Designing experiential learning activities for students in directions of STEM education at primary schools

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Abstract. STEM is a new educational model in the world which integrated many subjects and skills helping students to develop and integrate well in their lives. STEM education is basically understood to equip students with the necessary knowledge and skills related to the fields of science, technology, engineering and mathematics. Experiential learning activities for students in directions of STEM education help students combine the scientific and mathematical knowledge to solve the practical problems. In Experiential learning activities, students based on combining the knowledge of various education fields and skills to apply in reality and participate in the service activities for communities under the guidance and organization of their teachers. This paper focuses on the designing of experiential learning activities to develop the core skills of primary students with some main contents such as: overview of STEM education, experiential learning activities and experiential learning activities for students in directions of STEM education; designing the experiential learning activities in direction of STEM education at primary schools; for example about the experiential activities in direction of STEM education at primary schools,...

1. Introduction
We are living in an era of globalization and intensive integration among countries with different cultures, the need for cooperations in works and exchanging human resources is also increasing. This context requires that the education industry also needs to prepare for students the skills and knowledge that meet the global standards. STEM education is an interdisciplinary approach which creates a harmonious combination of Science, Technology, Engineering and Mathematics to give students meaningful real-life experiences. STEM education will lessen the gap between academia/theory and reality, create people who are capable of "immediate" working in a highly creative environment and use the “less-repetitive-working-mind” in the 21st century. STEM teaching and learning increases the attractiveness to students, helps them understand more intensively the issues, then, achieve better learning results. Besides providing science, technology, engineering and math skills, STEM education also provides students with the necessary skills to help students develop well in the 21st century such as problem solving skills, critical thinking, collaboration skills, communication skills...

STEM education with the mission to provide the necessary knowledge and skills for students in 21st century, so it will be a wide-area education model of the world in near future. STEM education is quite new and has a different approach in teaching and learning so it needs the proper attention and awareness of whole society. Policymakers need to have a measure to raise awareness of different social classes about STEM education, from parents, teachers, schools, to educators at all levels.
Educational reform is indispensable and deploying STEM education is a way to catch up with the advanced trend of education development which will lay a solid foundation for the country's development in the future.

According to the actual survey results, nowadays STEM education and the application of STEM education are quite new to teachers as well as pupils in Vietnamese primary schools. Only about 52% of teachers knowing about STEM education and 38% of teachers organized STEM activities for primary pupils but only focus on grades 4 and 5. Some teachers do not fully understand about the role of STEM education for primary pupils. When applying STEM education to teaching in primary schools, the biggest difficulty is that STEM requires experienced and creative teachers [11]. Therefore, in order to successfully implementing the STEM education model in primary schools, it is necessary to guide teachers and pupils about STEM education, STEM education curriculum, and how to apply STEM in teaching some natural sciences subjects as well as suggest some STEM models that are suitable for the content and objectives of teaching natural sciences at the primary schools.

2. Overview of STEM education, experiential learning activities and experiential learning activities in direction of STEM education

2.1. STEM education
Today, as we are entering the new era of Industrial Revolution 4.0, the development trend based on the highly integrated platform of the digital network along with the breakthrough of the Internet of Things (IoT) and artificial intelligence are fundamentally changing world production. In order to adapt to the Industrial Revolution 4.0, every places in the world are trying to innovate and the trend of STEM education is the essential choice of many countries, including Vietnam.

STEM stands for Science, Technology, Engineering and Math. STEM education is mostly understood as equipping learners with the necessary knowledge and skills related to the fields of science, technology, engineering, and math. This knowledge and skills (called STEM education) must be integrated and complementary to help students not only understand the theory but also apply it to practical use and able to create products in everyday life [5].

STEM education is a model of education based on an interdisciplinary approach, helping students apply scientific, technological, technical, and mathematical knowledge to solve practical problems in specific contexts [1], [12], [13]. Students study STEM education will have outstanding advantages such as solid scientific, technological, technical and mathematical knowledge, creative ability; logical thinking related to specialized field, academic performance and work enhanced and have the opportunity to develop more comprehensive skills. In particular, STEM is the foundation that allows people to dominate “virtual” associative skills so that they can learn and work anytime, anywhere, for a lifetime without being hindered by time, age, religion, personal development characteristics, or geographical distance.

