វិទ្យាស្ថានជាតិអប់រំ

NATIONAL INSTITUTE OF EDUCATION

មជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី

NEW GENERATION PEDAGOGICAL RESEARCH CENTER

បញ្ហាប្រឈម និងការអនុវត្តការបង្រៀនមុខវិជ្ជាគីមី តាមបែបអប់រំស្ទេម: ករណីសិក្សា វិទ្យាល័យព្រះស៊ីសុវត្ថិ (សាលារៀនជំនាន់ថ្មី) ក្រមិតមធ្យមសិក្សាបឋមភូមិ

The Challenges and the Current practice of Teaching Chemistry in Lower Secondary School through STEM Education: A Case Study at Preahsisowath High School (NGS)

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

Ry Rathanak

December 2022

វិទ្យាស្ថានជាតិអប់រំ

NATIONAL INSTITUTE OF EDUCATION

មជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី

NEW GENERATION PEDAGOGICAL RESEARCH CENTER

បញ្ហាប្រឈម និងការអនុវត្តការបង្រៀនមុខវិជ្ជាគីមី តាមបែបអប់រំស្ទេម: ករណីសិក្សា វិទ្យាល័យ ព្រះស៊ីសុវត្ថិ (សាលារៀនជំនាន់ថ្មី) កម្រិតមធ្យមសិក្សាបឋមភូមិ

The Challenges and the Current Practice of Teaching Chemistry in Lower Secondary School through STEM Education: A Case Study at Preahsisowath High School (NGS)

Supervisee : Ry Rathanak

Supervisor : H.E. Dr. Chan Roath

Thesis Committee : 1. Dr. Katherine Prammer

2. Mr. Stanislas Kowalski

3. Mr. Banh Hornmann

December 2022

មូលន័យសង្ខេប

ភាពរីកចម្រើននៃបច្ចេកវិទ្យាបានធ្វើឱ្យមានការផ្លាស់ប្តូរស្ទើរគ្រប់វិស័យ ក្នុងនោះ ស្ថិយប្រវត្តិកម្មវិស័យការងារ និងជំនួសការងារមួយចំនួន ដោយការងារថ្មីៗនឹងត្រូវបង្កើតឡើង។ ក្នុងន័យនេះ ការអប់រំស្ទែម (STEM Education) ពិតជាមានសារៈសំខាន់ណាស់ ព្រោះវាអាចជួយឱ្យសិស្សមាននូវជំនាញសំខាន់ៗសម្រាប់ទីផ្សារការងារថ្មីៗនេះ ដូចជា ជំនាញក្នុងការដោះស្រាយបញ្ហា ការត្រិះរិះពិចារណា ភាពច្នៃប្រឌិត ការគិតបែបទ្រឹងជីក(Logical Thinking) និងសមត្ថភាពក្នុងការវិភាគ។ បើតាមមជ្ឈមណ្ឌលកម្ពុជា៤.0 ការអប់រំស្ទែម ពិតជាមានសារៈសំខាន់ណាស់ ក្នុងការជួយជំរុញសិស្សានុសិស្សអាចចាប់យកជំនាញបច្ចេកវិទ្យា។

ការសិក្សានេះបានធ្វើឡើងនៅវិទ្យាល័យព្រះស៊ីសុវត្ថិសាលារៀនជំនាន់ថ្មី
ដែលជ្រើសរើសចំនួនគ្រូ៥នាក់ (ស្រី ៣នាក់)
ដែលត្រូវចូលរួមក្នុងការឆ្លើយសំណួរសម្ភាសរបស់អ្នកស្រាវជ្រាវ។
ការសិក្សានេះធ្វើឡើងតាមបែបគុណវិស័យក្នុងគោលបំណងរុករកចម្លើយពីគ្រូផ្ទាល់ឱ្យបានស៊ីជម្រៅ។ តាមរយៈលទ្ធផលនៃការសិក្សាបានរកឃើញការអនុវត្តការបង្រៀនគីមីតាមបែបអប់ស្ទែម ក៏ដូចជាអត្ថប្រយោជន៍នៃការអប់រំស្ទែម ដែលបានបែងចែកជាបីចំណុចធំៗដូចជា ទី១៖ ការប្រើប្រាស់បច្ចេកវិទ្យាក្នុងការបង្រៀន ទី២៖ អត្ថប្រយោជន៍ក្នុងការប្រើប្រាស់បច្ចេកវិទ្យា និងទី៣៖ ការបង្រៀនគីមីវិទ្យាតាមបែបអប់រំស្ទែម។
ចំពោះបញ្ហាប្រឈមនៃការបង្រៀនគីមីវិទ្យាតាមបែបអប់រំ ស្ទែមគឺ ទី១៖
កង្វះខាតក្នុងការបណ្តុះបណ្តាលការបង្រៀនតាមបែបអប់រំស្ទែម ទី២៖
កង្វះខាតសម្ភារឧបទ្ទេសមួយចំនួនសម្រាប់គាំទ្រការបង្រៀន ទី៣៖
កង្វះខាតពេលវេលាក្នុងការបង្រៀនតាមបែបអប់រំស្ទែម ទី៤៖
ចំណេះដឹងមូលដ្ឋានរបស់សិស្សនៅមានកម្រិត និងទី៥៖ សមត្ថភាពគ្រូបង្រៀននៅមានកម្រិត។

ទោះបីជាយ៉ាងណាក៏ដោយពេលវេលាគឺ

ជាបញ្ហាប្រឈមមួយសម្រាប់លើកយកមកពិចារណាក្នុងការបង្រៀនគីមីតាមបែបអប់រំស្មែម។

ABSTRACT

Technological advances have brought about changes in almost every field, including labour automation and replacing some jobs with new jobs are being created. In this sense, STEM Education is essential because it can help students acquire the necessary skills for the current job market, such as problem-solving, creative, and logical thinking. And the ability to analyze. Moreover, according to the Cambodian Center 4.0, STEM education is critical in helping students to acquire technology skills.

The study was conducted at Preah Sisowat High School (NGS). This study used purposive sampling by selecting five teachers (3 females) to take part in answering the researchers' interview questions. In addition, this study was conducted qualitatively to explore the teachers' answers. The study's results found the importance of the current practice of teaching chemistry through STEM education, divided into three main points; 1: using electronic devices in teaching chemistry, 2: the benefit of electronic devices, and 3: applying STEM education in teaching chemistry. The challenges of teaching chemistry through STEM education in the study were; 1: not enough STEM education training, 2: lack of experimental tools, 3: lack of time for teaching through STEM education, 4: students' content knowledge is still low, and 5: teacher competence in STEM processing. In short, time is a challenge to consider teaching chemistry through STEM education.

SUPERVISOR'S RESEARCH SUPERVISION STATEMENT

TO WHOM IT MAY CONCERN

Name of program: Master's Degree of Education in Mentoring

Name of candidate: Ry Rathanak

Title of thesis: The Challenges and the Current practice of Teaching Chemistry in Lower Secondary School through STEM Education: A Case Study at Preahsisowath High School (NGS)

This is to certify that the research carried out for the above-titled master's thesis was completed by the candidate mentioned earlier under my direct supervision. In addition, I played the following part in preparing this thesis: guidance in research problem development, literature review, methodology, data analysis, and discuss findings.

Supervisor (Name): H.E. Dr. Chan Roath

Supervisor (Sign): …….

Date: ……

CANDIDATE'S STATEMENT

TO WHOM IT MAY CONCERN

This is to certify that the thesis that I "**Ry Rathanak"** hereby present entitled "The Challenges and the Current practice of Teaching Chemistry in Lower Secondary School through STEM Education: A Case Study at Preahsisowath High School (NGS)" for the degree of Master of Education major 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

Pursuing this Master of Education in Mentoring through the Phnom Penh campus of the National Institute of Education and the New Generation Pedagogical Research Center, NGPRC, has been a fantastic experience for me. I loved the learning experience from beginning to finish of the program, even though some of the centre's criteria were challenging.

I want to thank those who prof sincerely. H.E. Dr. Chan Roath has been my supervisor and inspired me to do this research. Furthermore, the professors in each stream, including Dr Sun Sumara, Mr Stanislas Kowalski, Mr Kong Maneth, Mr Banh Hornmann, Mr Chi Kim Y, and Mr Phe Soarith, deserve special thanks for their contributions to my education and for working with me as gathered data.

Furthermore, I am grateful to H.E. Dr. Chan Roath, the director of the NGPRC, who gave me a chance to conduct this study, notably for the data collection proposal, by offering more seminars or workshops.

Lastly, I congratulate everyone who participated in this research, especially the director, the stakeholders, and Preah Sisowat High School (NGS). They were delighted to participate in the interview and offer crucial data for the research.

Contents

List of Tables

List of Abbreviations

ICT	: Information Communication Technology
KAPE	: Kampuchea Action to Promote Education
MoEYS	: Ministry of Education Youths and Sport
NGS	: New Generation School
UNDP	: United Nations Development Programme

CHAPTER 1: INTRODUCTION

As the world has moved to the fourth industrial revolution, some tasks are now performed by technology, particularly robots, rather than humans, leaving some individuals without employment. As a result, they must increase their technical proficiency. STEM education, or the integration of science, technology, engineering, and math, is a burgeoning field in developed and developing nations (Singh, 2010). We must base our efforts on education to enhance the next generation's technological skills to address this predicament. Because they are relevant in the digital age, Cambodia's Ministry of Education, Youth, and Sport (MoEYS) have urged students to concentrate on STEM topics (Dara, 2019). Consequently, this study examines the difficulties faced by Preah Sisowat high school science teachers in teaching STEM courses to students in grade 8. The backdrop of the phenomena, research issues, goals, purposes, and questions, as well as the significance of the study, are all covered in detail in this chapter.

1.1 Background of the Study

The first strategy has been used, but its efficacy and efficiency still need to be determined. Institutional capacity improvements can be carried out by either replacing ineffective decision-making employees or improving the knowledge and abilities of the current staff. Although the first strategy has been used, its efficacy and efficiency still need to be improved (Chhinh & Dy, 2007). Recent discussions at the Fourth Cambodian Economic Forum on "Cambodian Economy in Post-Crisis Environment: Industrial Development Policy Options toward a Sustainable Economic Development" have placed a heavy emphasis on the RGC's strategic goal of transitioning the nation's economy away from dependency on agriculture, clothing, tourism, and construction and toward a broadly based industrial and technology-oriented economy to raise the nation's income level to

that of a higher-middle income country by 2030 and a high-income country in 2050 (RGC, 2015). In response, the MoEYS (2016a) produced the Science, Technology, Engineering, and Mathematics (STEM) Education Policy. The policy underlined the need to encourage Cambodian citizens to investigate the demand for 21st-century skills and produce more human resources in STEM sectors to advance the Cambodian economy. Cambodia is a nation in development with an expanding economy. However, Cambodia still has a high demand for STEM graduates to be more competitive in the area and the wider world. (Un & Sok, 2016). Therefore, MoEYS aims to increase the overall enrolment in STEM subjects in public and private higher education institutions, as indicated in the ESP 2014-2018 (MoEYS, 2014a). Countries are placing a great deal of attention on their educational systems to develop students capable of competing on a global level in STEM subjects due to the emphasis on STEM education and the rising importance of countries competing in STEM fields. A knowledge-based economy capable of competing in STEM fields demands a well-educated populace that can compete worldwide and contribute to their local economies' growth and prosperity. In this global environment, lower-middle-income nations such as Cambodia face significant hurdles in supporting a knowledge-based economy that gives equitable access to educational and employment possibilities, especially for females. (Sothy & Whitney, 2015).

1.2 Statement of the Problem

The topic of the challenges of teaching chemistry through STEM education in the Cambodian education context cannot be illustrated by the number of research articles. However, the researcher has found that the three main issues that make Cambodian chemistry teachers in public schools have some obstacles to applying STEM education in their teaching process.

