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NEW GENERATION PEDAGOGICAL RESEARCH CENTER

ការប្រើប្រាស់ម៉ូឌែល 5Es ក្នុងការបង្រៀនគណិតវិទ្យាក្នុងមេរៀនវិសមីការ

Using 5Es instructional model in Mathematics teaching in inequation lesson

A Mini-Thesis
In Partial Fulfilment of the Requirement for
Master's Degree of Education in Mentoring

Try Kimhor

February 2021

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Using 5Es instructional model in Mathematics teaching in inequation lesson

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February 2021

មូលន័យសង្ខេប

ម៉ូឌែល5Es ជាម៉ូឌែលដ៏សំខាន់មួយក្នុងចំណោម វិធីសាស្ត្រ ឬ យុទ្ធសាស្ត្របែបទំនើបផ្សេងៗដែលបម្រើឲ្យការរៀន និងបង្រៀនដែលបាននឹងកំពុងប្រើប្រាស់ក្នុងយុគសម័យអប់រំបែបទំនើបនៅក្នុងប្រទេសកម្ពុជា ដើម្បីការរក្សាឲ្យបាននូវការយកចិត្តទុកដាក់រៀនសូត្រ និងភាពសកម្មនៅក្នុងថ្នាក់រៀន។ ម៉ូឌែល5Es មិនត្រឹមតែជួយបង្កើនលទ្ធផលនៃការសិក្សារបស់សិស្សប៉ុណ្ណោះទេ ប៉ុន្តែថែមទាំងជួយសិស្សឈានទៅដល់ការគិតបែបស៊ីជម្រៅ ដែលជាកម្រិតនៃការគិតរបស់ Bloom's Taxonomy ដែលសិស្សអាចវិភាគ ឬបង្កើតអ្វីដែលថ្មីបាន។ ការរួមបញ្ចូលម៉ូឌែល5Es ទៅក្នុងការបង្រៀនធ្វើឲ្យសិស្សកាន់តែប្រសើរក្នុងការដោះស្រាយបញ្ហា និងផ្តល់អំណះអំណាងសមហេតុផលទៅលើបញ្ហាត ដោយអនុវត្តទៅលើដំហានទាំងប្រាំរបស់ម៉ូឌែល5Es ដែលផ្តើមចេញពី ការចូលរួម ការរុករក ការពន្យល់ ការបញ្ជាក់លម្អិត និងការវាយតម្លៃ។ កិច្ចការស្រាវជ្រាវនេះ នឹងផ្តល់ទិដ្ឋភាពទូទៅនៃការនាំចូលគំរូបង្រៀនដោយប្រើម៉ូឌែល5Es ទៅលើមុខវិជ្ជាគណិតវិទ្យានៃមេរៀន វិសមីការ។ វិធីសាស្ត្រនៃការសិក្សាស្រាវជ្រាវនេះ ត្រូវបានផ្អែកលើការស្វែងរកឯកសារពាក់ព័ន្ធនានា ដែលអ្នកស្រាវជ្រាវបានដកស្រង់ចេញពីគេហទំព័រល្បីៗមួយចំនួនដូចជា Science Direct Springer Academia JSTOR Government Policy និងស្វែងរកតាមរយៈពាក្យគន្លឹះដូចជា ម៉ូឌែល5Es ការបង្រៀនគណិតវិទ្យា វិសមីការ និងប្រសិទ្ធិភាពនៃការបង្រៀន។ លទ្ធផលនៃការសិក្សានេះផ្អែកលើខ្លឹមសារសំខាន់ៗចំនួន ៦គឺ៖ (១)ដើមកំណើតម៉ូឌែល5Es (២)ការវិភាគលើសៀវភៅសិក្សាគោល (៣)ការប្រើប្រាស់ម៉ូឌែល5Es លើមុខវិជ្ជាគណិតវិទ្យា (៤)គំរូបង្រៀន5Es ទៅក្នុងដំណើរការរៀនសូត្របែបសកម្ម (៥)តួនាទីរបស់គ្រូនិងសិស្សនៅក្នុងគំរូនៃការបង្រៀន5Es និង(៦)ការយល់ឃើញរបស់គ្រូក្នុងការប្រើប្រាស់ម៉ូឌែល5Es ។ តាមរយៈនៃការសិក្សាស្រាវជ្រាវនេះ បានបង្ហាញឲ្យឃើញថា ការប្រើប្រាស់ម៉ូឌែល5Es នឹងក្លាយជាឯកសារជំនួយដល់អ្នកអប់រំដែលពុំទាន់យល់ច្បាស់ពីម៉ូឌែលនេះ ធ្វើការសិក្សាស្រាវជ្រាវបន្ថែមដើម្បីដឹងពីប្រសិទ្ធិភាពនៃការបង្រៀនដោយប្រើប្រាស់ម៉ូឌែល5Es ទៅក្នុងដំណើរការនៃការបង្រៀន។ មុននឹងបញ្ចប់នៃកិច្ចការស្រាវជ្រាវនេះ អ្នកស្រាវជ្រាវបានបង្កើតសកម្មភាពមួយដោយប្រើប្រាស់គំរូនៃការបង្រៀនដោយប្រើម៉ូឌែល5Es នៅក្នុងការបង្រៀន មេរៀនវិសមីការ ដែលមាននៅក្នុងសៀវភៅសិក្សាគោល

ថ្នាក់ទី១០។ ជាចុងបញ្ចប់អ្នកស្រាវជ្រាវសូមសំណូមពរដល់ថ្នាក់ដឹកនាំក្រសួងអប់រំ យុវជន និងកីឡា មជ្ឈមណ្ឌលបណ្តុះបណ្តាលគ្រូបង្រៀន ពិនិត្យ និងតាមដានបន្ទាប់ពីបានផ្តល់វគ្គបណ្តុះបណ្តាលសមត្ថភាពដល់លោកគ្រូ អ្នកគ្រូពីការប្រើប្រាស់ម៉ូឌែល5Es និងសំណូមពរដល់អ្នកស្រាវជ្រាវក្រោយៗ សូមធ្វើការសិក្សាស្រាវជ្រាវបន្ថែមលើការបង្រៀនដោយប្រើប្រាស់ម៉ូឌែល5Es តាមបែបបរិមាណវិស័យ គុណវិស័យ ឬតាមរយៈការធ្វើពិសោធ។

ពាក្យគន្លឹះ៖ ម៉ូឌែល5Es ការបង្រៀនគណិតវិទ្យា វិសមីការ ប្រសិទ្ធិភាពនៃការបង្រៀន

ABSTRACT

5Es instructional model is among of a crucial teaching technique or teaching strategy has been used in modern education era in Cambodia to keep students more motivative and active learning in classroom. 5Es instructional model not only to increase student's learning outcome but also reach to higher order thinking skill which is a higher level of Bloom's Taxonomy where student can create something new. The emergence of integrate 5Es instructional model in teaching, this model makes students better problem solver and logical thinkers through each phase of 5Es such as engage, explore, explain, elaborate and evaluate. This study provided an overview of what 5Es instructional model dominate in the implementation of integrated in a lesson. The research methodology was based on a review of relevant literature search strategy through Science Direct, Springer, Academia, JSTOR, Government Policy, and Journal of 5Es instructional model. The key words use in the search such as 5Es instructional model, Mathematic teaching, inequation and effective teaching. The result of this study based on six main themes: introduce 5Es instructional model, Curriculum Study analysis, 5Es instructional model into active learning process, teacher and student's role in 5Es instructional model and teacher's perception in 5Es instructional model. Findings from this review will lead educators who are new to 5Es instructional model to investigate on how 5Es instructional model affect to learning process. Last but not less, researcher design an activity by using 5Es instructional model in inequation lesson which is in grade 10 textbook. Finally, researcher would like to recommendation to MoEYS and teacher training center should follow up or investigate on how effective it is after providing a training or workshop to teacher about 5Es instructional model.

Key words: 5Es instructional model, Mathematics teaching, Inequation, Effective teaching

SUPERVISOR'S RESEARCH SUPERVISION STATEMENT

TO WHOM IT MAY CONCERN

Name of program: Master's Degree of Education in Mentoring
Name of candidate: Try Kimhor

Title of thesis: Using 5Es instructional model in Mathematics teaching in inequation

This is to certify that the research carried out for the above titled master's thesis was completed by the above-named candidate under my direct supervision. I played the following part in the preparation of this thesis: guidance in research problem development, literature review, methodology, data analysis, and discussion finding.

Supervisor (Name): …….

Supervisor (Sign): …….