STEM subject is a subject in which students would gain knowledge of science, technology, engineering, and math in an integrated manner. Typically, STEM subjects are designed in topic form, and students are taught integrated knowledge based on these topics. For example, when studying a topic about the solar system, students not only study components of the solar system or its characteristics but also learn ideas about how to develop a telescope (that is, to learn Technology), learn about telescopic racks (related to Engineering) or learn how to calculate the distance between stars or the radius of stars (related to Mathematics). Robotics is a typical subject for STEM education.

How to "learn STEM"? One of the most effective teaching and learning methods for STEM education is the “Learning by doing” method. The “Learning by doing” method helps students gain knowledge from hands-on experience, not just theory. By developing thematic and hands-on lectures, students learn a deep understanding of theory and principles through practical or experiential activities. It is these experiential learning activities that will help students remember knowledge longer and more profound. Students will work in groups, discuss and explore by themselves, apply knowledge to hands-on activities, and then pass on the knowledge to others. With this way of learning, teachers are no longer the ones who impart knowledge but will be the guides for students to build their knowledge.
2.2. Experiential learning activities
Experiential learning activities are educational activities organized in a way that links theory with practice to create a unity between awareness and action, forming and developing for students the belief, affection, and required competencies of future (comprehensive development of student's personality); organize various types of educational activities and rich and diverse communication relationships for students such as science and technology creation activities, social activities, cultural and artistic activities, career orientation, ... Thanks to that, students become more aware of themselves, discover and prove their abilities, accumulate experiences to transform them into competencies. Furthermore, students are allowed to practice, design, and create products which are highly applicable in practice [4], [14], [15].

Experiential learning activities and experiential, vocational learning activities are educational activities guided, designed and conducted by educators, allowing students to approach reality and experience positive emotions, exploit existing experience, and mobilize the combined knowledge and skills of different subjects to perform the assigned tasks or solve problems of real-life in school, family, and society age-appropriately. Doing this will transform past experiences into new knowledge, new skills contributing to the creative potential and adaptability to life, the environment and future careers.

Experiential learning activities and experiential, vocational learning activities are compulsory education activities carried out from grades 1 to 12; at the primary level is called experiential learning activities; at lower secondary and upper secondary levels are called experiential and vocational learning activities [1].

Experiential learning activities and experiential, vocational learning activities develop the key qualities, core competencies of students in relationships with themselves, society, natural and career environment; deployed through four main operating content areas: Self-directed activities; Society-directed activities; Nature-directed activities and Career-directed activities. The content experimental learning activities and experiential, vocational learning activities, is divided into two stages: the basic education stage and the career-oriented education stage.

At the primary level, the content of experiential learning activities focuses on activities: self-discovery, self-training activities, activities of developing relationships with friends, teachers, and family members. Social activities and learning about some career close to the students are also organized with content and form suitable for students’ age [1].

2.3. Experiential learning activities in direction of STEM education
Experiential learning activities as mentioned above can be carried out in many different ways such as observation, perception, evaluation, practice and problem-solving... STEM education is mainly directed to research activities, build projects, and conduct experiments.

Experiential learning activities in direction of STEM education can be understood as the organization of experience programs and students performing experiential tasks in the form of research activities, project development, experimentation, etc. Students will solve the problem of experience based on science, not just emotional perception. The information or proposals have specific data, proving the scientific basis of the proposed ideas.

However, with the characteristics of primary students, when dealing with experiential tasks, it does not necessarily require all the scientific or technological problems they rise to be rigorous. The problems may just stop at the idea to suggest students the solution to solve in later years of study, and the problems may also be only in pre-scientific nature. Most importantly, students will have real experiences based on their serious research activities to nurture their dreams and ideals.

3. Designing experiential learning activities for primary students in directions of STEM education
3.1. Experiential learning activities in primary schools
According to the 2018 general education curriculum at the primary school level, the subjects related to STEM such as "Social and natural sciences" in grade 1, 2 and 3; "Science" in grade 4 and 5;
"Informatics and technology" in grade 3, 4, 5. The knowledge of these subjects is widely applied in practice, so the application of STEM education method will be convenient and effective in forming and developing students' capacity, particularly scientific competencies such as the capacity to learn and explore nature through observation and experiment, the ability to apply and synthesize scientific knowledge to solve problems in life; design capacity; creative ability and some general competencies. As such, STEM is not a specific subject where teachers can organize STEM activities for students in related subjects or in "experiential learning activities" because of the educational orientation of STEM is in line with the educational orientation of the above subjects.

