

Proposing a Model for Developing Facilities to Support STEM-Oriented Natural Science Experiences in Junior High Schools in Vietnam

Tran Van Dat¹, Phan Ngoc Thach², Pham Nguyen Cam Tu^{3,*}

¹Faculty of Education, An Giang University, Long Xuyen City, Vietnam

²Foreign Languages Faculty, Dong Thap University, Cao Lanh City, Vietnam

³Natural Science Team, Nguyen Tu Secondary School, Cao Lanh City, Vietnam

Email address:

tvdat@agu.edu.vn (Tran Van Dat), pnthach@dthu.edu.vn (Phan Ngoc Thach), pncamtu82@gmail.com (Pham Nguyen Cam Tu)

*Corresponding author

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Abstract: In Vietnam, in the context of a fundamental and comprehensive renovation of education in the spirit of transforming from content-based education to education that develops the quality and capacity of learners; STEM education and experiential activities are encouraged to be implemented in schools from preschool, elementary, middle, and high school levels. Besides, Natural Science is an integrated subject between Physics, Chemistry, and Biology; is a convenient subject for organizing and implementing STEM education-oriented experiential activities. The STEM education-oriented natural science experience is a new educational model, and schools still face many physical difficulties when implementing practical activities, experiments, and scientific research, modeling Physics, Chemistry, and Biology. From that, it can be seen that the facilities are one of the factors contributing to the success of the operation. Therefore, it is necessary to propose a management model for the purpose of developing facilities in schools in order to create favorable conditions for teachers to implement STEM education-oriented natural science experiences. On the basis of theory, the research paper proposes a model of infrastructure development that contributes to supporting STEM experiences in natural sciences at the lower secondary level. The research results suggest the content and implementation method of surveying, planning, organizing, directing, and checking the implementation results. The research gives meaning to education managers to apply theory to practice to develop facilities in schools, contributing to improving the quality of education in the locality and national education.

Keywords: Model, Facilities, Experiential Activities, STEM, Natural Science, Vietnam

1. Introduction

Vietnam is in the process of renovating the curriculum, renovating the compilation of general education textbooks, and renovating teaching methods in the direction of developing learners' capacity in order to implement Resolution No. November 4, 2013, The 8th Central Conference of the XI term on fundamental and comprehensive reform of education and training [4, 1].

Accordingly, STEM Education (S-Science, T-Technology, E-Engineering, M-Math) is a program to provide, support,

and enhance Science, Technology, Engineering, and Mathematics education in primary and secondary school to graduate level [6, 2]; is most commonly used in educational contexts (educational interest in Science, Technology, Engineering and Mathematics subjects and the integration of practice-related subjects to enhance competence). for learners) and career contexts (STEM is understood as careers in the fields of Science, Technology, Engineering, and Mathematics) [15, 3]. The STEM competence of high school students is the ability to synthesize knowledge and skills in science, technology, engineering, and mathematics to solve practical problems in each specific context, bringing

value to high school students, value for individuals and communities [17].

For educational managers, the meaning of experiential activities is to help realize their integrated and differentiated purposes in order to develop practical and personalized capabilities and diversify their creative potential. pupil. Through practical activities, educational administrators can evaluate the effectiveness of the educational program and make changes and adjust the educational program to suit their students [18]. Through the organization of practical activities and experiments, the subject of Natural Science helps students explore the natural world, develop awareness, logical thinking, and the ability to apply knowledge in practice [14].

For the lower secondary level, the 2018 General Education Program starts from the 2021 - 2022 school year in grade 6. With the orientation of transitioning from knowledge transfer education to education that develops quality and competence For learners, the 2018 general education program requires that high schools need to apply many educational models to actively engage students' activities, enhance the experience, experiment, experiment, and practice in an integrated direction. science, technology, engineering, and applying mathematics to solve academic and practical problems.

Researching experiential activities of Natural Science subject to STEM education orientation is a dynamic combination of experiential activities with STEM education in the field of Natural Science, to concretize the path of formation and development. capacity development for junior high school students through organizing self-directed, nature-oriented, social-oriented, and career-oriented experiential activities; From there, students form a scientific worldview, scientific thinking, and scientific application skills. Managing the natural science experience activities in the direction of STEM education in junior high schools has a scientific meaning, which is to contribute to managers to perform educational management functions scientifically, in the right direction, and by the laws of movement of the

natural world; contribute to concretizing the path of formation and capacity development for students through the formation of the scientific worldview, scientific thinking, and scientific application skills; contribute to proposing measures suitable to educational management science based on practice. In the process of organizing and implementing activities, facilities are a factor that needs to be paid attention to and invested in to create favorable conditions for the process of organizing activities to take place by the purposes and requirements to be met. Facilities can be supported by socialization work, from state funding; Facilities are also developed through careful preservation of equipment and teaching aids and timely addition to the list of minimum use of teachers. Considering the need to pay attention to investment in facilities, the research author proposes a model of infrastructure development to support STEM experiences in the lower secondary school natural science subject in the context of Vietnam.