1.2.1 Student's Interest in STEM Education

As a result of the general lack of knowledge and an undervaluation of STEM courses, there is a fall in the number of students choosing STEM disciplines. In many nations as the world enters the fourth industrial revolution, often known as the era of digitalization (Tanenbaum, 2016). Similar to Cambodia's situation, most public school students show little interest in these subjects. They prefer to take social science classes instead. The number of students taking social science classes has increased 18-fold, from 2,492 in 2014 to 45,002 in 2018, while the number of students taking science classes has stayed at around 30,000. (Tong, 2019). Furthermore, an article identified that the gender gap is closely related to children's motivation to use technology. Research has shown that students view science subjects (math, physics, and chemistry) primarily as a male domain, although results do not provide a clear picture of which of these subjects is more closely linked to the male gender. Research among primary school students found that boys strongly supported stereotypical views that STEM school subjects are more appropriate for boys than for girls (Makarova et al., 2019). According to the statistics compiled by the Department of Higher Education (DHE), MoEYS, the percentage of student enrollment in these fields remains low. In short, according to the Cambodian Development Resource Institute [CDRI] (2015) and MoEYS (2017), despite higher market demand likely to transform and modernize Cambodia's industrial sector by 2025, not many students are enrolling in STEM-related fields but rather in non-STEM areas. More specially, Set, Sieng, and Kita (2014) conducted a study including 3,014 eighth graders to assess performance on key indicators of the cognitive domain using TIMSS assessment criteria to explore student skills in knowing, reasoning, and application of scientific knowledge. Results indicated that Cambodian students scored an average of 31.96% on the chemistry knowledge portion of the exam, ranging from 0.0% to 90.0%.

1.2.2 Teaching Competence of Science Teachers

The teaching methodology should support the process of teaching. Therefore, teachers should train in the teaching methodologies, mainly STEM education like Lessig, et al. (2021) raised the teacher's preparation and capabilities to use trans-disciplinary, interdisciplinary, and integrated approaches in STEM education. For this challenge are influential teachers' appropriate practices, pedagogical development, and balance between quality and quantity in daily life. There is a strong perception that the teacher has to know everything. The change from teachers' to students' centric approach can give students more possibilities to take responsibility for the learning and the learning progress. Moreover, El-Deghaidy and Mansour (2015) indicated that all of their study's teachers expressed concern that they felt underprepared to use STEM applications in their classrooms. More significantly, Berlin and White (2012) reported that teacher education for STEM curricula should provide teachers with opportunities to access similar, complementary, coordinated, conceptual, and procedural knowledge and skills, thus enabling teachers to gain a deep understanding of STEM content knowledge.

1.2.3 Teaching Facility

The facility plays an essential role in teaching chemistry through STEM education. The process of teaching will be a success if there is enough facility. However, lacking facility factors to support teaching chemistry always happens. An article identified that the school environment is critical in implementing STEM. Teachers' understanding of implementing STEM needs to be improved; a lack of information from authorities causes it. The teacher suggests that the school upgrade facilities (laboratory and computer) and some training in STEM. The participants appointed six significant barriers: motivation, syllabus, skill (movement), inadequate facilities, student involvement, and responsive environment (Widya, Rifandi& Laila Rahmi, 2019).

Based on the above factors, the researcher decided to find more challenges and the current practice for teaching chemistry through STEM education at a New Generation School (NGS). Although according to MoEYS (2016b) and KAPE (2019), it is a pilot school, the New Generation School, aimed to significantly enhance the presence of educational innovation throughout the school system. Empowers Cambodia's education system to effectively compete with other education systems to produce a workforce with 21st Century skills. Thus, more precisely than the standard/traditional upper secondary school, the goal of the New Generation School is to increase skill levels in STEM subjects at upper secondary school through intensive capacity building in educational technology and STEM.

1.3 Research Purposes

This research aims to explore about the current practice of teaching chemistry through STEM education and the challenges or obstacles regarding teaching chemistry in a new generation school and to discover the current practice of teaching chemistry through STEM education.

1.4 Research Objectives

1. To find out the current practice of teaching chemistry through STEM education.

2. To find the challenges of teaching chemistry in STEM education in grade 8 at Preahsisowat high school.

1.5 Research Questions

1. What are the current practices of teaching chemistry through STEM education?

2. What are the challenges of teaching chemistry subjects in STEM education?

1.6 Significance of the Study

The Ministry of Education has changed the learning process, Youth, and Sports to address 21st-century skills, especially encouraging educators and learners to focus on STEM education. Therefore, the learner should pay attention to math, technology, engineering, and science to link the theory to practice in daily life, or the learners can use the ideas in the class to solve the problems in their everyday life. Moreover, as the Preahsisowath high school is being reformed yearly, STEM education plays an essential role in today's learning. Therefore, this paper is helpful to those who are involved with the following:

1. This paper is beneficial to the school principal to know the benefits or obstacles of applying STEM education, which is the key to setting the policies about STEM education.

2. This paper is also essential for the chemistry teachers at Preahsisowath high school regarding the challenges of applying STEM education. They can effectively prepare enough before teaching chemistry through STEM education and get ideas to find the solutions for using STEM education.

3. There are many benefits for the learners regarding the keys to effective learning through STEM education and enhancing enjoyment in chemistry subjects higher than before through STEM education.

1.7 Operational Definition of Key Term

The researcher has provided extra definitions of three key terms to clarify the understanding as follows:

- **STEM education:** Science, technology, engineering, and math are collectively called STEM (Casey, 2012). Havice (2009) asserts that STEM education is a crucial component of obtaining technical literacy. Havice also emphasized the value of bringing the outside world into the classroom through hands-on technology and engineering instruction. This allows students to examine concerns, trends, and problems and respond to challenges with flexibility and adaptability.

- **NGS:** New Generation Schools are a new reform recently inaugurated by the MoEYS in 2014 to create 'independent' public schools with a mandate to innovate and improve educational quality (KAPE, 2019).

- **Chemistry:** Science that examines the characteristics, make-up, and structure of substances as well as the changes they go through and the energy emitted or absorbed throughout those processes (Libretexts, 2021).

1.8 Summary

STEM education is beneficial for every learner to reply to the 21st related to daily life's problem solving and even develop the learners' ability regarding technology. Thus, this chapter has reviewed the background of STEM education and the purpose of the study; more significantly, the next chapter will review the world literature regarding STEM education.

CHAPTER 2: LITERATURE REVIEW

This chapter reviews some related literature in the local and the world of STEM education. All of the literatures are examined from the current study, book, and chapter studies recently. To create the potential evidence to be discussed in the finding, the researcher has divided the literature review into six main themes as follows:

2.1 Definition of STEM

STEM (science, technology, engineering, and math) is an abbreviation (Casey, 2012). According to Havice (2009), STEM education is essential to achieving digital literacy. Havice also emphasized the power of hands-on technology and engineering education to bring the real world into the classroom, enabling students to examine issues, trends, and problems and respond to difficulties with flexibility and adaptation. Additionally, According to this viewpoint on STEM education, the diverse branches of science, technology, engineering, and mathematics should be taught as a single organism (Breiner et al., 2012).

2.2 STEM Teaching Method

FurtureLearn (2021) raised some of the main approaches you can take when teaching students STEM. All of these methods are useful, so it might be worth mixing up your lessons and using a variety of techniques to keep students interested.

2.3 Using the Engineering Design Process

According to Futurelearn (2021), using the Engineering Design Process is one way to plan lessons (EDP). These are a sequence of actions students can do as part of a project to create solutions to challenges. This project-based learning approach should promote flexible designs, images, and workable solutions. The steps are:

2.3.1 Ask

Start by challenging students' assumptions regarding their assignment or the desired result. Why is it required? How is it going to be made? Use the chance at the start of the lesson to spark students' interest and encourage critical thinking.

2.3.2 Research

Students should use this time to complete necessary research, whether speaking with a teacher, working with a STEM volunteer, using a laptop to research, or viewing pertinent videos. Through research, students can learn what solutions or products are similar to those that already exist and how they can improve.

2.3.3 Imagine

The students can now generate as many ideas as possible in groups. A teacher's responsibility is to ensure everyone's voice is heard in a collaborative process. A judgment-free environment where pupils must demonstrate practical listening skills and maintain focus would be beneficial. In addition to mind maps, brainstorming aloud is a powerful strategy for generating ideas.

2.3.4 Plan

It is time for student teams to select a solution and plan how to implement it. They will need to consider their initial concerns, the research they conducted, and everyone's various brainstorming suggestions to accomplish this. The most challenging aspect of planning can be ensuring everyone's suggestions are considered. To assist the kids, ensure they write their ideas down digitally or on paper.

2.3.5 Create

Students can build a prototype utilizing the designs they just made in this section of the session. They should use their imaginations, their hands, and their practicality at this time. Students will learn whether their answers are practical and satisfy the original requirements at this point. Therefore, teachers should only keep an eye on things and motivate the students rather than take over this place.

2.3.6 Test

After that, the students must come up with a method of evaluating the performance of their inventions. Are they appropriate, or do they address a problem? They have to have the capacity to test their goods and document the outcomes. When providing advice or provocative inquiries, a teacher can ask them what feedback they would provide themselves. A fantastic technique to promote critical thinking and teamwork is peer review.

2.3.7 Improve

In this lesson's final section, students explore how to improve their ideas. Students will then have the chance to remodel their creations, make changes, and produce the following prototype. This cycle can go on as long as or until the client is satisfied with the outcome. Teachers decide whether a project lasts for one lesson or several.

2.4 Advantages of Electronic devices

According to the study by Penuel et al. (2007), which involved 454 science instructors, those who received equipment and technology support significantly contributed to the program's integration and modifications in science teaching techniques. Principals should be more interested in STEM education, and chances should be provided

for them in this regard, despite the literature's emphasis on the relevance of school administrators, particularly in implementing STEM programs in schools.

2.5 Advantages of STEM Method

2.5.1 For Learners

Many integrated STEM-based tasks show the conceptual surprises that students experience as they learn new concepts. For instance, sixth-grade students who were designing and building an earthquake-proof structure displayed abstract surprise when they realized how the construction materials. their measurements and costs, as well as the structural shapes. They chose their engineering methods all contributed to making their building more robust and stable (English, King, & Smeed, 2016). Engineering plays a crucial role in enhancing and safeguarding infrastructure and the surrounding environment, and students' experience with engineering design and concepts helped their appreciation and comprehension of this. Wide walls used in STEM-based experiences empower students to share and communicate their learning within and outside the classroom as they explain to others the conceptual surprises they have encountered. In a study by Atweh and Ala'i (2012), instructors' resistance to using open-ended pedagogies hindered efforts to adopt Socially Response-able Mathematics activities. Their research showed that, in contrast to direct teaching, pupils consistently exhibit a more profound comprehension and engagement when teachers employ such tactics. Promoting all students' learning throughout the STEM disciplines would require removing any potential resistance to introducing more cognitively challenging, low-floor, high-ceiling activities that produce conceptual surprises. Developing early design-based issue-solving through the integration of the STEM disciplines can benefit significantly from young kids' predisposition to use many ideas and approaches to innovative and creative problem

resolution (Dorie, Cardella, & Svarovsky, 2014). Additionally, strengthening students' capacity for innovation and critical thinking, crucial for success after high school, is a significant focus of STEM education. Children can start to become autonomous at an early age because STEM courses are typically convenient and cognitively demanding. Experts from the STEM industries frequently participate in these sessions to give students a peek at what these occupations are genuinely like.

2.5.2 For Teachers

In the study by Alumbaugh (2015), which used qualitative methods to gather the data, participants from Missouri included three leaders from a professional STEM company, four primary school principals, and six primary school instructors. Each leader of the STEM professional companies was found to support STEM education at the primary education level and to have a positive attitude toward STEM for STEM education. Additionally, teachers and school principals' perspectives are comparable. Therefore, the pupils' involvement and academic success might be enhanced by STEM instruction, according to the principal and the teachers.