Date: ……

CANDIDATE'S STATEMENT

TO WHOM IT MAY CONCERN

This is to certify that the thesis that I "**Try Kimhor"** hereby present entitled "Using 5Es instructional model in Mathematics teaching in Inequation" for the degree of Master's of Education in Mentoring at New Generation Pedagogical Research Center is entirely my own work and, furthermore, that it has not been used to fulfill the requirements of any other qualification in whole or in part, at this or any other University or equivalent institution.

Signed by (the candidate): …….
Date: ……..

Countersigned by the Supervisor: ……
Date: …….

Acknowledgements

First, I would like to pay my respectful and thankful to the Ministry of Education, Youth and Sport (MoEYS) and Kampuchea Action to Promote Education in Cambodia (KAPE) the founder and supporter of Master Degree in Mentoring program at New Generation Pedagogical Research Center, where located in the National Institute of Education (NIE). Those two organizations provided financial and materials support to make this program happened.

I would like to express my special thanks of gratitude to my research supervisor **Mr. Srou Lihol** for his guidance and supporting to completing my research for Master Degree of Education in Mentoring Program. His guidance helps me for every step from the beginning till the end of the research project. He has taught me the methodology to carry out the research and present the research work as clearly as possible. He also encourages me to present my research work of the Cambodian 1st International Virtual Conference on Mentoring Educators under the theme: Mentoring and Professional Development of Educators. He always shares and pull me up when I face problem. I am extending my heartfelt thank him for his friendship, empathy, and great sense of humor.

I would also like to extend my gratitude to New Generation Pedagogical Research Center Director **Prof. Chan Roath and all instructors** for providing me with all facility that was required. They always encourage and stay by myside to complete the program as intensive program.

I am extremely grateful thank to my parents for their love, care, sacrifices for educating and encourage when I lost. I am really thankful to my friends for their friendship, heart fulfill, sharing, discussing, and help each other to walk through of completing the course successfully. Without them, I cannot walk through this hard journey.

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List of Abbreviations

MoEYS	: Ministry of Education Youth and Sport
ESP	: Education Strategy Plan
5Es	: Engagement, Exploration, Explanation, Elaboration, Evaluation
TTT	: Teacher Talking Time
NSES	: National Science Education Standards
BSCS	: Biological Sciences Curriculum Study
PSTs	: Pre-Service Teachers
POE	: Predict Observation and Explain

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

Teacher plays as a vital role in enhancing the quality of education. Likely other country, Cambodia fully paid that teachers are key to ensuring effective teaching and learning in classroom. A high-quality teaching workforce, the bedrock of all high-performing education systems is that the single most significant consider improving student learning. Teachers are the key element of education spending in Cambodia, and the most important determinant of school quality (Tandon, Prateek, & Fukao, 2015). Therefore, teacher requires specific knowledge, skills, attitude and that there are different ways in which they learn to do their work or develop as professional in their field (Toh, Diong, Boo, & Chia, 2006). According to Siribanpitak (2009), one among six of teacher's quality about teacher pedagogical, it means that teacher must have techniques or strategies of teaching. Teacher who is clear with content knowledge but it does not mean he or she can get student's involvement in the classroom or make his or her class become an active classroom. In 2015, Teacher Policy Action Plan (TPAP) had set up to guide comprehensive teacher management and development towards improvement of its educator system and stay embarrass with the rapid changes in 21st century (Sideth, 2017). Recently, modern teaching has been promoted for 21st century teaching and learning in Cambodia. Teacher may difficulty with implement the modern teaching method. During searching, teachers may find any methods that help students to develop a complete understanding of new concepts. One way to do so is through the introduction of 5Es instructional model which is focused on active learning in classroom. The 5Es instructional model is a teaching model that enables teachers to improve teaching effectiveness by using

five phases, including Engagement, Exploration, Explanation, Elaboration, and Evaluation. These five phases will facilitate by teachers to motivate students' interest in learning lessons into action and develop their knowledge. According to Mooney and Laubach (2002), National Science Education Standards (NSES) recommended that science teachers prepare an inquiry-based science curriculum for their students, direct and encourage learning, engage in ongoing evaluation of their teaching and student learning, and actively participate in ongoing school science curriculum planning and development.

1.2 Statement of the Problem

In 2001–2005 and 2006–2010 Strategic Education Plans of the MoEYS provide evidence that student achievement is a key concern in Cambodia, which is attracting greater focus in national policy (Ngo, 2012). According to PISA-D, there are 90% of students in Cambodia do not reach the baseline level of performance in mathematics that require mathematical problem-solving ability (MoEYS, 2018). Respond to this problem, the Minister of Education Youth and Sport said during the New Generation Pedagogical Research Center (NGPRC) inauguration's day about modern teaching and it was also including 5Es instructional model in teaching. However, there is no significance of evidence that teacher can apply it effectively because they do not familiar with and do not know how to apply it? A trainer who prepared train other teachers on 5Es instructional model at National Institute of Education (NIE) mention that, teachers are difficult to recognize the sequence of using 5Es. The core areas of concern such as feeling of fear and failure in mathematics among the majority of children, simplistic evaluation methods that promote the understanding of mathematics as mechanical computation, and lack of teacher training and support in mathematics teaching (Grouws, 2006). Ren and Kosal (2016) mention that, the education system in Cambodia does

not yet provide learning for children and youths that is sufficient in terms of quality and relevance. This is because some schools lack teachers, there are too many students per class, and there are insufficient materials, core textbooks and library resources. អាយុវឌ្ឍនវិជ្ជា (2019) found that, many factors that effect on mathematics subject such as lack of mathematic foundation, not enough resource which relevant to mathematics subject, and not enough materials to support the theory.

1.3 Research Purposes

Researcher aims to introduce of using 5Es instruction model in Mathematics teaching according to the 21st century teaching methodology by applying this method in a lesson in inequality of grade 10. This research will guide teachers who are willing to try this method in their teaching with a technique or activity which applies 5Es.

1.4 Research Objectives

The three specific research objectives are as follows:

- To encourage and develop teaching activities which promote 5Es instructional model in inequality lesson
- To identify the benefits and challenges of using 5Es instructional model
- To identify role of teacher and student in 5Es instructional model

1.5 Research Questions

In order to achieve the objectives, three of a specific research questions as the following:

1. In which way 5Es instructional model can put in teaching inequation?

2. What are the benefits and challenges of using 5Es instructional model?
3. What is the role of 5Es instructional for teacher and student?

1.6 Significance of the Study

By responding to the research objectives, the result of this study might be useful for mathematics teacher whose want to encourage and make their class more active and achieve their learning objective. Teacher may apply this in their classroom through the activity provided as the example. Anyway, this research also the guideline for teacher not only mathematic but also other teacher who willing to do so. They also can learn about what teacher and student do during instruction. In other words, they can apply 5Es instructional model in their teaching performance. Finally, the present study can serve as a basis for future research studies on 5Es instructional model in mathematics.

CHAPTER 2: RESEARCH SYNTHESIS PROCEDURE

2.1 Research Procedure

This present study employs research synthesis procedure to achieve the proposed objectives. The terms ‘review’ and ‘synthesis’ are often used synonymously and confusingly. For this study, review is used to refer to the whole process of bringing together a body of evidence which can be drawn from research and other sources, relevant to a particular decision in a policy or management context. The term synthesis is employed to discuss with the stage of a review when the evidence extracted from the individual sources is brought together in a way (Mays, Pope, & Popay, 2005). The aim of research synthesis is to find any primary sources to analyze and consult the sources to produce a new one which adapted to their own context (Suri, 2011). The topic was chosen by the researcher’s that want to improve mathematics teaching in inequation by using 5Es instructional model. Researcher read the sources from every relevant topic in country or other country. Then, analyze a textbook curriculum study on a lesson of inequation about pedagogical method which was the writer used. Moreover, researcher apply the activity of inequation lesson in 5Es instructional model. Finally, researcher identify the role of teacher and student in 5Es instructional model.

2.2 Selecting Sources

Researcher searches and get the source by using some key words such as 5E instructional model, effective mathematics teaching, and inequation. For the sources of this research, most of the references were download from Google Scholar, Springer, ERIC, Academia, JSTOR, Government Policy, Science Direct, and others recommended sources by Supervisors.

2.3 Data Analysis

After collecting the relevant sources from many reliable websites and some hard copied, the researcher categorized it into thematic analysis. Thematic analysis is a method for identifying, analyzing, and interpretation patterns of meaning ('theme') within qualitative data. Themes provide a framework for organizing and reporting the research's analytic observation (Clarke & Braun, 2016). From searching some relevant key words such as 5Es instructional model, effective mathematic teaching, and inequation. Researcher collected 476 papers. Then researcher read carefully on tittle, abstract, and outline in order to identify which papers are really relevant.

