traditional instructions.

Conclusion and Discussion

This part presents conclusions and discussion of the research results including are summaries as follows:

The Science Instructional Model

The science instructional model was developed based on contextual approach and Marzano's analysis processes. This model has been called FEACA Model consisted of 5 steps of learning namely 1) Focusing (F), 2) Exploring (E), 3) Analyzing (A), 4) Conceptual Developing (C),and 5)Applying (A). This model was effective to use in science classroom based on the results of implementation.

Conceptual Understanding

Considering conceptual understanding of students who were taught with the FEACA Model, the posttest mean scores were higher than the pretest mean scores at the .01 level of significance. Similar to the result in this part, Lubben, Campbell, and Dlamini (1996) conducted a research with Swazi secondary students to contextualized lessons on circuit electricity, air, and respiratory and found that the contextualized lessons influenced students' motivation and interest, their concept development, and their participation. It was also similar to Kruatong (2007), who used contextual approach to develop high school students' understanding and application of heat and thermodynamics concepts. The results have shown that the students' understanding and application of knowledge were enhanced through contextual approach.

The conceptual understanding posttest mean scores of the students who taught with the FEACA Model were higher than that of the students who taught with the traditional instruction at the .01 level of significance. The result in this part was similar to the finding of Bennett and Lubben (2006). They developed context-based courses for upper high school students called Salters Advanced Chemistry. Their results indicated that the students developed levels of understanding of chemical ideas comparable to those taking more conventional course. Similarly, Gutwill-Wise (2001) compared students who had followed the context-based approach of ChemConnections with matched groups of students who had followed a traditional approach to chemistry. The study found that in both groups, the students who had followed the context-based approach emerged with a better understanding of chemistry than their peers who has followed a traditional approach.

Correspondingly, Rennie and Parker (1996) investigated the effects of the present contexts in physics problems and found that the students understood and performed better on the tasks with context because the problems with context were generally perceived to be more interesting.

Therefore, all the results above confirmed the potency of the FEACA Model developed based on contextual approach to be more effective than the traditional instruction in terms of promoting scientific conceptual understanding of the students.

Analytical Thinking

Considering analytical thinking of students who were taught with the FEACA Model, the posttest mean scores were higher than the pretest mean scores at the .01 level of significance. In addition, the analytical thinking posttest mean scores of the students who taught with the FEACA Model were higher than that of the students who taught with the traditional instruction at the .05 level of significance.

The result of this part was similar to the finding of Macklin and Fosmire (2003). They used problem-based learning which based on real life situation in their workshop and found that it could promote critical and analytical thinking of the participants. Correspondingly, Harris (1995), has developed Competency-based Education and Training Programs which emphasized on real life situation and found that these programs could develop analytical thinking and the capacity for solving problems. Furthermore, research explained that the real-life context encourage the development of analytical thinking, critical thinking, and problem-solving skills (Orange, 2002).

Accordingly, all the results confirmed that the FEACA Model which based on contextual approach could enhance the students' analytical thinking better than the traditional instruction.

In conclusion, the research results indicated that the FEACA Model is an effective model for using in science classroom and could promote both science conceptual understanding and analytical thinking of students. The FEACA Model helped students to understand basic science concepts by using familial situations in real life. These situations could help students recall what they have seen before they learn the main concepts which make they understand more about science concept. Moreover, this model enhances analytical thinking development of the students by emphasizing on the activities which encourage the students to think analytically based on Marzano's analysis processes.

Recommendations

The results of the study indicated that the FEACA model is effective for using in science classroom. This study applied the familial experiment using in normal class but rearranged the processes of instruction which showed that the teacher could still use familial experiment and also promote students' conceptual understanding and analytical thinking by using the FEACA Model. Therefore, the executive should press more emphasize on the instruction by using this model. Additionally, this model could help promoting the PISA scores because the PISA test focuses on the real life situations.

For further study, changing the concepts should concern with the difficulty and appropriateness of the concepts by choosing the context or real life situation that go along with the concepts and can motivate students to get more readiness for learning.

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Appendix

Table 6 The Results of Evaluation Validity of the FEACA Model

Lists of Evaluation	N = 5					IOC	Interpretation
	E1	E2	E3	E4	E5		
1. The goals of learning management consistent with problems and importance.	1	1	0	0	1	0.60	Congruence
2. The goals of learning management consistent with the FEACA Model.	1	1	1	1	1	1.00	Strongly congruence
3. The FEACA Model consistent with basic idea.	1	1	1	1	1	1.00	Strongly congruence
4. Learning steps in the FEACA Model consistent with science instructional management.	1	1	0	1	1	0.80	Strongly congruence
5. Each step of the FEACA Model has consistency.	1	1	1	1	1	1.00	Strongly congruence
6. Activities in Focusing step were appropriate.	1	1	1	1	1	1.00	Strongly congruence
7. Activities in Exploring step were appropriate.	1	1	1	1	1	1.00	Strongly congruence
8. Activities in Analyzing step were appropriate.	1	1	1	1	1	1.00	Strongly congruence
9. Activities in Conceptual Developing step were appropriate.	1	1	1	1	1	1.00	Strongly congruence
10. Activities in Applying step were appropriate.	1	1	1	1	1	1.00	Strongly congruence
11. The FEACA Model was appropriate for content of learning unit.	1	1	1	1	1	1.00	Strongly congruence
12. The FEACA Model was appropriate for using.	1	1	1	1	1	1.00	Strongly congruence

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Table 7 The Instructional Plans Congruence Evaluation

List of evaluation	IOC of Instructional Plans					
	E_1	E_2	E_3	E_4	E_5	E_6
1. The learning goals consistent with indicators and the purposes of the science instructional model.	0.60	0.80	0.60	0.60	0.60	0.80
2. Learning activities consistent with the science instructional model.	1.00	1.00	1.00	1.00	1.00	1.00
3. Learning activities in Focusing step were appropriate.	1.00	1.00	1.00	1.00	1.00	1.00
4. Learning activities in Exploring step were appropriate.	1.00	1.00	1.00	1.00	1.00	0.80
5. Learning activities in Analyzing step were appropriate.	1.00	1.00	0.80	1.00	1.00	1.00
6. Learning activities in Conceptual Developing step were appropriate.	1.00	1.00	0.80	1.00	1.00	0.80
7. Learning activities in Applying step were appropriate.	1.00	1.00	0.80	1.00	1.00	1.00
8. Instructional materials were appropriate for learning activities.	1.00	1.00	1.00	1.00	1.00	1.00
9. Assessment and evaluation consistent with the learning goals.	1.00	0.80	0.80	0.80	0.80	1.00
10. Contents were appropriate for learners.	1.00	1.00	1.00	1.00	1.00	1.00
11. Content was correct.	1.00	1.00	1.00	1.00	1.00	1.00
12. Time allocation in learning unit was appropriate for contents.	1.00	0.80	1.00	1.00	1.00	1.00