2.6 The Challenges of STEM Education

2.6.1 Lacking of materials and laboratory

A general lack of laboratories and adequate materials or the teaching of science subjects at upper secondary school could lead students to feel unequal in pursuing a science-related degree successfully. Many needed to understand the employment opportunities available to science graduates. They were attracted to the more conventional route through a lack of confidence. Moreover, this trend also is rooted in the fact that more HEIs offer scholarship positions in non-STEM-related fields and fewer in the STEM fields (Sovansophal, 2019).

2.6.2 Lack of STEM Education Training

Teachers who graduated from universities and teacher candidates in Turkey must graduate with sufficient training. Their in-service training is separate from the deficiencies of the teachers regarding STEM education. It reported that secondary school science teachers in Turkey and some other countries feel incompetent regarding STEM education. University-industry collaboration is required to achieve these qualifications (El-Deghaidy et al., 2017). This paper strongly recommended that teachers be trained in STEM practices, which should be carried out with in-service training. Teachers can carry out their classroom activities more effectively by obtaining expertise in STEM education. Additionally, a study asserted that few math and science instructors have practical STEM teaching experience. According to a National Science Foundation report, teachers can also lack formal education in STEM pedagogies. According to the study, 30% of middle school science teachers lack practical experience (NSF 2012, as cited in Casey, 2012).

2.6.3 Gender

An article identified that the gender gap is closely related to children's motivation to use technology. Research has shown that students view science subjects (math, physics, and chemistry) primarily as a male domain, although results do not provide a clear picture of which of these subjects is more closely linked to the male gender. Research among primary school students found that boys more strongly supported stereotypical views that STEM school subjects are more appropriate for boys than for girls (Makarova et al., 2019).

2.6.4 Teacher Competence in Process STEM Education

This finding is supported by some literature, which asserts that teachers frequently feel they lack subject matter knowledge regarding the content of STEM lessons and that

pre-service and in-service teacher preparation programs fall short in preparing teachers for STEM implementation (Al salami et al., 2017; Nadelsom & Seifert, 2013)

2.6.5 School Principal's Management

Oparaocha (2017) raised the items that affected the STEM performance of the school. Within these, he pointed out the idea that effective STEM education can be realized in the school where an efficient manager with high STEM awareness cooperates with his colleagues.

2.6.6 Student Content Knowledge

Student concerns are another barrier to integrating STEM education. Teachers may think that pupils need help to participate fully in STEM integration. Sometimes teachers misjudge how capable their students are of handling STEM problems (Al Salami et al., 2017; Asghar et al., 2012; Bagiati and Evangelou, 2015; Goodpaster et al., 2012; Van Haneghan et al., 2015). Many educators think some subject matter is too challenging for kids, which could demotivate them. Teachers in remote locations worry that many of their students are underachievers, and it might be challenging to adapt the curriculum to fit these students' requirements (Goodpaster et al., 2012).

2.6.7 Lack of Time for Teaching through STEM Education

Teachers are concerned about the extra workload caused by planning and integrating STEM lessons into their existing curriculum. They have to allocate more time to work with teachers of other subjects and to prepare materials for students. Lack of time is a significant and prevalent issue teacher face while implementing STEM lessons (Bagiati and Evangelou, 2015; Hsu et al., 2012; Park et al., 2016).

2.8 Student Motivation

According to Tamara et al. (2016), primary school teachers significantly impacted their students' plans for STEM careers. Thus, teachers' perspectives on STEM are

essential because they play a significant role in their student's futures. According to Lesseig et al. (2016), involvement in the activity and adopting the movement are the second and third reasons students choose to major in science, math, and engineering. These viewpoints highlight the fundamental tenets of STEM education and are crucial for motivating students to participate in STEM-related activities.

.

CHAPTER 3: RESEARCH METHODOLOGY

In this chapter, the researcher describes seven main sub-sections: research design, sample size, sampling technique, research instrument, data collection procedure, data analysis, and ethical considerations.

3.1 Research Design

The researcher adopted this research design for the following reason. Firstly, the researcher wanted to achieve the objective of exploring the challenges of teaching chemistry through STEM education and the factors that cause those challenges at Preahsisowath high school. Moreover, this research paper was adopted to understand each element and the specific challenges. Then the result will be illustrated to the chemistry teacher, school administrator, and the relevant person to make them realize finding the solutions to those challenges. Secondly, to understand the challenges more deeply, the researcher collected the data from the samples trained in teaching chemistry through STEM education at Preahsisowath high school. The inductive qualitative methods like interviews were used for data collecting (Lunenburg & Irby, 2008). Finally, the researcher conducted the case study in this qualitative research to give a high value to the researcher's experience and knowledge about the problem of applying STEM education in chemistry at Preahsisowath high school (NGS). Furthermore, to make sure that the data were trustworthy and reliable. The researcher considered using the triangulation method. The first method is data collection, which means collecting data by interviewing the participants. The second method was participant triangulation. The participants were selected through their backgrounds related to STEM education, like chemistry, the science finical team leader. Those participants were the teachers inside the Preahsisowath high school (NGS); thus, they could know the phenomenon in their institution and

provide reliable information. The last method was data analysis triangulation to combine the knowledge and also find the central theme of the data to illustrate the research questions in more detail. These are the keys to finding solutions for those challenges to improve the applying STEM education to chemistry subjects. As a result, this research paper could help chemistry teachers effectively.

3.2 Sample Size and Sampling Technique

A purposive criterion-based sampling method was adopted in this study to help collect deep data to answer the research questions (Lunenburg & Irby, 2008). The participants were purposively selected by contacting the gatekeeper and suggesting that he allow the researcher to choose the samples needed. To determine the samples, the researcher considered choosing a lower secondary chemistry teacher with experience in applying STEM education in chemistry and who knew the information regarding STEM education. Then he provided clear information regarding the challenges of using STEM education in his teaching. These participants suggested having an interview for 30 minutes to provide information regarding teaching chemistry through STEM education and the challenges of applying STEM education. To get more information, a science technical team leader of Preahsisowath high school (NGS) was the potential participant for providing clear information about this study. These participants were chosen to interview the applying STEM education to the teaching process and the challenges.

Table1 *The numbers of participants from the NGs, namely Preah Sisowat high schools*

NGS	Grade	Teachers	Technical Team Leader
Preah Sisowat High School	7, 8, &9	4	1

3.3 Research Instrument

The researcher aimed to explore the extra information on the current practice of STEM education, the challenges of teaching chemistry through STEM education, and the current practice of STEM education in teaching chemistry. Thus, the semi-structured interview technique was conducted in this study which consists of two main themes regarding the current practice of STEM education and the challenges of teaching chemistry through STEM education. Twelve main questions are written in the interview guide under the different areas, and follow-up questions during the interview to explore extra information. All questions were written in Khmer because the respondents are Khmer.

3.4 Data Collection Procedure

Piloting phase: Five respondents from Preah Sisowat high school (NGS) was selected purposively to join the pilot phase one on one for 45 minutes. In addition, the researcher will choose four respondents of chemistry teachers who have taught at lower secondary schools and technical team leaders. There were two primary purposes for conducting the pilot: first, to determine whether each selection procedure of the above two sample selection techniques was acceptable for collecting the correct data. Second, to determine whether the interview guide could be adjusted to collect the most relevant and wealthiest data.

Main phases: The interviews were conducted in three rounds. The chemistry teacher was interviewed in the first round; the technical team leader will participate in the second round. The researcher interviewed semi-structured interview techniques for collecting the primary data. The interview procedure with the chemistry teacher and technical team leader was conducted in a one-to-one interview mode through Zoom meetings. Open-ended questions were asked, and written or unwritten follow-up

questions were asked for further clarification or explanation. However, leading questions were avoided so the respondents would give honest, comprehensive information and feelings. All interview interviews were conducted in Khmer, depending on the respondent's language preference. The interviews were recorded with the respondents' approval, and all the audio records were kept safely.

3.5 Data Analysis

Data analysis in qualitative research involves summarizing data dependably and accurately and leads to the presentation of study findings in a manner that has an air of undesirability (Mills & Gay, 2016). Both of constant comparative method and a generic qualitative analytical approach were adopted in this research paper; the generic qualitative analytical system related to transcription, coding, and thematizing. After finishing the interview, the researcher also transcribed the data and code. The data were collected from the samples through Khmer interviews depending on the audio records, and those data were transcribed in Khmer. Then, the researcher started to code the data as well as categorize the data into themes and sub-themes. This research paper was written in English; therefore, the data was translated into English to apply in the research paper. The descriptive method was adopted in this research paper, summarizing the primary topic of qualitative data into a word or short phrase. The constant comparative method was used in this research paper after the interview; the researcher analyzed the data by comparing the new data with the previous data (Lunnburg & Irby, 2008). The researcher asked more questions focused on the critical factors in the following interview; thus, the researcher got detailed information.

3.6 Ethical Considerations

The researcher wrote permission letters for Preah Sisowat high school (NGS) to get permission from the gatekeeper. During this stage, the researcher reported the consent to the sample by asking participants from each sample. Significantly, the researcher had a duty to keep the samples' opinions during the interview confidential and not to use the actual name of participants or other personal information to avoid unexpected happening after finishing this study. Moreover, the researcher did not edit the participants' answers by sending the transcription to check whether something was wrong. During interviews, the interviewees were not forced to answer each question, and the interviewees had the right to respond. Moreover, the audio recording of the conversation was kept private. Though it was deleted in case, the participants requested to do so. Furthermore, the researcher also gave credit to the authors and wrote the references before adopting the sources noted in this paper, and plagiarism was not seen in the form. The researchers will paraphrase those sources by using Grammarly to check.

CHAPTER 4: RESULTS

The research finding, which was consists of two questions, is covered in this chapter: (1) what are the current practices of teaching chemistry through STEM education? and (2) what are the challenges of teaching chemistry subject in STEM education?

4.1 Demographic Information

Table 2
A Brief Summary of the Parcticipants' Background at Preah Sisowath High School (NGS)

Code	Sex	Age	Level and grade	Teaching ex	Subject
P1	F	29	9	4	Chemistry
P2	F	32	8	5	Chemistry
P3	F	25	7, 8	2	Chemistry
P4	M	27	7	3	Chemistry
P5	M	29	8, 9	3	Chemistry

Participants: There were five participants, and among them, there were three female participants. A female participant is a technical team leader of lower secondary school at Preah Sisowath high school (NGS). Their ages from over 25 years old to over 30 years old.

Education background: All participants were trained at Teacher Training Center in Chemistry. Mainly, They used to be taught about STEM education.

Working Background: All participants have been teaching chemistry for at least three years. Their work duration is over 20 hours per week; most teach lower secondary and higher secondary schools. There are only two participants who teach only lower secondary schools. All of them have been applying STEM education in teaching chemistry.

The Current Practices of STEM Education in Teaching Chemistry: What are the current practices of teaching chemistry through STEM education?

This section presents the current practice of STEM education in teaching chemistry subjects from 5 participants. This current practice includes: using electronic devices in teaching chemistry, the benefits of electronic devices, some challenges of using electronic devices, applying STEM education in teaching chemistry, and the advantages of applying STEM education.

Using electronic devices in teaching chemistry: based on an interview, all respondents have been applying them in their teaching. They often use electronic devices in their education, even the internet, websites, apps, and social media such as group Telegram and Zoom meetings. Because there are enough of those materials in each room, the teacher needs to use them. Respondent P1 said that she had been using electronic devices in her teachings, such as a slide projector, YouTube for some experiment clips, a computer, and Microsoft Office. She also raised that sometimes she has used a slide projector to show chemistry contents to the learners. She has used the YouTube app for some experiment clips because of lacking experimental tools for some experiments. Thus, she found those experiment videos to show on the slide projector to her students and about Microsoft office, which she used for lesson plans, and contents slides, and used Microsoft excel for the students' scores. Respondent P2 mentioned that she has been using electronic devices in her teaching, like a slide projector, NGS mobile app, group telegram for collaborating with students, and other apps that were useful in teaching chemistry. For example, she used the chemistry app to weigh chemistry equations; therefore, when she used it to support her teaching, she recommended that her student use it to understand how to consider chemistry equations easily. However, she did not use electronic devices in all of the lessons because those lessons were not relevant to electronic devices.