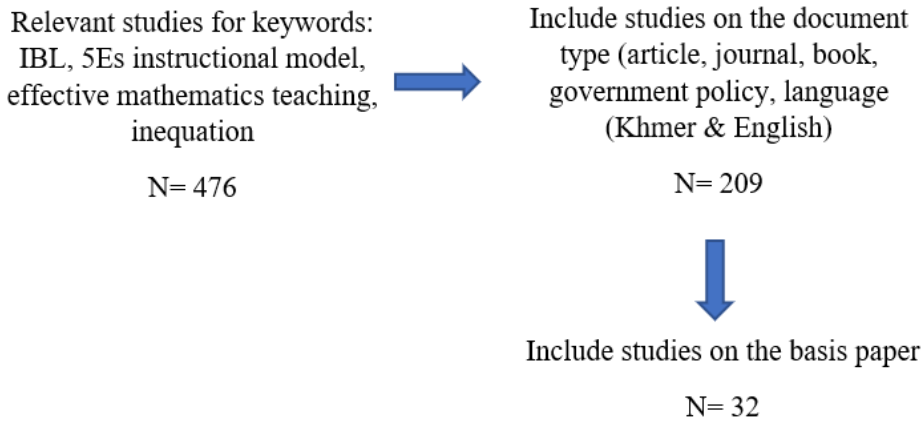

Figure 1: Data analysis summarizing

2.4 Scope and Limitations

Before moving to the next section, there are few limitations of this work should be noted. First of all, this study applies 5Es instructional model for mathematics teaching and a lesson in grade 10 of mathematics textbook which is specific in inequation lesson. Second, since this study employs research synthesis procedure, majority of data are secondary sources which are available online. Hence, there is a problem with generalization of the information in a very specific context. Third, although researcher tried to analyze Cambodia's textbook and integrated in the use of 5Es instructional model, there is no empirical evidence to prove the effectiveness of its usage. The experimental research approach might be needed to test whether it works or not.

CHAPTER 3: RESULTS

3.1 Introduce 5Es instructional model

In accordance with this model students acquire new knowledge gradually, on the basis of critical thinking and problem solving (Bybee, 1997; Dagys, 2017 ;Oğuz Ünver & ARABACIOĞLU, 2011).

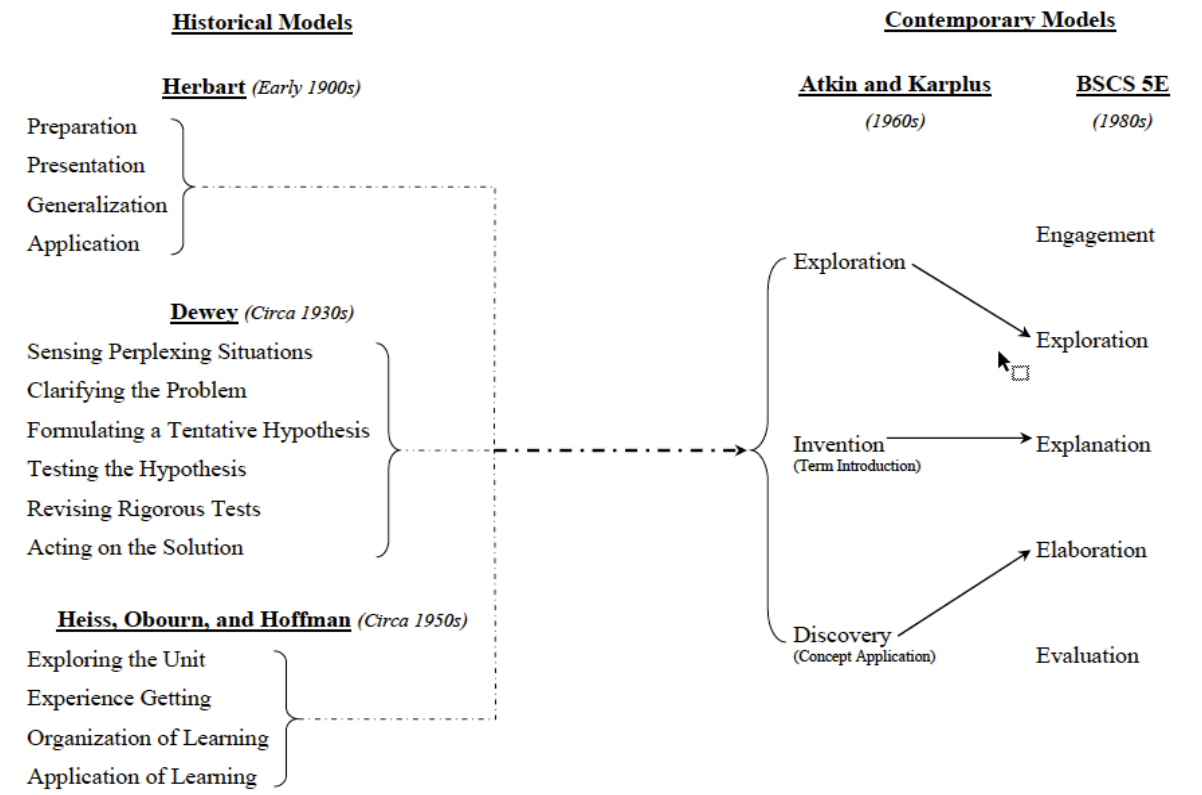

Figure 2: Origin and development of instructional model (Bybee et al. 2006)

5Es instructional model is one of the constructivist approaches and it's not a new concept according to figure 2: 5Es instructional model was developed a few times since 1890s by a Germania man (philosopher, physicist, and pedagogical development). This approach related to the Piagetian theory which was talking about the constructivism in education. Besides the two people above, a very famous in education was John Dewey; American

philosopher and educator. He was the one who criticized the traditional teaching style that limit students in learning, did not promote understanding as a man being, and too much authorization. Later on, there was a group of science educator took great attention to conduct the research and ran an institution called The Biological Science Curriculum Study **(BSCS) 5Es Instructional Model** has its origins with the work of earlier science educators and their learning cycle developed for the Science Curriculum Improvement Study (SCIS). The findings reported within the National Research Council research summary how people learn supports the planning and sequence of the BSCS 5Es Instructional Model. Since the late 1980s, BSCS has used the 5E Instructional Model extensively within the development of latest curriculum materials and professional development experiences and it is also enjoy widespread use beyond BSCS such as a minimum of three states strongly endorse using 5Es Instructional Model, and a Google search shows global use of the model for curriculum frameworks, assessment guidelines, or course outlines; curriculum materials; and teacher professional development. This method was established in early year of 1962 by some science educators and educationalists such as Myron J. Atkin and American physicist Robert Karplus (Mulder, 2019). The 5Es was emerged from the three main key terms that was used by establishers above such as exploratory, terminology, and application. In the mid-1980s, BSCS received a grant from IBM to conduct a design study that would create specifications for a new science and health curriculum for elementary schools. Among the result of innovations from this design study was 5Es Instructional Model. As mentioned earlier and elaborated later in this section, the BSCS model has five phases: engagement, exploration, explanation, elaboration, and evaluation. When formulating the BSCS the 5Es Instructional Model, we

consciously began with the SCIS learning cycle. The three key elements of the BSCS model are fundamentally corresponding to the three phases of the SCIS learning cycle.

Later on, these two developers are called the Aktin-Karplus to notify their effort in developing this the 5Es instructional model in 20th century. The original spirit of establishing this approach for helping science subjects more interested for the students. By using this approach, they observed that, students participate more in learning and even more active. As a result, students became interested in subjects, started asking questions, and discovered that they needed to look critically at their own insights. Once again, the development of the 5Es instructional model was developed in 1980s by the American educator and research institute BSCS science learning (Bybee et al., 2006).

The 5Es instructional model can be implemented in education and organizations since it provides support wherever people work. Moreover, this model is used as framework for ordering and organizing lessons. Its effective for helping teachers in class situation to make the best on-the-spot decisions to respond to challenges posed by students. The trainers, teachers, and instructors will model at their profession should incorporate opportunities for social interaction among students and between students and therefore the teacher. The 5E instructional model is that the psychological theory that informed the sequence and emphasis of the phases. Furthermore, this model used the work of Jean Piaget and subsequence research per the Piagetian theory (Bybee et al., 2006).

With the 5Es Instructional Model, teachers, trainers, and instructors have an instructional model at their disposal which helps their students, or trainees gain a whole understanding of recent concepts. They'll get more involve with their students within the given material, motivate and also helps to guide them in developing their skills. The model

is characterized by active learning, during which students work together to unravel problems and explore new concepts by asking questions, observing, analyzing, and drawing conclusions which might lead them with knowledge domain.