2. Some Concepts

2.1. Experiential Activities

From a philosophical point of view, experience is the process of interaction between people and people, between people and the environment through the senses and activities to create changes in the human worldview [9].

Experiential Learning Theory (ELT) defines experiential learning as the process by which knowledge is created through the transformation of experience. Knowledge is the result of a combination of capturing and transforming experience [10]. Lifelong learning requires the ability to learn from life experiences. Knowledge is created from experience through a cycle of learning driven by the two dialectics of action/reflection and experiential/abstract. Linking one experience to the next creates a learning spiral that leads to growth and development throughout life [19]. Kolb's experiential learning cycle is depicted in Figure 1. below:

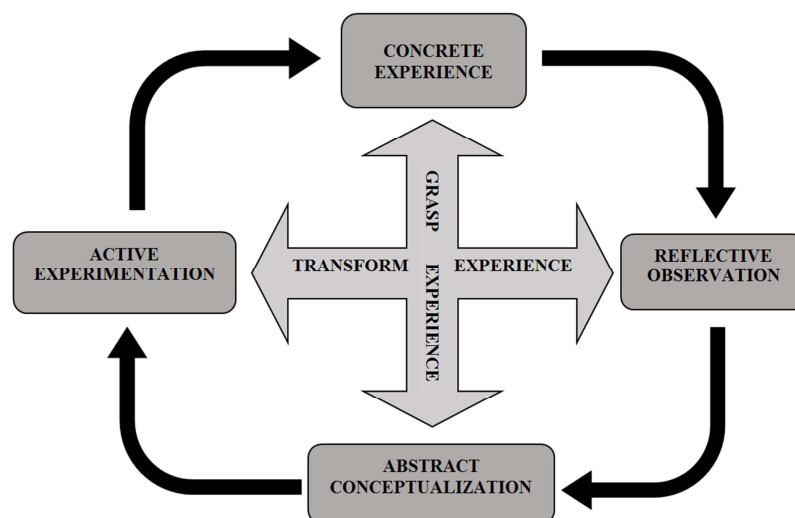


Figure 1. The Experiential Learning cycle [9].

Experiential learning and experiential learning are closely linked and can be used interchangeably, in which experiential teaching is a deliberate teaching process, based on experiential learning theories [11].

2.2. STEM and STEM Education

“STEM Education is a program that provides, supports, and enhances Science, Technology, Engineering, and Mathematics education in elementary and middle school through graduate school.” [6].

STEM education is an approach and discovery in teaching and learning between two or more STEM subjects, in schools and in specific contexts to connect schools and communities, thereby developing competencies in STEM education and being able to compete in the new economy [21, 22]. A prosperous economy in the 21st century will be based on Science, Technology, Engineering, and Mathematics” [12]. Furthermore, studies show that teachers have different perceptions of STEM integration [2]. STEM education combines fields into a cohesive learning model based on real-world applications rather than teaching them as separate and discrete objects [8]. Success in STEM education can affect careers, work productivity, and competitiveness in many fields [1].

2.3. Natural Sciences

Natural Science is built and developed based on Physics, Chemistry, Biology, and Earth Sciences. Research objects of natural science are things, phenomena, processes, basic properties of existence, and movement of the natural world [14].

Natural science is also a specific subject, with a close combination of theory and practice, so the lessons are a series of diverse learning activities, from observation, discovery, discovery, teaching, and learning. make scientific predictions, conduct experiments to test predictions, and apply knowledge to solve theoretical problems of the subject, as well as real-life situations [23].

The subject of Natural Science contributes to linking science with life, paying attention to the content of knowledge close to students' daily life, and increasing the application of scientific knowledge to real-life situations. Through this, students see that science is very interesting and must be close and practical to human life. The natural science education program contributes to the development of students' adaptive capacity in a constantly changing society, contributing to the sustainable development of society.

2.4. Activities to Experience Natural Science Subject to STEM Education

Experiential activities of natural science are activities of students, integrating natural science knowledge to experience creativity; linking theory with practice through activities of observing, exploring, discovering, and solving problems in learning as well as in life [20].