Moreover, respondent P3 reported that she has been using electronic devices in teachings, such as a slide projector, some apps, Microsoft office, the internet, and telegram. Because of the Covid-19 era, she should be flexible; thus, those electronic devices could help her with distance teaching. For some apps, she used them for lesson preparation or using chemistry formulas. Respondent P4 mentioned that he has been using electronic devices such as a computer, slide projector, some apps, and NGS mobile app. The reason was that there were enough those electronic devices at Preah Sisowath high school. Respondent P5 also mentioned that he has been using electronic devices like Microsoft office, a Slide projector, a computer, and some websites (Quizzes, Cahoot, and YouTube). He also mentioned using YouTube when needing experiment materials.

Benefits of electronic devices: The result of the interview has shown that electronic devices have provided many benefits for the process of teaching and learning, such as supporting complex experiments in chemistry, saving time, student attraction, and effectiveness in education. Respondent P1 mentioned the benefits of electronic devices, like the ease of teaching and learning, significantly saving time. When there was a complex experiment that was difficult to do and a lack of materials, she found a relevant clip-on YouTube to support that her students were interested. She understood the contents quickly because they had seen virtually rather than had nothing. Furthermore, respondent P3 raised that electronic devices were beneficial in supporting teachers, such as preparing the lesson to drop for students. The respondent P4 also reported the benefits of electronic devices, like they were more valuable than when he had taught at regular school. Still, at Preah Sisowath high school, there were enough that he could prepare for the students before teaching in class. They learned again in the class, which meant they knew twice so they could get the contents quickly. He mainly used the video clip of some experiments when lacking experiment materials. Respondent P5 said that electronic devices provided

many benefits because if we just taught the theory, the student would imagine. Still, when using the experiment videos on YouTube, the learner could see and understand the process.

Some challenges of using electronic devices: Even though they have provided many benefits, a respondent raised some difficulties using them in her competence use. Therefore, respondent P2 presented her challenges with using electronic devices, such as being unfamiliar with using them, so she wanted some help from the other. Moreover, they are so complex that she could not use them, and some of the theory of content differs from the view of the apps. The same with respondent P3 also said that she had many obstacles in using electronic devices. However, she tried to ask and learn more from mentors. For instance, the block was relevant to the Zoom meeting. Thus, she needed help from a mentor or using the NGS app. Therefore, she also needed help from a mentor. Applying STEM education in teaching chemistry: Every teacher I interviewed has used STEM education because they had been trained in STEM education. Thus they know the process of STEM education as well as had a weekly session with the technical team leader to follow up. Moreover, all the respondents also mentioned the steps of applying STEM education and some methods that support STEM education, such as the scientific method, IBL, and project-based learning. For example, respondent P1 said she has been applying for Korean STEM education. Each step checks students' basic knowledge by asking the questions and then providing a critical question related to the topic, especially daily life. Then the learners work in a group to make a hypothesis. After that, the learners test the theory through experimenting. When they finished the experiment, the learners started to analyze the result and then make a conclusion. Finally, the learners started to share results and linked to daily life. Furthermore, respondent P2 said she has been using STEM education in her teaching. For instance, she applied inquiry-based learning (IBL),

a collaborative teaching method in STEM education, and added some steps that use the contents in daily life. Moreover, she also applied to STEM education in Korea. Respondent P3 said that she had been involved in STEM education; she always led STEM experiments and let the students discuss in the group to improve their critical thinking. For example, in teaching chemistry through STEM education, she provided worksheets to the students, allowing them to find the objectives and think about the crucial question. After that, the students discussed in a group to make some hypotheses and test the theory by experiment. Next, the students started to discuss the result or analyze the impact before concluding. Finally, let each team share their development with the whole class. Moreover, respondent P4 said that he had been using STEM education in his teaching, like the topic of making ice cream:

1. He showed the learners about ice cream and asked a fundamental question about how the ice cream froze.
2. The learners started to think about the root of the problem.
3. The learners started to make hypotheses. After experimenting with their theory, they found the result under the teacher's facilitation.
4. Each team started to do a presentation to the whole class. The respondent P5 added that he provided the worksheet to the learners and then let the learners read and find out the experiment materials. After that, let the students find out the critical question, start to make the hypothesis, conduct the experiment to find the result, and give the presentation to the whole class.
5. The teacher facilitated where that content applies in daily life.

Advantages of applying STEM education: All respondents raised many benefits of using STEM education in their teaching, like spreading the theory to daily life, attracting the learners, and quickly understanding the content. Here is what respondent P1

said "In addition, If we know the theories but do not know where those theories related to or how to use those theories in daily life, therefore, the learners know the theories but they do not know or how to use those to apply in daily life. However, when applying STEM education in teaching, the learners understand the contents easily. When talking about the content, they know where those contents relate. Moreover, they can understand and remember those contents for a long time." Furthermore, respondent P2 mentioned that STEM education benefits the whole class. When she taught chemistry through STEM education, it made the students know about problems in daily life and could solve those problems as well, especially her students interested in STEM education rather than traditional teaching. The students needed to learn the lessons' benefits in daily life. Moreover, respondent P3 reported many benefits from STEM education, which could help the students think or learn by themselves. If we tell them, they will not believe themselves, meaning they listen to the teacher without paying attention. Respondent P4 added that STEM education could help to apply the lesson to real life, for instance, the study on a freeze; thus, in theory, it just showed how the liquid froze. However, the learner needed to learn how that topic was helpful in real life. However, when applying STEM education, the learners knew how that topic applied in daily life, like they could make ice cream using the theory of the lesson. Respondent P5 added that he was satisfied with STEM education because it could help the learners know where the ideas apply in daily life and help society solve problems.

The challenges of applying STEM education to chemistry subjects: What are the challenges of teaching chemistry subjects in STEM education?

Those teachers who were interviewees have been working as chemistry teachers at Preah Sisowat high school (NGS) and used to be trained in STEM education and have been applying STEM education in teaching chemistry. Therefore, they have found some

challenges in applying STEM education to teaching chemistry, such as Not enough STEM education training, lacking experimental tools, lack of time for teaching through STEM education, Student content knowledge, teacher competence in processing, and STEM education, difficult to apply some theories in daily life,

More STEM education training: Some respondents showed their perception of STEM education training. They raise that they just got STEM education training once or twice online; therefore, the respondents mention that if there are more STEM education courses, they will join again because they are not clear enough about STEM education. Similarly, respondent P2 suggested more STEM education training because she said she was trained once and could not know much about STEM education. Therefore, she felt blurred with teaching chemistry through STEM education. Similarly, respondent P3 said that she used to be trained by a technical team leader. Therefore, she thought the training was not enough for her, and she wanted to join more about STEM education. Moreover, respondent P4 mentioned that he used to be trained in STEM education once and practised the theory he was taught in his teaching; however, he wants more STEM training despite the repeated contents.

Lacking experimental tools: The testing tool is essential for teaching chemistry through STEM education to help the learners see directly and link the theories to practice. However, some of the respondents at Preah Sisowat high school (NGS) reported needing more experimental tools because those practical tools are expensive. Therefore, the school managers cannot buy those, and the respondents also said the challenge was creating an experiment when they reached that content. Respondent P2 noted that the problem lacked some experimental tools because some practical tools were expensive. For instance, when she conducted experimental tools regarding concentration, she needed to know whether the attention was the same as the theory; therefore, she needed the

equipment to measure that concentration. That equipment was necessary for teachers and students to know about the amount of attention in school. She also mentioned that standard experimental tools were enough, but when she did a complex experiment, there needed to be more, such as the expensive chemical elements; therefore, she used video clips instead. Respondent P3 also reported lacking experimental materials; however, the school tried to solve this problem. For example, when she taught in grade 8 about the mixture, she wanted to create an experiment. Still, there needed to be more experiment materials, and she could estimate that there was fifty to sixty per cent of the experiment materials. Respondent P5 also raised that sometimes, there were not enough experiment materials; thus, he needed to invent more. There were enough common experiment materials, but if he wanted to do a deep experiment, the materials needed to be more; like the atomic lesson, he could not experiment.

Lack of time for teaching through STEM education: Some respondents were concerned about the need for more time for teaching chemistry through STEM education. Because teaching through STEM education has many activities, the teachers at Preah Sisowath high school (NGS) cannot complete each step of STEM education on time that will need to be finished the next time. The respondent P1 said that the time taught at his school needs to be more teaching through STEM education because, at this school, chemistry is taught only 40mn to 45mn, and the class is also busy every time as well as teachers. Therefore, there needed to be more time to pre-prepare before teaching. Moreover, in teaching STEM education, the teacher should spend time preparing the experimental tools. Thus, the students needed more time to finish the step. They reached the fourth step at the end, and the left actions continued the next time. However, he can teach on time if there is one hour thirty minutes to two hours. Respondent P3 also raised the need for more time for teaching chemistry through STEM education because the

experiment lap is busy every day, causing the teacher could not prepare the experiment materials on time. We knew that the teachers needed to prepare the materials before teaching. That was why the teacher could not teach chemistry through STEM education and needed to finish the process next time.

Student content knowledge: In addition, Students of lower secondary school are not familiar with chemistry, especially STEM education, because the primary school is a regular school, but when they join Preah Sisowath high school (NGS), it is a new experience for them that is difficult for them to learn chemistry through STEM education. Thus, most respondents mentioned students' content knowledge, especially those in grades seventh and eight who had transferred from primary school; therefore, they need to gain basic knowledge regarding STEM education. Respondent P1 mentioned that most students needed to learn how to make a hypothesis and the experimental tools. When she taught about those experimental tools, the students still needed to learn those practical tools, so it was not easy for when the students to write experimental reports. Similarly, respondent P2 reported that sometimes it could be caused by students' habits like some learners did not want to learn through STEM education. Still, they preferred memorization because before they reached lower secondary school, they had been taught through traditional instruction. As a result, the teacher was challenged to change their habit. The respondent P3 also said that most of the students at lower secondary schools had a problem with the content knowledge regarding STEM education, especially in grade 7. STEM education was new for them, and they graded eight because the previous year was the Covid-19 era, so they were learning online without knowing STEM education. Respondent P4 also mentioned that student content knowledge was still low when he gave the learners a topic, but the learners could find the deep meaning of that topic.

Teacher competence in processing STEM education: Many respondents mentioned their competence in teaching chemistry through STEM education. Thus, they also said that if there is STEM education training, they want to join again. However, respondent P2 mentioned that some lessons were challenging to apply daily because of teacher content knowledge. For example, studying molecule geometry was challenging to use in daily life, which caused the learners to learn by imagination. As a result, the learners did not understand the contents and did not want to study this lesson. Furthermore, Respondent P1 raised that he always created sessions with his members regarding some challenges of teaching, especially STEM education. Members were always raised about how to write a hypothesis, critical questions, and the difficulty of applying some content in daily life. For instance, members needed to learn where Sodium had been used in everyday life or what the benefit of Sodium was in daily life. Furthermore, when we explained the using sodium in air-conditioners, the teachers needed to learn the process, and the students did not learn. Respondent P3 mentioned that she had a problem with the content knowledge, but she tried to ask the other teachers in her team. Similarly, respondent P4 said he needed daily help with applying the theory. Sometimes, some ideas took time to apply the real life. Respondent P5 added that some approach is challenging to use in everyday life. It could cause by his content knowledge that he could not find relevant in daily life, for instance, Atomic.

CHAPTER 5. DISCUSSION

In this part, the researcher emerged themes and sub-themes from the findings against the literature. The literature supports many theories. The key results of this study which discussed and identified the current practice and the challenges of teaching chemistry that related to the following two objectives: (1) the current practice of teaching chemistry through STEM education and (2) the challenges of teaching chemistry in STEM education in grade 8 at Preahsisowat high school.