3.2 Curriculum study

Researcher aims to analyze the two points of the curriculum study. First, student's mathematics knowledge. As an experience of teaching, teacher did not access to the learner's prior knowledge for reviewing the previous lesson or sometime they jump into a new concept. In the other hand, there is no instruction for what teacher should do before starting a new lesson or lead in question which connect to a new lesson or concept. It is a difficulty for new teachers who are inexperience in teaching because the writer did not give the instruction for what teacher should do. Beside this, there's also effect to students who are lack of foundation of mathematics or misunderstand in the previous lesson, they might be difficult to catch up a new lesson. Next, writer's methodology. In the textbook, student-centered has been use in inequation lesson. Collaborative learning method was given by a writer to practice in this lesson. Teacher assigns students to work in group discussion and teacher give direct instruction to students (Teacher's book, 2008). Researcher relies that, group discussion is really useful for students for working together or gathering the idea, but this method is not enough for enhance student's knowledge or activities because students have not an opportunity to share or express their result after discussing. Through this, student's knowledge is in the lower level of Bloom's Taxonomy which students could only in apply or practice stage. To increase the activity and more active classroom researcher introduce about 5Es instructional model for teacher to try on and apply in their teaching performance in inequation or any needed lesson as an activity in the appendix A.

3.3 5Es instructional model in Mathematics

This study is supported the 5Es instructional model in mathematics teaching in inequation. The 5Es instructional model builds on the work of other instructional models and is supported by current research on learning. 5Es instructional model was mostly implemented within the sector of science, but today it's become a really useful model within which mathematics is included and studied. Within the majority of the studies, the 5Es model was used extensively in international mathematics education and therefore the effects of scholars on scientific process skills were investigated (Bybee, 2009). The phase of the 5Es instructional model is to have engage, explore, explain, elaborate and evaluate. This model was developed by Bybee (2009) and it is named the 5Es instructional model as each stage starts with the letter 'E'.

> "Bybee and Landes (1990) mention that, using a learning cycle approach in the classroom helps to facilitate inquiry practices because learning cycles focus on constructivist principles and emphasize the explanation and investigation of phenomena, the use of evidence to back up conclusions, and experimental design. Although there are several variations of learning cycles, the one that is highlighted in this manuscript as a method to support inquiry-based teaching is the 5Es Instructional Model (Duran & Duran, 2004, p.49)."

5Es instructional models are a few things that improves students' enthusiasm of investigation, meets their expectations and encourages them concentrate on active research (Pulat & Selma, 2009). It is important for in-depth understanding of science content and students are expected to interact within the practice of constructing knowledge domain instead of rote memorization of science concepts. The 5Es model is an instructional method that uses

inquiry to teach students about science content (NRC, 2012; Enugu, 2016). The 5Es model is suitable in an inquiry learning environment as the teacher presents learning experiences with problematic, challenging but achievable situations that are slightly beyond the current level of understanding of learners. The 5Es model is designed to facilitate learning with the teacher deliberately providing experiences that allow learners to experience learning through common activities (hands-on, minds-on scientific and mathematical inquiry) to build on prior knowledge and experience, construct meaning, and to assess their understanding of concepts continually. The teacher monitors learner's exploration, guides their inquiry, and promotes new patterns of thinking in a systematic way (Nairobi & Kenya, 2017).

3.4 The 5Es engage into active learning process

5Es instructional model-oriented activities in the subject of probability, prime numbers, natural numbers, statistics, integers, times, factors, multiples, divisible and fractions. The effect of 5Es learning model on pre-service science teachers' achievement of acids-bases subject suggested that 5Es learning model in comparison with traditional approach to teaching had a great number advantages, such as engaging students in the course content, contributing to students' learning and interest to the course, helping students to develop their scientific process skills. According to, a previous study shown that the activities based on 5Es model could be easily implemented in science classes and help students improve meaningful learning (YALÇIN & BAYRAKÇEKEN, 2010). Each phase will be presented below with some practical examples:

Theme 1: ENGAGEMENT phase by the 5Es instructional model

The first phase of the 5Es model is "engage". It is about creating a scene to promote student curiosity, eliciting students' prior knowledge, creating students' cognitive conflicts, organizing students' thinking and finding problems to explore (Hu, Gao, & Liu, 2017). The learners' prior knowledge is accessed by the teacher or a curriculum and the teachers assist them to be engaged in the lessons through the use of short activities which make them curious about learning and assess the present knowledge. A connection was made between past and present knowledge (Bybee et al., 2006). In these students mentally focus on an object, problem, situation, or event. Asking a question, defining a problem, showing a discrepant event, and acting out a problematic situation are all ways to engage the students and focus them on the instructional task mentioning by. Encouragers were designed to help keep students motivated which included with such comments as: "Well done; Yes, that's right; I can see you're nearly finished (Gillies & Rafter, 2019). Teachers engage students in leading questions connect to the concept, events in the environment, and probe background knowledge and conceptions (Bybee et al., 2006; Yoon & Onchwari, 2006). Without any explanation the concept of the topic, explaining a scenario, a demonstration of an event, showing a picture or making a discussion can be used to focus the students' attention on the tasks that will follow and connections to past learning and experience (Bybee et al., 2006; Tuna & Kacar, 2013). During engagement learners should become mentally engaged in the concept, process, or skill to be learned before jump into the new lesson learn.

Example 1: To teach this phase of doing an experiment research on sixth grade, students are asked questions about their daily life or amazing events in order to draw their attention in Math class teaching. The questions are directly connected to the topic to let students discuss among

each other. Teacher is the person who will be present the situation and identify the instructional task. The teacher also sets the rules and procedures for establishing the task. Successful engagement results in students being puzzled by, and actively motivated in, the learning activity (Pulat & Selma, 2009).

Example 2: According to Yoon and Onchwari, in teaching ice cream making by the 5Es instructional model, teacher asks questions about concept, organisms, and event in the environment (a teacher could even give children real ice-cream to observe (and even eat) as he or she asks these preliminary questions).

1. Have you ever eaten ice cream? (Knowledge)
2. Describe the taste of the ice cream? (Comprehension)
3. Name the ingredients you think the ice cream was made from? (Knowledge)
4. How do you think ice cream is made? (Analysis). Specifically, there is no intervention from teachers so that students are on their own discussing ideas.

Example 3: Acid-base teaching by the 5Es model, teacher handed a picture of acid rain to students and ask "Do you have any idea about 'acid, base and acid rain' concepts?". From what the picture is, students work in small group to create a short story about acid rain by using their pre-existing knowledge. A representative from each group read the story to their peers and answer questions using their pre-existing knowledge by Çalik (2015).

Meanwhile, their attention is taken to the subjects during the discussion and the answers given from students are all free to tell ignoring true or false (Pulat & Selma, 2009).

Theme 2: EXPLORATION phase by the 5Es model in teaching

Exploration phase, students are provided with a common base of activities by exploration experiences. Learners are let to use pre-knowledge to compose new ideas, explore questions and possibilities and design an investigation (Bybee et al., 2006). It is to establish experiences that teachers and students can use later to introduce and discuss concepts, processes, or skills so students need time to explore objects, events, or situations as a result of their mental and physical involvement in the activity, the students establish relationships, observe patterns, identify variables, and question events, besides this, students plan and conduct investigations to gather evidence to answer the questions.

Example 1: In doing his experiment, Pulat mentioned that students are provided activities to do along with short explanations before the activities. Students do their activities individually or in a group to gain knowledge on their own while the teacher guided them only giving direction and controlling questions so students will not lose track. Students are allowed to concrete material so they can produce a long -term memory. In his observation, he found out that students learn through concrete things. According to his observation by the help of concrete materials, children learned mathematics and also mathematics became very enjoyable for them. Teacher roles is to direct and guide them through the process of discussion.

Example 2: Ask questions to gather evidence to answer the questions posed.

1. How can you make ice cream with the ingredients? (synthesis).
2. Think of several ways to make ice cream (synthesis). Bring the ingredients for making ice cream. Each student puts the ingredients into a sandwich size zip-close bag. Put three

or four of the students' bags into a large Zip-close plastic bag that is half-filled with ice and shake the bag for about 5 min (Yoon & Onchwari, 2006).

Teacher does not intervene in students' activities but guide them by using different questions to direct them to the answers.

Example 3: Students are requested conduct hands-on activities by recognizing acids-bases and measuring their pH values). Let's them identify acids and bases so that they are able to use their own pre-existing knowledge in order for discovering and building the new one. Then using their observation in the same group to fill in the experiment report.

Providing students with a common base of activities, initiating of activity by teacher and allowing students time and opportunities to investigate, probing questions when necessary, guiding students indirectly, creating a sense of wanting to learn and giving students time to raise questions when exploring are activities in exploration stage (Hu et al., 2017; Yoon & Onchwari, 2006).