In primary schools, experiential learning activities have duration of 105 periods/year in each grade to form students' positive habits in daily life, such as being hard-working; carrying out responsibilities of students at home, school, and communities; self-assessment and self-regulation; forming communicative and cultural behaviors; consciously cooperating in groups and building problem-solving capacity. After participating in experiential learning activities, students are able to build life-adaptive capacity, design and organize activities, career-oriented capacity. With such goals and requirements, the experiential learning activity program for the primary school should include the following basic contents:

1. Self-directed activities content
   - Discovering yourself activities, such as understanding your image, personality, and abilities.
   - Self-training activities such as self-discipline, self-service habits, and sense of responsibility in life, practice life-adaptive skills.

2. Society-directed activities content
   - Family care activities: Attention, care for relatives, and relationships in the family. Participate in family affairs;
   - School building activities: Building and developing relationships with friends and teachers. Participate in building and promoting the traditions of the school and of the Union
   - Community building activities: Building and developing relationships with people. Participating in social activities, traditional education activities, political, ethical, and legal education.

3. Nature-directed activities content
   - Activities of understanding and preserving natural landscapes: Discovering the beauty and meaning of natural landscapes. Participating in preserving the natural landscape.
   - Activities of learning and protecting the environment: Understanding the actual situation of the environment, participating in environmental protection.

4. Career-oriented activities content
   - Career exploration activities: Finding out the meaning, characteristics and requirements of the profession; Understanding occupational safety and health requirements; Understanding the labor market.
   - Activities of training quality and capacity suitable to career orientation: Self-assessment of self-suitability with career orientation; Qualities and competencies training in line with career orientation.
   - Activities of choosing career-oriented and planning career-oriented learning.

Based on these basic contents, each grade would have specific content and requirements. The main organizational method of experiential learning activities is discovery, experimentation, dedication and research. In order to design experiential learning activities in directions of STEM education, the most important method is to organize activities that create opportunities for students to participate in scientific research projects inspired by practical experiences, then proposing measures to solve problems scientifically. This group of organizational methods includes survey, investigation, research project conduct, technology, art creation, and other similar methods.
3.2. Way to design experiential learning activities in directions of STEM education in primary schools

To design experiential learning activities, teachers need to study the curriculum, determine the goals, on that basis select the topic, identify the content and the activities corresponding to the content, and choose the organizational method meeting their goals. For the experiential learning activities to be effective, planning is extremely important. In addition to the master plan, detailed plans for each activity also need attention. Even in the plan, it is necessary to identify specific evaluation criteria to guide the implementation.

The design of experiential learning activities in directions of STEM is similarly implemented, but there will be some differences. The design process is carried out as follows:

(1) Step 1: Select the topic of experiential learning activities

Based on the content and requirements that need to be met in the primary students experiential learning activities program, link it to the natural issues, processes, or technological devices that use that knowledge in practice to choose the topic of experiential learning activities. The applications can be the movement of the water flow, the effects and the harms of nature, what people have done to protect themselves against natural disasters, the life of plants and trees, and the nature of rehabilitation serving people.

From these issues, teachers will select the experiential learning topic. To attract the attention and interest of students, the topic needs to be clear, concise, accurate, ensuring the goals and requirements to be achieved, reflecting the content and impressing the students. For example, for students to experience the job of growing vegetables, teachers can name the topic "Talented farmers". Wanting students to experience life-adaptive skills activities teachers can call the topic "Robinson on a deserted island". Wanting students to experience nature-oriented activities, teachers can name the topic "How does the tree drink water?"...

(2) Step 2: Determine the problem to be solved

After choosing the topic of the lesson, it is necessary to identify the problem to be solved so that when solving that problem, students must build the necessary competencies required by the curriculum. According to the examples above, the task assigned to students to perform in the experiential learning activities may be: Planting and tending a bed of vegetables (or a pot, a foam box ...) until harvest. Design and erect a rain/ sun shelter using natural materials with condition that people can shelter from rain/ sun in it. Prove that the plants drink water and the plants will be affected by the water source by organizing a discoloration flower experiment. From that, it can be shown how to grow safe veggies and food.