5.1 The Current Practice of Teaching Chemistry through STEM Education

The result of the current practice of teaching chemistry through STEM education, which found the data from the teachers at Preahsisowat high school who have teaching chemistry through STEM education, pointed out the answers as follows discussion:

5.1.1 Using electronic devices in teaching chemistry

All participants mentioned that they apply electronic devices in their teachings, such as the internet, some websites, some apps, and social media. This finding is supported by Havice (2009), STEM education is an essential step toward achieving digital literacy. Havice also emphasized the power of hands-on technology and engineering education to bring the real world into the classroom, enabling students to examine issues, trends, and problems and respond to difficulties with flexibility and adaptation.

After all, all participants have been using electronic devices in their teaching because new-generation schools require teachers to teach in the 21st century especially using electronic devices. However, some respondents said they need to become more familiar with some electronic devices.

5.1.2 Benefits of electronic devices

According to the participants, electronic devices have provided many benefits for teaching and learning, such as supporting complex experiments in chemistry, saving time, student attraction, and effectiveness in education. Similarly, According to the study by Penuel et al. (2007), which involved 454 science instructors, those who received equipment and technology support made a significant contribution to the program's integration and modifications in science teaching techniques. Therefore, principals should be more interested in STEM education, and chances should be provided for them in this regard, despite the literature's emphasis on the relevance of school administrators, particularly in implementing STEM programs in schools.

Therefore, electronic devices play an essential role in 21st-century teaching. It could save time for teachers in education and can make the students more interested in learning. The outcome is crucial in our setting as a developing nation where students must use technology to learn new things from around the globe.

5.1.3 Applying STEM education in teaching chemistry

All of the participants said they know the process of teaching through STEM education and some methods that support STEM education, such as the scientific method, IBL, and project-based learning. This finding is supported by Futurelearn (2021), using the Engineering Design Process is one way to plan lessons (EDP). These are a sequence of actions students can do as part of a project to create solutions to challenges. This project-based learning approach should promote flexible designs, images, and workable solutions.

Thus, all participants have been using STEM education in teaching they had trained regarding the Korean STEM model. However, most respondents still blur with

STEM education because they just had been trained by the technical team leader and also requested more STEM training from the expert.

5.1.4 Advantages of applying STEM education

There are a lot of advantages to teaching through STEM education, like P1, P2, P3, P4, and P5 raised, as the researcher has mentioned in the previous chapter. This result is supported by Dorie, Cardella, & Svarovsky (2014). Young students' propensity for applying multiple ideas and approaches to innovative and creative problem-solving is regarded as providing a rich basis for fostering early design-based problem-solving through integrating STEM disciplines. Similarly, English, King, & Smeed (2016) mentioned that students' conceptual surprises as they uncover new ideas are evident in many integrated STEM-based problems. For example, in designing and constructing an earthquake-proof building, sixth-grade students displayed abstract surprise as they discovered how construction materials, their measurements and costs, the structural shapes chosen, and the engineering techniques used all contributed to strengthening and stabilizing their building. And the study by Alumbaugh (2015) reported that the pupils' involvement and academic success might be enhanced by STEM instruction, according to the principal and the teachers.

In sum, STEM education provides many benefits for learners and teachers. It can bring real-world situations to the class and offer 21st-century skills. Moreover, it can make the students more interested in learning.

5.2 The Challenges of Teaching Chemistry through STEM Education

The result of research question two, which found the data from the participants who had taught chemistry through STEM education, showed the answers as follows discussion:

5.2.1 Not enough STEM education training

Lacking STEM education training is what the researcher has explored. The result of this study is supported by the survey by El-Deghaidy et al. (2017). It is observed that teachers who graduated from universities and teacher candidates in Turkey need to graduate with sufficient training. Their in-service training is separate from the deficiencies of the teachers regarding STEM education. It reported that secondary school science teachers in Turkey and some other countries feel incompetent regarding STEM education. University-industry collaboration is required to achieve these qualifications. Moreover, this result is supported by the study by Casey, (2012). The number of mathematics and science teachers with hands-on experience in STEM education is limited. According to a National Science Foundation report, teachers can also lack formal education in STEM pedagogies. According to the study, 30% of middle school science teachers lack practical experience.

In total, even though all respondents have applied STEM education in teaching and were trained in STEM education, they are still blurred. However, all of them mentioned that if there is more STEM education training, they will join again despite the repeated content. So this issue should solve for them, especially for more STEM education training.

5.2.2 Lacking experimental tools

Another important conclusion is that there isn't a need to be more educational resources, technology tools, or support services. This finding has also been documented in earlier research, particularly in rural areas and developing nations (Goodpaster et al., 2012; Hsu et al., 2011; Margot and Kettler, 2019). Furthermore, this study is supported by Sovansophal, (2019) general Lack of laboratories and adequate materials or the teaching of science subjects at upper secondary school leaded students to feel unequal in pursuing

a science-related degree successfully. Many needed to understand the employment opportunities available to science graduates. They were attracted to the more conventional route through a Lack of confidence. Moreover, this trend also is rooted in the fact that more HEIs offer scholarship positions in non-STEM-related fields and fewer in the STEM fields.

Most participants in the current study expressed dissatisfaction with the Lack of practical circumstances they felt were necessary for effective STEM instruction. However, the solution to this problem can take some time and work. Therefore, in-service teacher training and professional development programs may need to emphasize helping teachers learn coping mechanisms to implement STEM integration while working with the resources currently accessible in the teaching and learning environments.

5.2.3 Lack of time for teaching through STEM education

According to the research finding, some respondents raised about lacking time for teaching through STEM education. Some scholars acknowledged that teachers are concerned about the extra workload caused by planning and integrating STEM lessons into their existing curriculum. They have to allocate more time to work with teachers of other subjects and to prepare materials for students. Lack of time is one of the significant and most prevalent issues teachers face while implementing STEM lessons (Bagiati and Evangelou, 2015; Hsu et al., 2012; Park et al., 2016).

In sum, time is essential for teaching through STEM education, and this method needs enough time. However, some respondents mentioned that teaching through STEM education takes a long time because they need to prepare the material for the experiment and clean it after an investigation which shows that they were workload; therefore, they can finish the content on time. Consequently, we should solve this problem by creating a lap assistant to help the teacher.

5.2.4 Student content knowledge

Most of the respondents mention that student content knowledge on STEM education is still low at lower secondary. This finding is in line with some literature that claimed that student concerns are yet another roadblock to integrating STEM instruction. Teachers may think that pupils need help to participate fully in STEM integration. Sometimes teachers misjudge how capable their students are of handling STEM problems (Al Salami et al., 2017; Asghar et al., 2012; Bagiati and Evangelou, 2015; Goodpaster et al., 2012; Van Haneghan et al., 2015). Many educators think some subject matter is too challenging for kids, which could demotivate them. Teachers in remote locations worry that many of their students are underachievers, and it might be challenging to adapt the curriculum to fit these students' requirements (Goodpaster et al., 2012).

5.2.5 Teacher competence in processing STEM education

The most significant difficulties in teaching chemistry through STEM education are related to teacher competence. All participants acknowledged that some lessons took more work to implement daily due to teacher content knowledge. This finding is supported by some literature which asserts teachers frequently feel they lack subject matter knowledge regarding the content of STEM lessons and that pre-service and in-service teacher preparation programs fall short in preparing teachers for STEM implementation (Al salami et al., 2017; Nadelsom and Seifert, 2013).

In brief, all of the participants mentioned their limited content knowledge. They said that some contents are difficult to apply in daily life, which can cause by their content knowledge. Moreover, they found it challenging to do some experiments. Thus, we should solve this issue to develop teacher competence.

CHAPTER 6: CONCLUSION

The researcher outlined the overall study results in this chapter based on each research issue and discussed the limits of the study's conduct. He then advised the study's participants about its findings.

6.1 Conclusion

The current study examined the problems Preah Sisowath High School faced in integrating STEM education into chemistry teaching. The research found that teaching chemistry using STEM methods and technology was effective. However, the results revealed several obstacles teachers faced in their attempts to integrate STEM modules into their curricula. These obstacles included the teachers' and students' need for more expertise in innovative STEM teaching techniques and practical obstacles like a shortage of time, space, materials, and technical resources. For teachers to feel more secure and better prepared to teach STEM, in-service teacher professional development programs should emphasize providing instructors with current STEM knowledge and teaching techniques. Additionally, It is essential for professional learning and development designers and trainers to provide teachers with the resources they need to handle difficulties and alter their current teaching contexts to fit STEM education for their students and schools.

6.2 Limitations of the Study

Despite the benefits mentioned above, the study has several drawbacks that require more investigation. First, the study used a qualitative research approach and involved five teachers from a Phnom Penh school. This might prevent the study's conclusions from being broadly applied. Future studies could use mixed-methods research designs to ensure the breadth and depth of the findings. Second, only teacher

voices were examined within the parameters of the study. Through the perspectives of many stakeholders, including students, students' parents, school administrators, and school leaders, future research could examine the difficulties facing STEM education in Preah Sisowath high school (NGS) and other situations of a similar nature. This might paint a thorough picture of the challenges faced by teachers in STEM education.

6.3 Recommendations

Given the information from the respondents, some recommendations may improve the efficacy of teaching chemistry through STEM education. First, the first school administrator should develop more STEM education training so that the instructors can advance their STEM knowledge. The teacher should let the students practice the STEM experiment in groups and, in particular, should repeat the STEM experiment frequently to ensure that the students are familiar with it. Second, the teacher should be concerned about the students' content knowledge and how they can effectively process their STEM practice. Finally, a lap helper should be available in each lap to assist the teacher in carrying out the experiments or clean the materials afterwards. It might save time for teachers in particular. Furthermore, it should be highlighted that although this qualitative study involved instructors from a Phnom Penh high school, the conclusions and suggestions apply to various regions of Cambodia.

REFERENCES

Al Salami,M.K.,Makela, C.J., deMiranda, M.A., 2017. Assessing changes in teachers' attitudestoward interdisciplinary STEM teaching. Int. J. Technol. Des. Educ. *27* (1), 63–88.

Alumbaugh, K. M. (2015). *The Perceptions of Elementary STEM Schools in Missouri – ProQuest*. Https://Www.Proquest.Com/Openview/4997e4df9137ac836635343a8d0adcd0/1?Pq-Origsite=gscholar&cbl=18750. Retrieved 2015, from https://www.proquest.com/openview/4997e4df9137ac836635343a8d0adcd0/1?pq-origsite=gscholar&cbl=18750

Asghar, A., Ellington, R., Rice, E., Johnson, F., Prime, G.M., 2012. Supporting STEM education in secondary science contexts. Interdiscip. J. Probl. Bas. Learn. *6* (2), 4.

Atweh, B., & Ala'i, K. (2012). Socially response-able mathematics education: Lessons from three teachers. In *Proceedings of the 35th Annual Conference of the Mathematics Education Research Group of Australasia*. Mathematics Education Research Group of Australasia Inc.

Bagiati, A., Evangelou, D., 2015. Engineering curriculum in the preschool classroom: the teacher's experience. Eur. Early Child. Educ. Res. J. *23* (1), 112–128.

Berlin, D. F., & White, A. L. (2012). A longitudinal look at attitudes and perceptions related to the integration of mathematics, science, and technology education. *School Science and Mathematics, 112*(1), 20–30.

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, *112*(1), 3-11.

Cambodia Development Resource Institute [CDRI]. (2015). *Cambodia education 2015: Employment and empowerment?*

Casey, B. (2012). STEM education: Preparing for the jobs of the future. Report by the U.S. Congress Joint Economic Committee. Retrieved from: http://www.jec.senate.gov/public/index.cfm?a=Files.Serve&File_id=6aaa7e1f-9586-47be82e7-326f47658320

Chhinh, S., & Dy, S. S. (2009). *Education reform context and process in Cambodia*. SpringerLink. https://link.springer.com/chapter/10.1007/978-1-4020-9377-7_8?error=cookies_not_supported&code=38ccf7c7-42be-4416-86a9-460d3b3a250b

Dara, V. (2019, February 22). *Minister of Education: Students are showing greater STEM interest*. Phnom Penh Post. https://www.phnompenhpost.com/national/minister-education-students-are-showing-greater-stem-interest

Dorie, B.L., Cardella, M.E. & Svarovsky, G.N. (2014). Capturing the design thinking of young children interacting with a parent. Paper presented at the *121st SEE Annual Conference & Exposition, Indianapolis*, IN.