Theme 3: EXPLANATION phase by the 5Es instructional model

The students' concentration is directed through experiences, by the explanation phase the students are given opportunities to point out their conceptual understanding, process skills or behaviors. The critical element of this phase, there can occur a deeper understanding by the teachers' explanations (Bybee et al., 2006). Encouraging students to debate and analyze the process themselves, asking students to provide explanations about new concepts, introducing by the teachers of scientific, or technological explanations in a direct, explicit, and formal manner, using student experiences as the basis of explaining new knowledge are explanation

stage are (Hu et al., 2017). Students, guided by the teachers, use new knowledge to construct scientific explanations and answer initiating questions (Yoon & Onchwari, 2006).

Example 1: students were required to explain what they learned by using their own words after activities. Teacher want students to present their idea by giving examples from the activities to proof (Pulat & Selma, 2009). The teacher asked questions to students to help them recognize the information that was to given and notice them by making them meaningful in their minds. After that, the teacher made some explanations and corrections in the definitions by using correct and clear expressions and making connections with the students' explanations.

Example 2: Asking questions to use new knowledge and observable evidence to construct scientific explanations and answer initiating questions.

1. Why are the liquid ingredients turning into ice cream? (Analysis)
2. How long does it take to turn ingredient into ice cream? (Knowledge)
3. What does the salt do in the ice cream making process? (Analysis)

The role of the teacher was to give clues instead of correct answers directly, and to make connections between pre-knowledge and new knowledge.

Example 3: Explain Didactically explained acid-base theories, the conjugate acid-base pairs, reactions in acid rain and autoproteolysis of water. Carefully listened lecturer's explanations and took notes if necessary.

Theme 4. ELABORATE phase by the 5Es instructional model

In this phase, it is about creating new and unfamiliar problem situations for student applications, encouraging students to participate in discussions for strengthening the understanding of new knowledge, guiding students to analyze problems from multiple angles and expanding new knowledge, and guiding students to summarize the corresponding knowledge, processes, and methods.

Example 1: New questions are provided for them so they can put what they have learn into practice to develop more understanding. Teacher helps share alternative explanations and problem solving when the students cannot reach with them; students were enthusiastic to go to the blackboard and willing to ask questions by raising their hands (Bybee et al., 2006; Pulat & Selma, 2009).

Example 2: Students apply new understandings to new problems (Yoon & Onchwari, 2006).

1. Is it possible to make different flavors of ice cream? (Applications)
2. Can you make ice cream without one of the ingredients? (synthesis). Students will have a fieldtrip to an ice cream factory and will find out how ice cream is made in the factory.

In the study of Bybee provides a clear description of this phase that during the elaboration phase, students engage in discussions and information- seeking activities. The group's goal is to identify and execute a small number of promising approaches to the task. During the group discussion, students present and defend their ideas. This discussion results in better definition of the task as well as the identification and gathering of information that is necessary for successful completion of the task. The teaching cycle is not closed to information

from the outside. Students get information from each other, the teacher, printed materials, experts, electronic databases, and experiments that they conduct.

Example 3: Teacher lets them determinize acid-base strengths by electrical conductivity, conducted the hands-on POE activities, and improved their knowledge and remedied their alternative conceptions of the acid-base chemistry topic through a whole-class discussion. Group discussions and cooperative learning situations provide opportunities for students to express their understanding of the subject and receive feedback from others who are very close to their own level of understanding (Hu et al., 2017).

This phase is also provided an activity to involve students in new concept and problems that require the deeper or similar explanations. The primary purpose is to generalization of concepts, processes, and skills.

Theme 5. EVALUATE phase by the 5Es instructional model

In this phase, students are allowed to reflect and evaluate their own knowledge and skills when learning, observe and evaluating the students' new knowledge and skills, assess knowledge and skills and giving them suggestions as well as evaluating their gradual development of understanding in every teaching phase (Hu et al., 2017). Yoon (2006) mentioned that teachers use formative and authentic assessment means to assess young children's new knowledge and abilities.

Example: Students' learning levels are observed on both what they have done in their learning process and the degree of their development. In this stage, teacher wants to know whether student understand concept of subject matter. Sometimes teacher lets them to perform the activities so that their mistakes will be noticed and corrected.

Example 2: Ask questions to assess developing understandings and inquiry skills (Yoon & Onchwari, 2006).

Teacher use continuous (formative) assessment to assess performance on the activity sheet (for older children), and/or oral explanations and predictions.

Example 3: Teacher ask students to write down what they had learned in these classes and handed over an acid-base diagnostic tree to evaluate their gained knowledge of the 'acid-base' concepts by Çalik (2015).

This is the important opportunity for students to use the abilities they need acquired and evaluate their understanding. Additionally, the student should receive feedback on the adequacy of their explanations. Informal evaluation can occur at the start and throughout the 5E sequence. The teacher can complete a proper evaluation after the elaboration phase. As a practical educational matter, teachers must assess educational outcomes. this is often the introduce which teachers administer assessments to see each student's level of understanding.

3.5 Summary teacher and student's role in 5Es instructional model

Teacher and student's activities is defined in this section for further understanding and useful when teacher apply 5Es instructional model in his or her teaching performance. Each phase presents the specific activity what teacher and student should do.

Table 1: Teacher and student's role for "Engage"

Engage means how the teacher engages the students before starting a new lesson in order to actively engage between the teacher and the student. Participation is the first step that students need to be involved in teaching. In this step, the teacher can assess the learning ability based on existing knowledge or identify students' misunderstandings. Teachers can use inspirational questions, posters, diagrams, demonstrations, discussions of new events, demonstrations of phenomena and experiments related to existing knowledge or life experiences that are often encountered in everyday life to create Curious. An important feature in this step is what the teacher has to do to create the student's desire to learn, to be curious, to know. According to a study by Gillies and Rafter (2019), teachers can help keep students motivated by using a few words of encouragement, such as "You did very well, you did exactly right, and you keep trying.". Teachers can use different words of encouragement depending on the actual situation in the classroom.

Engage		**T**	- Lead in by creating interest - Access student's existing knowledge - Connect to real life - Propose question
		S	- Ask question with *why, what,?* - Show interest
Explore		**T**	- Encourage S to work as group without any direction instruction - Give time for S to do a research or investigate a new concept - Give some hints or any needed documentation - Acts as a facilitator

		S	- Working in collaborative learning - Do research on a concept - Unlimited thinking of the activity - Analyze the problem - Show result - Ask related to question

Table 2: Teacher and student's role for "Explore"

Exploration is a step that gives students a new, specific experience. Students are encouraged to use technology in information retrieval, data collection, surveying, questioning, discussion, testing, forecasting, and hypothesis development through small, large, partner, or individual collaboration. Individuals to conduct a search or gather relevant information related to the questions, tips or issues raised by the teacher in the first step as a result of mental and physical involvement in student activities. Teacher provides students with general activities, time and opportunity to investigate, ask questions when needed. In this step, teacher acts as a facilitator or counselor to indirectly lead students, creating a sense of curiosity and giving students time to ask questions while exploring. Students can gain new experiences before reaching the explanations of the rules, key words, as well as various experiments.

Explain		**T**	- Encourage S to present their result - Encourage other student to ask question - Asks more for justification - Draw conclusion
		S	- Explains possible solutions or answers to others - Listens carefully to others' explanations - Questions others' explanations - Take note of group presenting - Reflect to own understanding

Table 3: Teacher and student's role for "Explain"

Explanation is a step that helps students reach the Higher Order Thinking Skills (HOTS). After group discussions, teacher encourages students to come up with explanations, assign tasks or information obtained from the exploration to present new ideas that are facilitated by the teacher. It is a time for students to comment or ask additional questions for what they have been exploring. Explanation is an important step where students can express their perceptions and thoughts before the teacher makes an explanation. In this step, the teacher plays an important role in facilitating the students during the search for information and synthesizing the students' answers after the explanation.

Elaborate		**T**	- Give a new concept which is familiar or deeper - Random or keep as the same group member - Based on previous knowledge - Give time for S to do a research and explain the work
		S	- Work in group for searching the result of the concept - Present their work - Draws conclusion

Table 4: Teacher and student's role for "Elaborate"

In this phase, group discussion and collaborative learning are used to provide students with opportunities as well as new experiences for students to share knowledge in lessons and gain constructive feedback from classmates. Students analyze the other parts of the concept. In addition, teachers assign new tasks that are more similar or in-depth for students to reach deeper and broader thinking. Teachers can give examples happen in real society for students to apply and assign task on how to transfer knowledge and help students apply concept which familiar and unknown contexts and provide some documents or hints to students.