(3) Step 3: Develop criteria of equipment/ problem-solving solutions

After identifying the problem/ product to be created, the solution /product criteria must be clearly defined. These criteria are an important basis to propose scientific hypotheses/ problem solving solutions/ product design. For the examples above, the criteria may be:

- With the topic "Talented farmers": Vegetables are grown up green with specific criteria such as productivity calculated by the volume of vegetables obtained, the freshness is assessed by the senses, the cleanliness of the students after each care, the student's initiative to take care of vegetables to be gentle, does not take much effort but still achieve high efficiency ...

- With the topic "Robinson on the desert island": Set up a tent so that all members of the group can go in and out safely, not leaking in the rain, cool in the sun. Tents have a high degree of certainty through stacking, tying, and attaining ... Besides, there are criteria such as the initiative to use alternative materials, the cooperation to support each other when setting up the tent...

- Topic "How does the tree drink water": Students conduct an experiment that causes a flower to change color, explaining the reason for the change. Especially apply that knowledge into practice when tending plants with clean water and unclean water. Especially with fruits and vegetables, food plants. From that, it is possible to formulate a project to build a clean watering system for a vegetable garden of the school or the family... The evaluation criteria are logical analysis of the problem with persuasive language, concrete proof and feasible project.
(4) Step 4: Process design to organize experiential learning activities

The process of organizing experiential learning activities is designed according to the methods and forms of active organization in practice or in the laboratory, which can be done both inside and outside the classroom (at school, at home and community). Each experiential learning activity should be clearly designed with the purpose, content, and learning product that the student must complete. With experiential learning activities that require a long time to complete, teachers can guide students to record clips of daily activities, report on Facebook or Zalo groups of class. Throughout the process, it is necessary to continually support students both directly and indirectly if they are needed. However, teachers must always actively exchange and supervise activities to promptly detect difficulties and problems of students and support them to achieve the best results.

(5) Step 5: Contact individuals and organizations inside and outside the school

The implementation of experiential learning activities may take place within or outside the school. Therefore, for this activity to be effective before implementation, it is necessary to contact relevant individuals and organizations to agree on an operation plan. It can be done with the help of craftsmen of the trade village, the local families with appropriate conditions to support the introduction of experiential learning content. They can also be the ones who carry out simulation activities for students to stud ... With large-scale experiential learning activities, they need to contact professional organizations to operate smoothly.

3.3. The meaning of implementation of experiential learning activities in the direction of STEM education in primary schools

Experiential learning activities in primary schools create opportunities for students to approach reality, experience positive emotions, exploit existing experiences, and mobilize the combined knowledge and skills of the subjects to perform assigned tasks or solve problems of school, family and social life that are age-appropriate; Through this, transforming past experiences into new knowledge and skills to contribute to the promotion of creative potential and adaptability to life, the environment and future careers.

When organizing a STEM-oriented experiential learning activity, students will develop creative skills, stimulating imagination, patience, teamwork, leadership, and public-speaking, problem solving skills, computer thinking, language development. The combination of learning, playing and practicing will stimulate a passion for science. They see the need for learning as important. They will always explore, learn and research themselves to fill the gaps in their knowledge.

Project-based and problem-based problem solving allows students to understand the relevance of their work to their lives and the world around them. Creating a lively, open student environment, bridging the gap between teachers and students. This brings excitement and happiness in performing the task, from which students can apply the principles learned in real-world practices. As a result, knowledge stays longer and is more meaningful to all students. Students are able to express their rich thoughts and imagination.

Organize STEM-oriented experiential learning activities that helps connect schools with the community. Expressed by the school exploiting human resources, facilities implementing experiential learning activities. In addition, the experience in the direction of STEM education also aims to require students to solve family-specific or local-specific issues.

4. Examples of experiential learning activities in direction of STEM education in primary schools

Topic: Saving electricity in life

4.1. Description of topic

Saving electricity in daily life is a requirement for students after activity off taking care of family in 3rd grade. The number of periods to conduct this experiential learning activity in class will require 04 periods with total time to operate is 1 month.
4.2. Objectives:
After this experiential learning activity, students should achieve:

(1) Knowledge: Presenting the meaning of saving electricity in life related to economic, health and environmental protection issues; Name the forms of electricity saving in daily life such as selecting economical equipment, reasonable installation, and scientific usage to avoid waste.

(2) Skills: Analyzing the advantages and limitations in installing equipment and using electricity of the family; Developing a proposal to adjust the installation of electrical equipment to save money and reasonable power usage plans; Presenting, defending your own opinions, and criticizing others’ opinions.