Eng, S., & Szmodis, W. (2016). STEM learning achievement among Cambodian middle school students: An examination of gender and psychosocial factors. *Annual Review of Comparative and International Education 2015*, 279–305. https://doi.org/10.1108/s1479-367920150000028018

English, L. D., King, D., & Smeed, J. (2016). Advancing integrated STEM learning through engineering design: Sixth-grade students' design and construction of earthquake resistant buildings. *The Journal of Educational Research*, *110*(3), 255–271. https://doi.org/10.1080/00220671.2016.1264053

F. (2021, March 23). *How to effectively teach STEM subjects in the classroom*. FutureLearn. https://www.futurelearn.com/info/blog/effectively-teach-stem-subjects

Franz-Odendaal, T. A., Blotnicky, K., French, F., & Joy, P. (2016). Experiences and perceptions of STEM subjects, careers, and engagement in STEM activities among middle school students in the Maritime provinces. *Canadian Journal of Science, Mathematics and Technology Education*, *16*(2), 153–168. https://doi.org/10.1080/14926156.2016.1166291

Havice, W. (2009). The power and promise of a STEM education: Thriving in a complex technological world. *The overlooked STEM imperatives: Technology and engineering*, 10-17.

https://doi.org/10.12973/eurasia.2017.01235a

El-Deghaidy, H., & Mansour, N. (2015). Science teachers' perceptions of STEM education: Possibilities and challenges. International Journal of Learning and Teaching, *1*(1), 51–54.

Goodpaster, K.P., Adedokun, O.A., Weaver, G.C., 2012. Teachers' perceptions of rural STEM teaching: implications for rural teacher retention. Rural Educat. *33*(3), 9–22.

Hsu, M.-C., Purzer, S., Cardella, M.E., 2011. Elementary teachers' views about teaching design, engineering, and technology. J. Pre-Coll. Engin. Educ. Res. *1*(2), 31–39.

KAPE., (2019b). *New Generation School (NGS)*. http://kapekh.org/en/what-we-do/16/?pro_id=20

Lesseig, K., Nelson, T. H., Slavit, D., & Seidel, R. A. (2016). Supporting middle school teachers' implementation of STEM design challenges. *School Science and Mathematics*, *116*(4), 177–188. https://doi.org/10.1111/ssm.12172

Libretexts. (2021, July 12). *Chemistry in Foods*. Chemistry LibreTexts. https://chem.libretexts.org/Ancillary_Materials/Exemplars_and_Case_Studies/Exemplars/Foods/Chemistry_in_Foods

Lunenburg, F. C., & Irby. B. J. (2008). *Writing a successful thesis or dissertation*. Phoenix, AZ: Crown Press.

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The Gender Gap in STEM Fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. *Frontiers in Education*, *4*. https://doi.org/10.3389/feduc.2019.00060

Ministry of Education, Youth and Sport [MoEYS]. (2014). *Higher education vision 2020–2030*. Department of Higher Education, Phnom Penh, Kingdom of Cambodia.

Ministry of Education, Youth and Sport [MoEYS]. (2016a). *Policy on science, technology, engineering and mathematics (STEM) education*. Phnom Penh, Kingdom of Cambodia.

Ministry of Education, Youth and Sport [MoEYS]. (2016b). *Policy on New Generation School. Phnom Penh*, Kingdom of Cambodia.

Ministry of Education, Youth and Sport [MoEYS]. (2017). *Statistic of enrollment in science and social science track in general education*. Department of General Education, Phnom Penh, Kingdom of Cambodia.

Nadelson, L.S., Seifert, A., 2013. Perceptions, engagement, and practices of teachers seeking professional development in place-based integrated STEM. Teach. Educ. Pract. *26* (2), 242–26

Oparaocha, D. O. (2017). *Urban high school Students in STEM programs: An explanatory case study – ProQuest*. Https://Www.Proquest.Com/Openview/Dda3daf425afe6aa5ca741633390e1f2/1?Pq-Origsite=gscholar&cbl=18750. Retrieved 2017, from https://www.proquest.com/openview/dda3daf425afe6aa5ca741633390e1f2/1?pq-origsite=gscholar&cbl=18750

Park, H., Byun, S. Y., Sim, J., Han, H. S., & Baek, Y. S. (2016). Teachers' perceptions and practices of STEAM education in south Korea. *EURASIA Journal of Mathematics, Science and Technology Education*, *12*(7). https://doi.org/10.12973/eurasia.2016.1531a

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal*, *44*(4), 921–958. https://doi.org/10.3102/0002831207308221

Phirom, L., Sothy, K., Rethy, C., & Smith, G. (2021). *De-framing STEM discourses in Cambodia* (No. 127). CDRI Working Paper Series.

Royal Government of Cambodia [RGC]. (2015*). Cambodia industrial development policy 2015–2025. "Market orientation and enabling environment for industrial development*." Phnom Penh, Kingdom of Cambodia.

Set, S., Sieng, S., & Kita, M. (2014). *Understanding Cambodian student competencies in chemistry at lower secondary school compared to regional neighbors and Japan*. Phnom Penh: National Institute of Education.

Sovansophal, K. (2019). Family socioeconomic status and students' choice of STEM majors. *International Journal of Comparative Education and Development*, *22*(1), 49–65. https://doi.org/10.1108/ijced-03-2019-0025

Soprach, T. (2019, August 1). *Science classes' promotion is progressing slowly*. Phnom Penh Post. https://www.phnompenhpost.com/opinion/science-classes-promotion-progressing-slowly

Singh, J. (2010). United Nations Educational, Scientific, and Cultural Organization (UNESCO). *Annual Report 2010*. https://doi.org/10.4324/9780203838587

Tanenbaum, C. (2016). STEM 2026: A vision for innovation in STEM education. *US Department of Education, Washington, DC*.

Un, L., & Sok, S. (2016). *Higher education governance in Cambodia*. Education Research Council, Ministry of Education, Youth and Sport.

Van Haneghan, J.P., Pruet, S.A., Neal-Waltman, R., Harlan, J.M., 2015. Teacher beliefs about motivating and teaching students to carry out engineering design challenges: some initial data. J. Pre-Coll. Engin. Educ. Res. *5*(2), 1–9.

Widya, Rifandi, R., & Laila Rahmi, Y. (2019b). STEM education to 44ulfill the 21st century demand: a literature review. *Journal of Physics: Conference Series*, *1317*(1), 012208. https://doi.org/10.1088/1742-6596/1317/1/012208

APPENDICES

APPENDIX A: INTERVIEW QUESTIONS (ENGLISH VERSION)

មជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី

NEW GENERATION PEDAGOGICAL RESEARCH CENTER

Research Topic: *The Challenges of Teaching Chemistry in Lower Secondary School through STEM Education: A Case Study at Preahsisowath High School*

Supervisee: Ry Rathanak

Supervisor: H.E. Dr. Chan Roath

Interview Questions (Semi-Structure)

Opening

Greeting! How are you doing today? Thank you so much for accepting the request to participate in this pilot interview. First of all, I would like to introduce myself. My name is Ry Rathanak. I'm perusing M.Ed in majoring Mentoring at New Generation Pedagogical Research Center (NGPRC) of National Institute of Education (NIE). In order to complete my master's degree successfully, I'm currently conducting one research over the **topic "The Challenges of Teaching Chemistry in grade 8 through STEM Education: A Case Study at Preahsisowath High School."**

This is such a great opportunity for letting me ask questions regarding my topic. I'm really appreciate your time for spending on this interview. Please be noted that all your information that you have talked will be kept confidential.

Teacher interview protocol
I. General information
• Could you introduce yourself? • Which grade do you teach?

- How many classes do you teach?
- How many hours do you teach per week?
- How many years do you experience in teaching Chemistry subject?

II. Current practice of teaching chemistry through STEM education

Digitalizing teaching and learning activities

1. Have you used electronic devices in teaching chemistry so far? What electronic devices have you been using?
2. Can you raise some examples that electronic devices support your teaching practice?

STEM teaching method

3. Have you adopted STEM teaching method into your teaching practice? Why or why not?
4. Can you tell me some about them?

❖ Possible/expected answers:

- Teacher asks the question
- Students conduct the research to answer the teacher's question
- Students imagine
- teacher and students plan
- Students create hypotheses
- Students test the hypotheses
- Student improve the knowledge after experiment

III. The challenges of teaching chemistry through STEM education

Lack of Training on STEM Education

5. Have you ever been trained regarding the STEM method?
6. How often have you been trained per year?
7. Are you satisfied with the training? Why or why not?

Lacking of materials and laboratory

8. Do you think the experimental equipment and laboratory important in teaching chemistry through STEM education? Why and why not?
9. Do you there are enough experimental materials for you and your students? Why and why not?

Gender and Student Motivation

10. In your experience, have you noticed any significant difference between male and

female students in terms of their interest in chemistry subject?

11. If yes how does it affect your teaching? Please provide specific example.

12. Could you raise some barriers that you think it's difficult to deal with? Why?

Closing

Do you have any more questions you want to clarify or add? It comes to an end of this interview now. I'm so grateful for this insightful information that you provided. Thank you so much. Please have a great day.

APPENDIX B: PILOT-INTERVIEW QUESTIONS (KHMER VERSION)

មជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី
NEW GENERATION PEDAGOGICAL RESEARCH CENTER

ប្រធានបទស្រាវជ្រាវ៖ បញ្ហាប្រឈមក្នុងការបង្រៀនមុខវិជ្ជាគីមីតាមបែបអប់រំស្ទេម: ករណីសិក្សា វិទ្យាល័យព្រះស៊ីសុវត្ថ(សាលារៀនជំនាន់ថ្មី) កម្រិតមធ្យមសិក្សាបឋមភូមិ

អ្នកស្រាវជ្រាវ៖ រី រតនៈ

គ្រូដឹកនាំ៖ ឯកឧត្តមបណ្ឌិតសភាចារ្យ ច័ន្ទ រ័ត្ន

សំណួរសម្ភាសន៍សាកល្បង (Semi-Structure)

សេចក្តីផ្តើម

ជម្រាបសួរអ្នកគ្រូ/លោកគ្រូ! តើលោកគ្រូ/អ្នកគ្រូសុខសប្បាយជាទេ ថ្ងៃនេះ?
សូមអរគុណច្រើនដែលលោកគ្រូ/អ្នកគ្រូ
បានយល់ព្រមចូលរួមក្នុងការសម្ភាសន៍លក្ខណៈសាកល្បង។ ជាបឋម ខ្ញុំសូមណែនាំខ្លួនបន្តិច។
ខ្ញុំឈ្មោះ រី រតនៈ។ ខ្ញុំកំពុងតែបន្តការសិក្សាបរិញ្ញាបត្រជាន់ខ្ពស់អប់រំ
ឯកទេសប្រឹក្សាគរុកោសល្យ នៅឯមជ្ឈមណ្ឌលគរុកោសល្យជំនាន់ថ្មីនៃវិទ្យាស្ថានជាតិអប់រំ។
ដើម្បីបញ្ចប់កម្រិតបរិញ្ញាបត្រជាន់ខ្ពស់នេះដោយជោគជ័យ, សព្វថ្ងៃ
ខ្ញុំកំពុងតែធ្វើការសិក្សាស្រាវជ្រាវមួយលើប្រធានបទ
"**បញ្ហាប្រឈមក្នុងការបង្រៀនមុខវិជ្ជាគីមីតាមបែបអប់រំស្ទេម: ករណីសិក្សា វិទ្យាល័យព្រះស៊ីសុវត្ថ(សាលារៀនជំនាន់ថ្មី) កម្រិតមធ្យមសិក្សាបឋមភូមិ។**"
ពេលនេះពិតជាល្អណាស់
ដែលលោកគ្រូ/អ្នកគ្រូបានអនុញ្ញាតិឲ្យខ្ញុំសួរនូវសំណួរមួយចំនួន
ទាក់ទងជាមួយប្រធានបទរបស់ខ្ញុំ។
ខ្ញុំពិតជាថ្លែងអំណរគុណយ៉ាងក្រៃលែងចំពោះការចំណាយពេលរបស់លោកគ្រូ/អ្នកគ្រូក្នុងការធ្វើ
បទសម្ភាសន៍នេះ។ សូមលោកគ្រូ/អ្នកគ្រូកត់សម្គាល់ថា ព័ត៌មានដែលលោកគ្រូ/អ្នកគ្រូ
បាននិយាយនឹងត្រូវបានរក្សាទុកជាសម្ងាត់។ លោកគ្រូ/អ្នកគ្រូអាចធ្វើអារម្មណ៍ឲ្យធូរស្រាល
ហើយរីករាយក្នុងការឆ្លើយនូវសំណួរ។ ប្រសិនបើលោកគ្រូ/អ្នកគ្រូ

មិនចង់ឆ្លើយនូវសំណួរណាមួយ លោកគ្រូ/អ្នកគ្រូអាចរំលង
ឬមិនឆ្លើយនូវសំណួរនោះបានគ្រប់ពេល។ សូមលោកគ្រូ/អ្នកគ្រូ កុំមានអារម្មណ៍ថាតឹងតែង។
សូមធ្វើតាមសម្រួលចុះ។ តើលោកគ្រូ/អ្នកគ្រូ ត្រៀមខ្លួនហើយឬនៅ?
តើពួកយើងអាចចាប់ផ្តើមបានដែរឬទេ?