Evaluate		**T**	- Observes each activity since the engage phase - Access student's understanding both formal and informal assessment - Allow student to reflect on their own understanding by peer or group - Make a whole conclusion of learning process
		S	- Answer question - Writing assignment - Self or peer assessment

Table 5: Teacher and student's role for "Evaluate"

Evaluation is the final step of the 5Es teaching method. The assessment, both formal and informal, should be considered and appropriate to the actual situation. In this step, the teacher uses tools to assess student's learning through tests, oral questions, lesson summaries, or assignments that reflect students' learning outcome during class or lesson. Student may ask question, self-assessment or peer-assessment which related to the lesson or future investigation. Teacher collects the data or the whole information of the lesson to make a new overall conclusion.

3.6 Teacher's perception on 5Es instructional model

At this point researcher wants to know the benefits and consequences of using 5Es instructional model. This section, may help teachers to be aware of or vigilant regarding other challenges that arise. They may consider that cause and find any possible solutions before they apply this model into a lesson.

5Es instructional model is regarded as an important learning goal by encouraged and mandated to pursue an inquiry-based learning for science teachers. An inquiry-based curriculum is one that seeks to actively engage students in their own learning, to develop

strategies for generating and solving problems, and the capacity to pursue those strategies to produce, analyze, and evaluate empirical data (Fazio, Melville, & Bartley, 2010). The study from Pulat & Selma (2009) showed that the students who studied with the activities of 5Es instructional model learnt better than the students who studied with traditional teaching methods. They mention that, 5Es instructional design is effective and ideal for instructors and it also motivates students to increase their learning level and expand its domain. One another study shown that, 5Es instructional model is more efficient and well-organized, comparing to traditional teaching methods (Fazelian, ebrahim, & Soraghi, 2010). Bybee's assumption is that teachers should ordinarily use strategies that enable students to take an active role in their learning and construction of knowledge. According to District et al. (2016) found that, learning with 5Es instructional model keep student learning and active learning. They also mention that, study with 5Es instructional model, student become active creator not passive learners. It is also providing student with the topic is more concrete, more pleasure and interest to the lesson, increase communication skill, encourage for doing research, self-development or independent learner, and student also can evaluate what they have been learn by their own selves.

While 5Es instructional model continues to be a highly recommended practice for teaching mathematics. Among of the factors reported as affecting teacher's practice of 5Es instructional model are, time, resources, professional development, science topic or content, classroom management and mandatory assessment (District et al., 2016; Liu, Peng, Wu, & Lin, 2009). Time factor refers to the class time or hour of teaching (i.e., block versus non-block schedule), semester or school year that is difficult for teacher make decision to practice or apply the inquiry-based learning. Then, the resources refer to the equipment or materials, supplemental to a course text, that affect instructional model. Resources may include

laboratory equipment, online access, etc. The professional development factor refers to the training that teacher receive to inform their practice and increase their pedagogical knowledge and confidence in this practice (Puteh & Nawastheen, 2013). The researcher has shown that certain science content or topic (s) may lend themselves to a more inquiry-based learning approach and therefore be a factor on a teacher's conscious pedagogical approach (Enugu, 2016; Liu et al., 2009; Enugu, 2016). Finally, it has been shown that the need to administer high-stakes mandatory assessments may forces a teacher to make choices between using an approach that encourages more student inquiry and covering material for an exam. According to a study of (Windschitl & Thompson, 2006) challenge for new teachers is that most of them, even those with degrees in science, are virtual strangers to authentic forms of inquiry. Thus, the study of District et al. (2016) about teacher's perception on negative effect of 5Es instructional model, application is very tiering, misunderstanding appear, difficult with student controlling, confuse to student mind.

CHAPTER 4: CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

According to what mentioned above, this study found that 5Es instructional model is one that seeks to actively engage students in their own learning, to establish strategies for generating and solving problems, and the capacity to maintain those strategies to produce, analyze, and evaluate empirical data. In moving students to become self-directed teachers would have to shift from being disciplined based content experts to becoming facilitators of student explorations. Understandably this shift threatened those who felt unable or unsuitable to perform adequately or to those whose reputations or careers were grounded in teacher's pedagogy. The 5Es instructional model is playing the main role in mathematics knowledge. The five phases of the 5Es clarify that engagement comes first followed by exploring, explaining, elaborating, and finally evaluating phase. Moreover, the problem with this model is that the 5Es are not separate from each other. By seeing insight into the nature of this approach it tells that, the freedom of learners, their freedom in engagement, and inquiring new things will allow students to dig out things new. In other words, this is the scientific method for teaching students go get more scientific knowledge which means that students have chance to break their limitation. Through engaging with finding out via collaborating with others and then they able to show out what they found with explaining to classmate and even teacher. So, by practicing this technique, for soon they will become the active students. Teachers can help their students to increase a complete understanding of new concepts through this model. They will more optimally involve their students within the given material and motivate them to be told more. The model also helps to guide them in developing their skills, characterized by active learning, during which students work together to resolve problems and explore new

concepts by asking questions, observing, analyzing, and drawing conclusions which might lead them with knowledge domain. Therefore, it's vital to adopt the 5Es instructional model in learning environment. Students or learners are encouraged to go through the learning process, and then they are led by the teacher or instructor for group activities. The teacher or educator tries to increase students' understanding and assist them in applying new concepts in new situations, as well as assess their own learning experiences. Students contend deep and meaningful concepts which help them to extend their level of curiosity for research processes, and provides them the chance to consider a subject-matter area. In general, 5Es instructional model is effective and ideal for instructors. It also motivates students to extend their learning level and expand its domain. On the opposite hand, there are some challenges of utilizing the 5Es in teaching since this approach require some suitable condition so as to use it correctly. Those qualification are time, resources, professional development, science topic or content, classroom management and mandatory assessment.

4.2 Recommendations

According to the literature review article, researcher recommended sequencing differs in several broad respects from past treatments of the sequence issue. First, MoEYS should follow up or investigate the effectiveness after providing a training or workshop to the management teams, national lecturer teachers and teachers about this model as professional development. Next, teacher training institute should integrate this model to train student who becomes teacher. Then, recommended teacher who are interested in the model give a try to apply in his or her teaching. Last, as this study is a research synthesis, researcher cannot criticize how effective it is of applying this model in teaching. Researcher would recommend

for any further research should do as a primary research or experimental research design to get the specific data and analyze how effective and more critical.

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APPENDIX A: សកម្មភាពនៃការបង្រៀនដោយប្រើប្រាស់ម៉ូដែល 5E

សកម្មភាពក្នុងការបង្រៀនមេរៀន វិសមីការ ត្រូវបានបង្កើតឡើងដោយអ្នកស្រាវជ្រាវដើម្បីជាជំនួយបន្ថែមសម្រាប់ការបង្រៀនតាមម៉ូឌែល 5Es។

សកម្មភាពទី១៖ ការចូលរួម

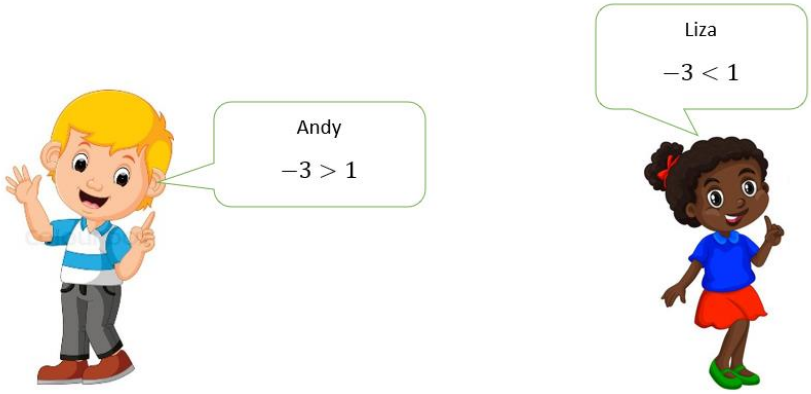
ការចូលរួម ជំហ៊ានដំបូងដែលគ្រូត្រូវធ្វើយ៉ាងណា ឬរកមធ្យោបាយណាមួយក្នុងការទាញយកចំណាប់អារម្មណ៍សិស្សឲ្យមានការចង់ចេះ ចង់ដឹង ចង់ស្គាល់ដែលផ្សារភ្ជាប់ទៅនឹងចំណេះដឹងដែលមានស្រាប់ ក៏ដូចជាការផ្សារភ្ជាប់ជាមួយជីវភាពប្រចាំថ្ងៃ។ ម្យ៉ាងវិញទៀតគ្រូបង្រៀនអាចប្រើប្រាស់ជាសំណួរបំផុស ផ្ទាំងរូបភាព ដ្យាក្រាម ការពិសោធផ្សេងៗ ដើម្បីបង្កើតឲ្យមានការជម្រុញទឹកចិត្តសិស្សបន្ថែមទៀត។