(3) Attitude: Demonstrating positive attitude in fact-finding research; Being keen, passionate about scientific research; Being conscious of environmental protection.

(4) Capacity development orientation: Forming experimental capacity, scientific research; Problem solving; Offering help from families; Communication and cooperation.

4.3. Equipment for operation
Computers, projectors: Introducing types of energy-saving devices, water in the home and appropriate installation suitable for daily use; the video introduces the meaning of saving electricity in life.

A family or a unit who installs and uses appropriate electrical equipment for students to visit and experience.

4.4. Evaluation criteria
4.4.1. Project evaluation criteria

| No | 1.0 point                                                                 | 2.0 point                                                                 | 3.0 point                                                                 |
|----|--------------------------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------|
| 1  | Briefly introduce rooms and electrical appliances in the house           | Introduce more about the characteristics and purposes of rooms            | A thorough introduction to the number and electrical appliances available in the rooms |
| 2  | Preliminary comments on installation as well as current electricity usage | Comment on whether electrical appliances and their installation is scientific and suitable for use? | Further assess the appliances and its installation and current use of electricity and confirm where can be further saved? |
| 3  | General recommendations for adjusting the installation or economical use | Explain clearly what appliances to adjust, which one to replace to save power | Add daily usage of electricity such as taking advantage of light and wind, reasonable living mode, going to bed early |

Points for Project presentation: Ordinary presentation: 0.5 points; Combining language with illustrations: 1 point.
4.4.2. Report evaluation criteria

Table 2. Evaluation form No. 2

| No | Criteria                                             | Max point | Achieved point |
|----|------------------------------------------------------|-----------|----------------|
| 1  | Restate strictly according to the scheme             | 2         |                |
| 2  | Explain the limitations and proposed ideas           | 4         |                |
| 3  | Give a coherent, confident presentation              | 2         |                |
| 4  | Answer questions and review persuasive suggestions    | 2         |                |
|    | Total score                                          | 10        |                |

4.5. Experiential learning activities organization

(1) Activity 1: The meaning of saving electricity
   Duration: 10 minutes
   Step 1: Students work in small groups to come up with ideas about what electricity savings mean.
   Results presented quickly in class.
   Step 2: Teacher shows the clip about the meaning of saving electricity. Invite students to find new information from the clip compared to what they already know.

(2) Activity 2: How to save electricity in daily use
   Duration: 30 minutes
   Step 1: Students introduce ways to save energy that they already know.
   Step 2: Teacher introduces:
   - Devices that help save electricity in the family such as solar water heaters, energy storage lamps, solar batteries, touch lamps...
   - How to install the devices in accordance with usage needs: For example, bathrooms should use small lights, studying rooms should use desk lamps, stairs and corridors should use touch lamps, sitting alone should only use fan with small or moderate capacity...
   - How to use electricity and water appropriately in daily life: For example, take advantage of natural light or wind, only use electricity for lighting and cooling when necessary, if in the room there are many people, a light bulb should be put in a position so that it can light enough for everyone, or a fan can cool for all...
   When introducing the above content, teachers always relate to the information that students have introduced at the beginning.

(3) Activity 3: Visiting a real model
   Organizing for students to visit a model using and installing economical electrical equipment
   Duration: 40 minutes
   Step 1: Have students work in groups with the task of: observing and commenting on the installation, suggesting the use of devices in this house in different situations to save the most electricity.
   Step 2: The teacher summarizes the accurate comments, concludes the ways to save electricity in daily life.

(4) Activity 4: Students develop a proposal to adjust the installation of electrical equipment in their home and appropriate power usage options.
   Duration: 1 week for the project
   Requirements of the project: Introduce the characteristics of the rooms in the family with the area, characteristics, uses and lighting systems as well as cooling or warming of the room being used currently; Is the review of equipment and installation scientific? Is it consistent with the intended use? Can more electricity be saved?; Propose how to use electricity every day in the most economical way.
Simultaneously with the requirements of the project, students should be introduced to the criteria for evaluating the project and the criteria for awards so that students can strive for and implement effectively.

(5) Activity 5: Project report
   Duration: 2 periods
   Round 1: Each individual reports to the group on their proposal, the group members make comments accordingly. Each group chooses the best project to report to the class.
   Round 2: Selected projects to be reported to the class, the whole class makes comments. Specially, teachers direct the children to comment on the necessary content. Students need to answer further questions.
   After 2 rounds of reporting, class vote for the outstanding individuals and groups to be awarded the "Family Scientist".