សំណួរសម្ភាសន៍សម្រាប់គ្រូ
I.ព័តមានទូទៅ
• តើលោកគ្រូអ្នកគ្រូអាចណែនាំខ្លួនបន្តិចបានទេ? • តើលោកគ្រូអ្នកគ្រូបង្រៀនថ្នាក់ទីប៉ុន្មានខ្លះ? • តើលោកគ្រូអ្នកគ្រូបង្រៀនប៉ុន្មានថ្នាក់? • តើលោកគ្រូអ្នកគ្រូបង្រៀនប៉ុន្មានម៉ោងក្នុងមួយសប្តាហ៍? • តើលោកគ្រូអ្នកគ្រូមានបទពិសោធន៍បង្រៀនគីមីវិទ្យាប៉ុន្មានឆ្នាំហើយ?
II. ការអនុវត្តន៍ការបង្រៀនគីមីវិទ្យានាពេលបច្ចុប្បន្ន
ការបញ្ចូលបច្ចេកវិទ្យា និងសកម្មភាពនៃការរៀន
1. តើលោកគ្រូអ្នកគ្រូបានប្រើឧបករណ៍អេឡិចត្រូនិចក្នុងការបង្រៀនមុខវិជ្ជាគីមីដែរឬទេមកទល់ពេលនេះ ?តើឧបករណ៍អេឡិចត្រូនិចអ្វីខ្លះដែលលោកគ្រូអ្នកគ្រូបានប្រើ? 2. តើលោកគ្រូអ្នកគ្រូអាចលើកជាឧទាហរណ៍ខ្លះៗអំពីការប្រើប្រាស់ឧបករណ៍អេឡិចត្រូនិចក្នុងការបង្រៀន?
វិធីសាស្ត្រតាមបែបអប់រំស្ទឹម
3. តើលោកគ្រូអ្នកគ្រូបានបញ្ចូលការអប់រំតាមបែបស្ទឹមទៅក្នុងការបង្រៀនដែរឬទេ ? ហេតុអ្វីបានជាលោកគ្រូអ្នកគ្រូបញ្ចូល ឬហេតុអ្វីបានជាលោកគ្រូមិនបញ្ចូល? 4. តើលោកគ្រូអាចរៀបរាប់អំពីវិធីសាស្ត្រតាមបែបអប់រំស្ទឹមដែលលោកគ្រូអ្នកគ្រូធ្លាប់បានប្រើក

ន្លងមកបានដែរឬទេ? ❖ ចម្លើយរំពឹងទុក៖ • គ្រូសួរសំណួរ • ពិនិត្យមើលចំណេះដឹងសិស្ស • សិស្សកំណត់សម្មតិកម្ម • សិស្សផ្ទៀងផ្ទាត់សម្មតិកម្មតាមរយៈការពិសោធន៍ • សិស្សវិភាគភាគលទ្ធផល • សិស្សធ្វើការសន្និដ្ឋាន • សិស្សចែករំលែកលទ្ធផល
III. បញ្ហាប្រឈមក្នុងការបង្រៀនគីមីតាមបែបអប់រំស្ទេម
កង្វះក្នុងការបណ្តុះបណ្តាលស្តីអំពីការអប់រំតាមបែបស្ទេម
5. តើលោកគ្រូអ្នកគ្រូធ្លាប់ត្រូវបានទទួលការបណ្តុះបណ្តាលអំពីវិធីសាស្ត្រអប់រំតាមបែបស្ទេមដែរឬទេ? 6. តើលោកគ្រូអ្នកគ្រូទទួលបានការបណ្តុះបណ្តាលប៉ុន្មានដងក្នុងមួយឆ្នាំ? 7. តើលោកគ្រូអ្នកគ្រូពេញចិត្តនឹងការបណ្តុះបណ្តាលនេះដែរឬទេហេតុអ្វីពេញចិត្ត ? ?ហេតុអ្វីមិនពេញចិត្ត
កង្វះនូវសម្ភារឧបទេស និងបន្ទប់ពិសោធន៍
8. តើលោកគ្រូអ្នកគ្រូគិតថាឧបករណ៍ពិសោធន៍ និងបន្ទប់ពីសោធន៍មានសារៈសំខាន់ក្នុងការបង្រៀនគីមីវិទ្យាតាមបែបអប់រំស្ទេមដែរឬទេ ? ?ហេតុអ្វីសំខាន់ ហេតុអ្វីមិនសំខាន់

9. តើមានសម្ភារពិសោធន៍គ្រប់គ្រាប់សម្រាប់លោកគ្រូអ្នកគ្រូ និងសិស្សានុសិស្សដែរឬទេ ? ?ហេតុអ្វីបានគ្រប់គ្រាន់ ហេតុអ្វីមិនគ្រប់គ្រាន់
សមភាពយេនឌ័រ និងការលើកទឹកចិត្តសិស្ស
10. តាមបទពិសោធន៍របស់លោកគ្រូអ្នកគ្រូ តើលោកគ្រូអ្នកគ្រូកត់សម្គាល់ឃើញថារវាងសិស្សសិស្សប្រុស និងសិស្សស្រី តើប្រភេទសិស្សណាដែលពេញចិត្តនឹងមុខវិជ្ជាគីមី?. 11. ប្រសិនបើមានតើវាប៉ះពាល់ដល់ការបង្រៀនរបស់លោកគ្រូដូចម្តេចខ្លះ ? សូមលោកគ្រូអ្នកគ្រូលើកយកឧទាហរណ៍មកបញ្ជាក់។ 12. តើលោកគ្រូអ្នកគ្រូអាចលើកយកបញ្ហាប្រឈមមួយចំនួនបានទេ ដែលលោកគ្រូអ្នកគ្រូគិតថាវាពិបាកដើម្បីដោះស្រាយហេតុអ្វីបានវាពិបាកដោះស្រាយ។ ?

សេចក្តីបញ្ចប់

តើលោកគ្រូ/អ្នកគ្រូមានសំណួរអ្វី ដើម្បីសួរបញ្ជាក់ឬ ចង់បន្ថែមកន្លែងណាមួយដែរឬទេ? ឥឡូវនេះកិច្ចសម្ភាសន៍នេះ បានឈានមកដល់ទីបញ្ចប់ហើយ។ ខ្ញុំពិតជាអរគុណលោកគ្រូ/អ្នកគ្រូណាស់ ដែលបានផ្តល់ព័ត៌មានដ៏ស៊ីជម្រៅនេះ។ អរគុណច្រើនលោកគ្រូ/អ្នកគ្រូ។ ជូនពរលោកគ្រូ/អ្នកគ្រូរីករាយ និងជោគជ័យគ្រប់ភារកិច្ច។

APPENDEX D: COSENT LETTERS FORMAT

ខ្ញុំបាទឈ្មោះ រី រតន: ជាគរុនិស្សិតកំពុងសិក្សាថ្នាក់បរិញ្ញាបត្រជាន់ខ្ពស់អប់រំ
ឯកទេសផ្នែកប្រឹក្សាគរុកោសល្យ នៅមជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មីនៃវិទ្យាស្ថានជាតិអប់រំ។
ខ្ញុំបាទបាន នឹងកំពុងធ្វើការសិក្សាស្រាវជ្រាវលើប្រធានបទ
"**បញ្ហាប្រឈមក្នុងការបង្រៀនមុខវិជ្ជាគីមីតាមបែបអប់រំស្មេម: ករណីសិក្សាវិទ្យាល័យព្រះស៊ីសុវត្ថ(សាលារៀនជំនាន់ថ្មី) ក្រមិតមធ្យមសិក្សាបឋមភូមិ**"
ដែលជាសារណាបញ្ចប់ថ្នាក់បរិញ្ញាបត្រជាន់ខ្ពស់របស់ខ្ញុំ។

១. គោលបំណងនៃការស្រាវជ្រាវ

ជាការពិតណាស់ ការសិក្សាស្រាវជ្រាវត្រូវបានធ្វើឡើងក្នុងគោលបំណង
រុករកនូវព័ត៌មានដែលជាបញ្ហាប្រឈមរបស់គ្រូបង្រៀនគីមីវិទ្យាមធ្យមសិក្សាបឋមភូមិ
ទៅលើការបង្រៀនមុខវិជ្ជាគីមីវិទ្យា នៃសាលារៀនជំនាន់ថ្មី វិទ្យាល័យព្រះស៊ីសុវត្ថិ។
ជាមួយគ្នានេះផងដែរ ការស្រាវជ្រាវនេះក៏ចង់រកឲ្យឃើញនូវដំណោះស្រាយដែលលោកគ្រូ
អ្នកគ្រូនៅសាលានេះបានអនុវត្ត ក្នុងការដោះស្រាយរាល់បញ្ហា នីមួយៗ។
លទ្ធផលដែលបានរកឃើញពីការប្រមូលទិន្នន័យពីភាគីពាក់ព័ន្ធដូចជា លោកគ្រូ អ្នកគ្រូ
ឯកទេសគីមីវិទ្យាទាំងអស់ និងផ្តល់ព័ត៌មានយ៉ាងសំខាន់ៗ ក្នុងការរួមចំណែកជាឯកសារយោង
ដែលជាមូលដ្ឋានគ្រឹះ សម្រាប់បង្ហាញអ្នកពាក់ព័ន្ធទាំងអស់ក្នុងវិស័យអប់រំដូចជា គណៈគ្រប់គ្រងសាលា
និងគ្រូបង្រៀន ឲ្យដឹងនូវរាល់បញ្ហាប្រឈមដែលបានកើតមានឡើងកំឡុងពេលបង្រៀនតាមបែបស្មេម
ព្រមទាំងបង្ហាញនូវដំណោះស្រាយសមស្របទៅលើបញ្ហាប្រឈមនីមួយៗ។ លើសពីនេះ
ការសិក្សាមួយនេះ ក៏បានជួយសម្រួលដល់ការរៀន និងបង្រៀនតាមបែបអប់រំស្មេម
ដែលឆ្លើយតបទៅនឹងការអប់រំនា សតវត្សន៍ទី២១។ ជាចុងក្រោយ
ការសិក្សាមួយនេះអាចនឹងក្លាយទៅជាឯកសារយោងដ៏សំខាន់ចំពោះសិស្ស និស្សិត សាស្ត្រាចារ្យ

គ្រូបង្រៀន
ក៏ដូចជាស្តាប់ឥតពាក់ព័ន្ធសម្រាប់យកទៅធ្វើការស្រាវជ្រាវបន្ថែមទៀតលើប្រធានបទនេះឲ្យកាន់តែស៊ីជម្រៅ។