សកម្មភាពគ្រូ

- គ្រូបង្ហាញរូបភាពពីការប្រៀបធៀបវិសមីការ ដោយប្រើសញ្ញាវិសមីការ

សកម្មភាពសិស្ស

- សិស្សពិនិត្យមើលរូបភាព
- សិស្សប្រៀបធៀបវិសមីការក្នុងប្រអប់សំណួរ
- សិស្សបង្ហាញការយល់ឃើញទៅលើចម្លើយនៃវិសមីការ មិនថាត្រូវ ឬ ខុស
    - Andy បានបង្ហាញការយល់ឃើញថា $-3 > 1$ ព្រោះលេខ 3 ធំជាង 1
    - Liza បានបង្ហាញការយល់ឃើញថា $-3 < 1$ ព្រោះគ្រប់ចំនួនអវិជ្ជមានត្រូវតែតូចជាចំនួនវិជ្ជមាន
    - Jenny បានបង្ហាញការយល់ឃើញថា $-1 = -1$ ព្រោះគាត់បានសម្រួល-2 និង $+2$
    - David បានបង្ហាញការយល់ឃើញថា $1 < -3$ ព្រោះ ចំនួន 3 ធំជាង 1 ជានិច្ច



ប្រៀបធៀបវិសមីការខាងក្រោមដោយប្រើសញ្ញាវិសមីការ

$-1 - 2 \square -1 + 2$

សកម្មភាពគ្រូ

- គ្រូផ្តល់ចម្លើយដែលត្រឹមត្រូវ រួមផ្សំជាមួយការពន្យល់

សកម្មភាពទី២៖ ការរុករក

នៅក្នុងដំហ៊ាននេះដៃរទាមទារឲ្យគ្រូផ្តល់ពេលវេលាសម្រាប់សិស្សដើម្បីធ្វើការស្រាវជ្រាវ ស្វែងរកព័ត៌មាន ស៊ើប អង្កេត រកកស្តុតាងដើម្បីគាំទ្រដល់បញ្ញាតិរបស់ពួកគេ។ គ្រូបង្រៀនត្រូវបានដើរតួយ៉ាងសំខាន់ជាអ្នកសម្រប សម្រួលដល់សិស្សនៅពេលដែលពួកគេមានសំណួរ ឬបញ្ហាផ្សេងៗក្នុងអំឡុងពេលស្វែងរកព័ត៌មាន។ បន្ថែមពី នេះទៅទៀតគ្រូបង្រៀន គួរតែផ្តល់ឲ្យសិស្សនូវតម្រុយខ្លះៗសម្រាប់ផ្តល់ជាភាពងាយស្រួលសម្រាប់សិស្សក្នុង

ការស្វែងរកព័ត៌មាន។ ជាមួយគ្នានេះដែរការរៀនតាមបែបសហការ (Collaborative Learning) ត្រូវបានប្រើប្រាស់នៅក្នុងជំហាននេះផងដែរ។

សកម្មភាពគ្រូ

- គ្រូបែងចែកសិស្សជាក្រុមតូច (៤ ឬ៥នាក់ក្នុងមួយក្រុម)
- សមាជិកក្រុមនីមួយៗពិភាក្សាលើលក្ខណៈនៃប្រមាណវិធីបូកនិងដក
  - $-2+2\square\ -3+(-5)$
  - $-2-2\square\ -3-(-5)$

សកម្មភាពសិស្ស

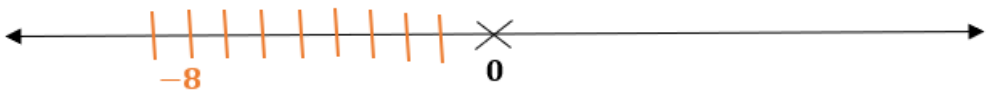
- សិស្សចាប់ផ្តើមពិភាក្សាក្រុម លើបញ្ហាតិដែលគ្រូបានដាក់
  - $-2+2\square\ -3+(-5)$

    $=-2+2\square\ -3-5$

    $=0\square\ -8$

    $=0>-8$

    សម្រាយលើបន្ទាត់ចំនួន



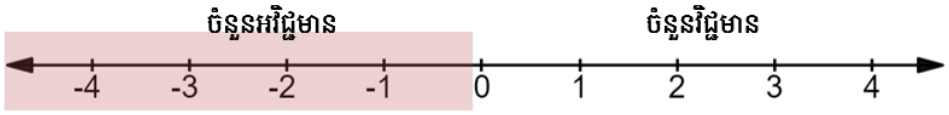
  - $-2+2\square\ -3-(-5)$

    $=-4\square\ -3+5$

    $=-4\square\ -2$

$= -4 < -2$

សម្រាយលើបន្ទាត់ចំនួន



សកម្មភាពទី៣៖ ការពន្យល់

ដំណើរការនៃការពន្យល់ត្រូវបានធ្វើឡើងនៅក្នុងដំហ៊ាននេះ។ ការពន្យល់ជាដំហ៊ានសំខាន់មួយផ្សេងទៀតដែលគ្រូបង្រៀនលើកទឹកចិត្តសិស្សឲ្យឡើងបកស្រាយពីលទ្ធដែលពួកគេបានរកឃើញនៅក្នុងសកម្មភាពទី២ (ការរុករក)។សមាជិកក្នុងក្រុម ធ្វើការជ្រើសតាំងសមាជិកដំណាងក្រុមដើម្បីឡើងធ្វើបទបង្ហាញពីលទ្ធផលដៃកពួកគេបានរកឃើញ។ សមាជិកក្រុមដទៃសង្កេត ស្តាប់ការពន្យល់ និងលើកជាសំណួរបើមានចម្ងល់។

សកម្មភាពសិស្ស

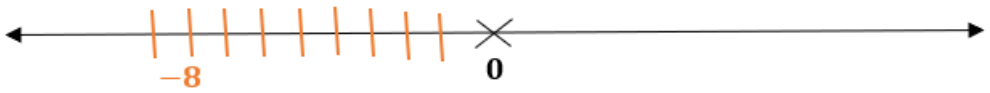
- សិស្សធ្វើការបកស្រាយពន្យល់ អំណះអំណាង និងលក្ខណៈសញ្ញានៃវិសមភាព
  - $-2 + 2 \square \ -3 + (-5)$

    $= -2 + 2 \square \ -3 - 5$

    $= 0 \square \ -8$

    $= 0 > -8$

    សម្រាយលើបន្ទាត់ចំនួន



ចំពោះចនួនអវជ្ជមានដែលស្ថននៅខាងឆ្វេង តូចជាងចនួនដែលស្ថតនៅខាងស្តាងដៃ ឬចនួនដែលស្ថិតនៅពីខាងមុខលេខសូន្យ ជាចំនួនដែលតូចជាងចំនួនដែលស្ថិននៅពីខាងក្រោយលេខសូន្យ។ ដូចនេះ $-8 < 0$ ពីព្រោះចំនួន -8 ស្ថិតនៅខាងឆ្វេង ឬពីខាងមុខលេខសូន្យ។

- $-2+2 \square -3-(-5)$

  $= -4 \square -3+5$

  $=-4 \square -2$

  $= -4 < -2$

  សម្រាយលើបន្ទាត់ចំនួន

គ្រប់ចំនួនអវិជ្ជមានដែលស្ថិតនៅខាងឆ្វេង តូចជាងចំនួនដែលស្ថិតនៅខាងស្តាំង។ ដូចនេះ $-4 < -2$ ពីព្រោះចំនួន -4 ស្ថិតនៅខាងឆ្វេង ឬពីខាងមុខ-2 ។

សកម្មភាពទី៤៖ ការបញ្ជាក់លម្អិត

ការពន្យល់បន្ថែមជាជំហ៊ានមួយដែលគ្រូបង្រៀនដាក់បញ្ជាតិថ្មី ឬដែលមានលក្ខណៈស្រដៀង ដើម្បីឲ្យសិស្ស មានការសិក្សាស្រាវជ្រាវ និងយល់ដឹងបន្ថែមលើបញ្ជាតិដើម។ សកម្មភាពទី២ និងទី៣ ត្រូវបានប្រើប្រាស់ជាថ្មីម្តងទៀតនៅក្នុងជំហ៊ាននេះផងដែរ។ ជាថ្មីម្តងទៀតការរៀនបែបសហការ(Collaborative Learning) ត្រូវបានប្រើប្រាស់នៅក្នុងជំហ៊ាននេះផងដែរ។

សកម្មភាពគ្រូ

- ឲ្យសិស្សធ្វើការជាក្រុមលើលក្ខណៈនៃប្រមាណវិធីគុណនិងចែកក្នុង ២ករណីនិងបកស្រាយលើបន្ទាត់ចំនួន
  - ករណីចំនួនពិតថេរ $C > 0$
  - ករណីចំនួនពិត $C < 0$
    - $-2 < 3$