(6) Activity 6: Apply the project into practice
   Duration: 3 weeks
   Ask students to go home to talk with family members, persuade parents to apply electricity-saving projects. If economic conditions do not allow the modification or adjustment of equipment, the economical use of electricity shall be applied.
   Ask for parents to see the previous month's electricity consumption, record carefully to compare with the month of applying the electricity saving method. Can take photos as evidence.
   The results are recorded in a report before class, to continue in the following months...

5. Conclusion
In order for this activity to work as expected, it is necessary to design according to the process of selecting topics, identifying problems that need to be solved in practices according to each topic, developing criteria to evaluate the results of experiential learning activities, designing the process of organizing experiential learning activities, contacting relevant individuals or organizations for support. The organization of experiential learning activities in direction of STEM should be flexible in terms of timing and implementation. With outdoor activities, attention should be paid to weather and areas to ensure the highest safety for students. Teachers should guide students to apply their created work in the practical implementation to maintain the results and train the necessary competencies for students meeting set goals.

References
[1] Ministry of Education and Training (2018), General Education Curriculum – Comprehensive Curriculum - Issued together with Circular No. 32/2018/ TT-BGDĐT December 26, 2018 of the Minister of Education and Training.
[2] Ministry of Education and Training (2018), Program of Experiential learning activities and Experiential, vocational learning activities - Issued together with the Minister's Circular No. 32/2018 / TT-BGDĐT December 26, 2018 Ministry of Education and Training.
[3] Tran Thi Gai, Nguyen Thi Phuong, Nguyen Thi Hoai Thanh (2018), Designing the topic of STEM education in teaching the part "material and energy metabolism in plants" – biology grade 11, high school, Journal of Education, No. 443 (Period 1 - 12/2018), page 59 -64.
[4] Nguyen Thi Lien, Nguyen Thi Hang, Tuong Duy Hai, Dao Thi Ngoc Minh (2016), Organize creative experiential learning activities in high schools, Education Publishing House, Hanoi.
[5] Nguyen Duc Minh, Tran Thi Huong Giang (2017), STEM education for girls towards Industrial 4.0, Hanoi.
[6] Nguyen Thanh Nga, Hoang Phuoc Muoi (2018), Organize experiential learning activities in direction of STEM education through club activities and use of high school laboratory facilities, Journal of Science, Ho Chi Minh City University of Education HCM volume 15 number 4.
[7] Department of Secondary Education (2019), Training material Developing and implementing STEM education topics in high schools - Internal circulation documents, Hanoi.
[8] M. Sencer Corlu, Robert M. Capraro, Mary M. Capraro (2014), *Introducing STEM education: Implications for Educating our teachers for the age of innovation*, Education and Science Journal, vol. 39, No 171.

[9] Leema K. Berland (2013), *Designing for STEM integration*, Journal of Pre-College Engineering Education Research, volume 3, issue 1, article 3.

[10] Robert M. Capraro, Mary M. Capraro, James R. Morgan (2013), *STEM Project – Based Learning: An Integrated Science, Technology, Engineering and Mathematics Approach*, Sense publisher, Netherlands.

[11] [http://www.khoahocphothong.com.vn/vai-tro-cua-stem-do-i-vo-i-hoc-sinh-tieu-hoc-49426.html](http://www.khoahocphothong.com.vn/vai-tro-cua-stem-do-i-vo-i-hoc-sinh-tieu-hoc-49426.html)

[12] Sutaphan, S. Yuenyong, C. 2019. STEM Education Teaching approach: Inquiry from the Context Based. Journal of Physics: Conference Series, 1340 (1), 012003

[13] Chomphuphra P, Chaipidech P, Yuenyong C 2019. Trends and Research Issues of STEM Education: A Review of Academic Publications from 2007 to 2017. Journal of Physics: Conference Series, 1340 (1), 012069

[14] Duc NM, Linh NQ, Yuenyong C 2019. Implement of STEM education in Vietnamese high school: unit of acid-base reagent from purple cabbage. Journal of Physics: Conference Series, 1340 (1), 012029

[15] Linh NQ, Duc NM, Yuenyong C 2019. Developing critical thinking of students through STEM educational orientation program in Vietnam. Journal of Physics: Conference Series, 1340 (1), 012025