២. ដំណើរការនៃការស្រាវជ្រាវ

ប្រសិនបើលោកគ្រូ/អ្នកគ្រូអនុញ្ញាតអោយចូលរួមក្នុងការសម្ភាសនេះ
នោះលោកគ្រូ/អ្នកគ្រូនិងត្រូវសួរនូវសំនួរសំខាន់ៗមួយចំនួនដែលទាក់ទងគោលបំណងនៃការសិក្សាស្រាវជ្រាវមួយនេះប៉ុណ្ណោះ។
តាមផ្នែកនៃសំនួរនីមួយៗលោកគ្រូ/អ្នកគ្រូអាចនឹងចំណាយពេលវេលាប្រមាណពី ១៥ ទៅ ២០នាទី
ដូច្នេះការសម្ភាសន៍អាចចំណាយពេលរបស់លោកគ្រូ/អ្នកគ្រូប្រហែល ៣០ ទៅ ៤៥នាទី។
ព្រមគ្នានេះដែរ កំឡុងពេលសម្ភាស ខ្ញុំសូមអនុញ្ញាតធ្វើការថតសម្លេង ក៏ដូចជាថតវីដេអូ
(ប្រសិនបើសម្ភាសន៍តាមរយៈកម្មវិធី Zoom)
ដើម្បីទុកជាឯកសារនិងរបាយការណ៍ដែលជាជំនួយក្នុងការបកស្រាយទិន្នន័យសម្រាប់ការសិក្សាស្រាវជ្រាវមួយនេះ
ហើយឯកសារទាំងនេះនឹងអាចមានការផ្ទៀងផ្ទាត់ជាមួយលោកគ្រូ/អ្នកគ្រូនៅពេលក្រោយទៀតប្រសិនបើមានករណីមួយចំនួន ដែលខ្ញុំអាចនិងសូមលោកគ្រូ/អ្នកគ្រូផ្តល់ការសម្ភាសសារជាថ្មីម្តងទៀត។
អ្វីដែលសំខាន់នោះគឺរាល់ព័ត៌មាននិងឯកសារទាំងឡាយដែលទាក់ទងនិងលោកគ្រូ/អ្នកគ្រូខ្ញុំនិងរក្សាការសម្ងាត់ជូន ដោយពុំមានការបង្ហាញព័ត៌មានផ្ទាល់ខ្លួនរបស់លោកគ្រូ/អ្នកគ្រូក្នុងការស្រាវជ្រាវឡើយ
ប្រសិនបើពុំមានការអនុញ្ញាតពីលោកគ្រូ/អ្នកគ្រូដែលជា
សាមីខ្លួន។

៣. គោលការណ៍រក្សាការសម្ងាត់

ព័ត៌មានទាំងអស់នឹងរក្សាការសម្ងាត់
ដោយមានតែអ្នកស្រាវជ្រាវតែម្នាក់ដែលអាចប្រើប្រាស់បាន។ វាមិនមែនជាតេស្ត
ហើយក៏គ្មានចម្លើយខុសឬត្រូវដែរ។
ព័ត៌មានរបស់លោកគ្រូ/អ្នកគ្រូពិតជាមានសារៈសំខាន់ណាស់សំរាប់ខ្ញុំ
ហើយខ្ញុំសង្ឃឹមថាលោកគ្រូ/អ្នកគ្រូ អាចចូលរួមជាការសិក្សាស្រាវជ្រាវនេះ។
វាជាជម្រើសរបស់លោកគ្រូ/អ្នកគ្រូ បើទោះបីលោកគ្រូ/អ្នកគ្រូ ចង់ឬមិនចង់ចូលរួមក៏ដោយ។
ប្រសិនបើលោកគ្រូ/អ្នកគ្រូជ្រើសរើសចូលរួមជាមួយការសិក្សានេះ
លោកគ្រូ/អ្នកគ្រូមានសិទ្ធិមិនឆ្លើយសំនួរណាមួយឬបញ្ចប់ការឆ្លើយសំណួរនៅត្រង់សំណួរណាមួយ។

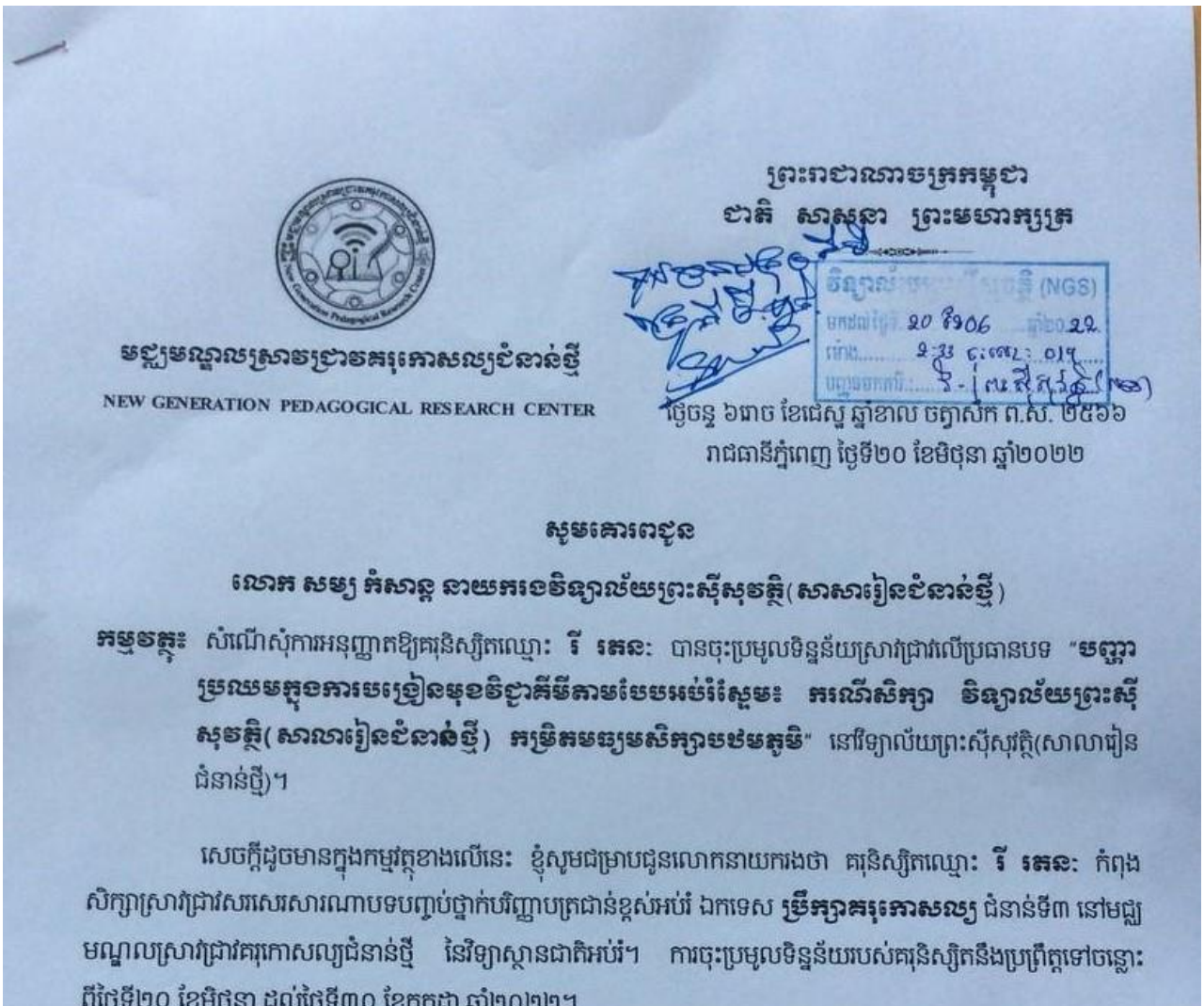
៤. ការទំនាក់ទំនងមកអ្នកស្រាវជ្រាវ

ប្រសិនបើលោកគ្រូ/អ្នកគ្រូមានសំនួរឬបញ្ហាណាមួយពាក់ព័ន្ធនឹងការស្រាវជ្រាវនេះ លោកគ្រូ/អ្នកគ្រូអាចទំនាក់ទំនងមកកាន់ខ្ញុំផ្ទាល់ដែលជាអ្នកស្រាវជ្រាវតាមរយៈលេខទូរស័ព្ទ: ០១១ ៩២១ ៦៦៤(តេឡេក្រាម) និង E-mail: rathanakry95@gmail.com ។

៥. កិច្ចព្រមព្រៀងក្នុងការចូលរួម

គោលបំណង របស់ការស្រាវជ្រាវបានពន្យល់យ៉ាងច្បាស់ដោយអ្នកស្រាវជ្រាវ ហើយខ្ញុំនឹងចូលរួមក្នុងការសិក្សាស្រាវជ្រាវមួយនេះ។ ខ្ញុំដឹងថា ខ្ញុំអាចឆ្លើយឬ មិនឆ្លើយនូវសំនួរណាមួយ ដោយគ្មានលំក្ខខណ្ឌអ្វីទាំងអស់។

អ្នកចូលរួម	**អ្នកស្រាវជ្រាវ**
កាលបរិច្ឆេទ៖ _____	កាលបរិច្ឆេទ៖ _____
ហត្ថលេខា៖ _____	ហត្ថលេខា៖ _____
ឈ្មោះ៖ _____	ឈ្មោះ៖ _____



ព្រះរាជាណាចក្រកម្ពុជា
ជាតិ សាសនា ព្រះមហាក្សត្រ

មជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី
NEW GENERATION PEDAGOGICAL RESEARCH CENTER

ថ្ងៃចន្ទ ៦រោច ខែជេស្ឋ ឆ្នាំខាល ចត្វាស័ក ព.ស. ២៥៦៦
រាជធានីភ្នំពេញ ថ្ងៃទី២០ ខែមិថុនា ឆ្នាំ២០២២

សូមគោរពជូន

លោក សម្ប កំសាន្ត នាយករងវិទ្យាល័យព្រះស៊ីសុវត្ថិ(សាសារៀនជំនាន់ថ្មី)

កម្មវត្ថុ: សំណើសុំការអនុញ្ញាតឱ្យគុនិស្សិតឈ្មោះ: **ទី រតន:** បានចុះប្រមូលទិន្នន័យស្រាវជ្រាវលើប្រធានបទ "**បញ្ហាប្រឈមក្នុងការបង្រៀនមុខវិជ្ជាគីមីតាមបែបអប់រំស្មែម: ករណីសិក្សា វិទ្យាល័យព្រះស៊ីសុវត្ថិ(សាសារៀនជំនាន់ថ្មី) ក្រមិតមធ្យមសិក្សាបឋមភូមិ**" នៅវិទ្យាល័យព្រៈស៊ីសុវត្ថិ(សាសារៀនជំនាន់ថ្មី)។

សេចក្តីដូចមានក្នុងកម្មវត្ថុខាងលើនេះ: ខ្ញុំសូមជម្រាបជូនលោកនាយករងថា គុនិស្សិតឈ្មោះ: **ទី រតន:** កំពុងសិក្សាស្រាវជ្រាវសារសេរសារណាបទបញ្ចប់ថ្នាក់បរិញ្ញាបត្រជាន់ខ្ពស់អប់រំ ឯកទេស **គ្រឹក្សាគរុកោសល្យ** ជំនាន់ទី៣ នៅមជ្ឈមណ្ឌលស្រាវជ្រាវគរុកោសល្យជំនាន់ថ្មី នៃវិទ្យាស្ថានជាតិអប់រំ។ ការចុះប្រមូលទិន្នន័យរបស់គុនិស្សិតនឹងប្រព្រឹត្តទៅចន្លោះពីថ្ងៃទី២០ ខែមិថុនា ដល់ថ្ងៃទី៣០ ខែកក្កដា ឆ្នាំ២០២២។

Empowering educators with ethical and evidence-based practices

Email: ngprc.faculty@gmail.com
Website: www.ngprc.edu.kh