- គ្រូបង្រៀនធ្វើសេចក្តីសន្និដ្ឋានរួមបន្ទាប់ពីសិស្សធ្វើបទបង្ហាញរួចរាល់

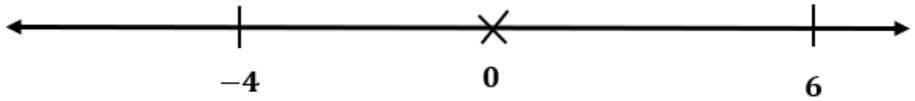
សកម្មភាពសិស្ស

- សិស្សបន្តធ្វើការជាក្រុមលើលក្ខណៈនៃប្រមាណវិធីគុណ និងចែកក្នុង២ករណី និងបកស្រាយលើបន្ទាត់ចំនួន

  គេមានវិសមីការ $-2 < 3$ (លក្ខណៈលើប្រមាណវិធីគុណ)

  - ករណីចំនួនពិតវេរ $C > 0$ គេឲ្យ $C = 2$ នោះ
    - $-2 \times 2 < 3 \times (2)$

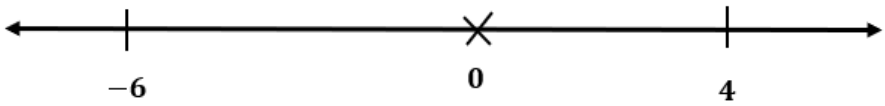
      $= -4 < 6$



  ក្នុងករណី $C > 0$ បើគេចែមចំនួនពតវជ្ជមាន $C = 2$ នោះយើងបានវិសមភាពឬមានទិសដៅដូចវិសមភាពដើម។

  - ករណីចំនួនពិតវេរ $C < 0$ គេឲ្យ $C = -2$ នោះ
    - $-2 \times (-2) \square 3 \times (-2)$

      $= 4 > -6$



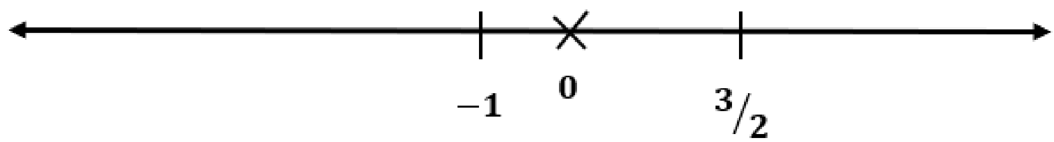
  ក្នុងករណី $C > 0$ បើគេថែមចំនួនពិតអវិជ្ជមាន $C = -2$ នោះយើងបានវិសមភាពថ្មី មានទិសដៅផ្ទុយពីវិសមភាពដើម។

  គេមានវិសមីការ $-2 < 3$ (លក្ខណៈលើប្រមាណវិធីចែក)

  - ករណីចំនួនពិតវេរ $C > 0$ គេឲ្យ $C = 2$ នោះ

- $-2 \div 2 < 3 \div 2$

  $= -1 < 3/2$



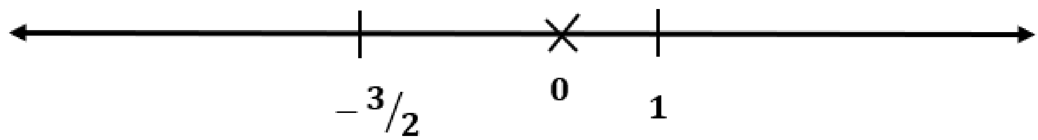
ក្នុងករណី $C > 0$ បើគេចែកចំនួនពិតវិជ្ជមាន $C = 2$ នោះយើងបានវិសមភាពថ្មី មានទិសដៅដូចវិសម

ភាពដើម។

- ករណីចំនួនពិតថេរ $C < 0$ គេឲ្យ $C = -2$ នោះ

  - $-2 \div (-2) < 3 \div (-2)$

    $= 1 > -3/2$



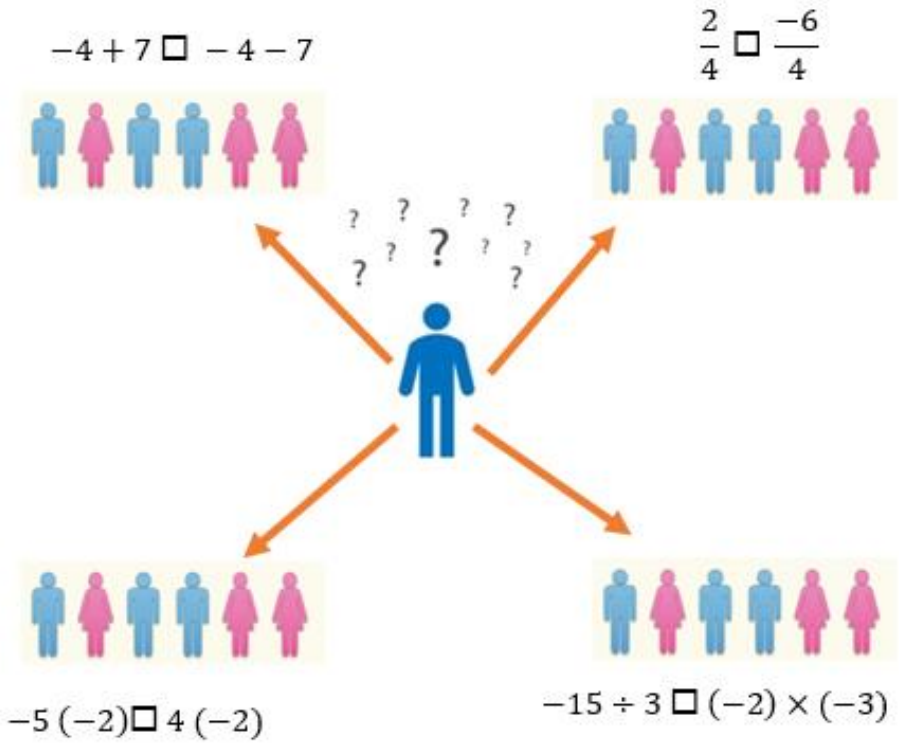
ក្នុងករណី $C > 0$ បើគេថែមចំនួនពិតអវិជ្ជមាន $C = -2$ នោះយើងបានវិសមភាពថ្មី មានទិសដៅផ្ទុយពីវិសមភាពដើម។

សកម្មភាពទី៥៖ ការវាយតម្លៃ

ជំហាននេះជាជំហានចុងក្រោយរបស់ 5Es។ ការវាយតម្លៃត្រូវបានធ្វើឡើងចាប់ពីជំហានទី១ ការចូលរួមមកម្លេះ។ គ្រូបង្រៀនអាចធ្វើការវាយតម្លៃតាមរយៈសកម្មភាពនានាដែលសិស្សបានចូលរួម ចែករំលែក វិភាគ ស្វែងរក ស៊ើបអង្កេត និងការពិភាក្សាការងារក្រុមជាដើម។ គ្រូបង្រៀនអាចប្រើប្រាស់តេស្តវាយតម្លៃផ្លូវការ និងមិនផ្លូវការ។ ម្យ៉ាងវិញទៀតគ្រូបង្រៀនអាចឲ្យសិស្សធ្វើការឆ្លុះបញ្ចាំងលើការសិក្សារបស់ពួកគេបាន ដោយខ្លួនគេផ្ទាល់តាមរយៈសំនួរមួយចំនួនដូចជា៖ តើប្អូនរៀនបានអ្វីខ្លះពីមេរៀននេះ? ឬតាមរយៈសកម្មភាពដូចខាងក្រោម៖

- គ្រូឲ្យសិស្សធ្វើការឆ្លុះបញ្ចាំងលើអ្វីដែលពួកគេបានរៀនក្នុងមេរៀននេះ
- គ្រូចែកប័ណ្ណចំនួនដែលមានលេខជាចំនួនវិជ្ជមាន និងអវិជ្ជមាន ព្រមទាំងប័ណ្ណសញ្ញានៃវិសមភាព

- គ្រូឲ្យសិស្សធ្វើការជាក្រុមតូចៗ ដោយមានទាំងចំនួនវិជ្ជមាន និងអវិជ្ជមាន
- សិស្សដែលមានប័ណ្ណជាសញ្ញាវិសមីការ ត្រូវរត់ទៅប្រៀបធៀបចំនួននៃវិសមីការដែលសមាជិកក្រុមបានបង្កើតឡើងអោយបានត្រឹមត្រូវ
- សិស្សដែលមានប័ណ្ណសញ្ញាវិសមីការ នឹងត្រូវបំពេញសញ្ញាឲ្យបានត្រឹមត្រូវ



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