The STEM education-oriented natural science experience activity is the activity of students observing, exploring, and discovering through experiments and exercises; the act of applying natural scientific knowledge in combination with the application of science and technology to solve academic problems as well as in real life. Thereby, students acquire knowledge, foster qualities, develop skills, and at the same time realize the meaning of Science, Technology, Engineering, and Mathematics for human life, and enhance their interest [20].

2.5. Infrastructure

Facilities are understood as all means used for teaching, learning, and other activities related to fostering and training at the school to help teachers improve the quality of teaching and learning. Students improve their ability to absorb and experience knowledge, and at the same time practice and perfect the necessary skills in the process of studying at school [16].

2.6. Socialize

Socialization is mobilizing broad participation and expanding investment in human, material, and financial resources of the people and the whole society. Socialization of education and training is to create a deep learning movement in the whole society in many forms; mobilize the entire population, implement lifelong learning to work better, earn higher incomes, and have a better life, making our society a learning society [7]. Education development must be associated with the needs of socio-economic development, scientific and technological progress, consolidation of national defense and security; carry out standardization, modernization, and socialization [5].

3. Innovation Orientation of the 2018 General Education Program in Vietnam

3.1. Perspectives on Building the Program

The 2018 general education program is a document expressing the general education goals, specifying the requirements to be met in terms of student quality and capacity, educational content, educational methods, and methods of assessing outcomes. educational results, serving as a basis for general education quality management; at the same time is the commitment of the state to ensure the quality of the whole system and each general education institution.

The general education program is built based on the Party and State's views on a fundamental and comprehensive renovation of education and training; inheriting and developing the advantages of Vietnam's existing general education programs, and at the same time absorbing research achievements in educational science

and experience in building programs according to the model of capacity development of Vietnam. advanced education in the world; associated with the development needs of the country, the advances of the times in science, technology, and society; suitable to the characteristics of the people, Vietnamese culture, traditional values of the nation, and the common values of humanity as well as the initiatives and general development orientations of UNESCO on education; create equal opportunities for students' rights to protection, care, learning and development, rights to be heard, respected and involved; lay the foundation for a humane society, sustainable development, and prosperity.

The general education program ensures the development of learners' quality and capacity through educational content with basic, practical, and modern knowledge and skills; harmonizes virtue, wisdom, body, and beauty; focuses on practice, applying learned knowledge and skills to solve problems in study and life; highly integrated in the lower classes, gradually differentiated in the upper classes; through methods and forms of educational organization to promote the initiative and potential of each student, assessment methods suitable to educational goals and educational methods to achieve that goal.

The general education program ensures a close connection between classes and levels and links with the preschool education program, the vocational education program, and the higher education program.

The general education program is built in an open direction, namely:

- 1) The program ensures a uniform orientation and core educational contents, which are compulsory for students nationwide, and at the same time empowers local authorities and schools to take initiative and responsibility in selecting and supplementing a school, several educational contents, and implementation of educational plans suitable to the educational subjects and conditions of the locality and the school, contributing to ensuring the connection of the school's activities with the family, the government, and society.
- 2) The program only stipulates the general principles and orientations on the requirements to be met in terms of the quality and capacity of students, educational content, educational methods, and the evaluation of educational results. details, to create conditions for textbook authors and teachers to promote initiative and creativity in program implementation.
- 3) The program ensures stability and development during implementation by scientific and technological progress and actual requirements [13].

3.2. Objectives of the General Education Program

The general education program concretizes the general

education goal, helps students master general knowledge, know how to effectively apply knowledge and skills learned in life, and lifelong self-study must have orientation. choose the right career, know how to build and develop harmonious social relationships, and have a rich personality, personality, and spiritual life, thereby having a meaningful life and making positive contributions to the development of the country and humanity.

The lower secondary education program helps students develop the qualities and competencies that have been formed and developed at the primary level, adjust themselves according to the general standards of society, and know how to apply different methods of teaching and learning. active learning methods to complete foundational knowledge and skills have an initial understanding of professions, and have a sense of career guidance to continue to study in high school, learn a trade, or participate in life labor [13].

3.3. Requirements to Meet in Terms of Quality and Capacity

The general education program forms and develops for students the following main qualities: patriotism, compassion, hard work, honesty, and responsibility.

The general education program forms and develops for students the following core competencies:

- a) Common competencies are formed and developed through all subjects and educational activities: autonomy and self-study, communication and cooperation, problem-solving, and creativity.;
- b) Specific competencies are formed and developed mainly through several subjects and certain educational activities: language competence, computing capacity, scientific capacity, technological capacity, and technical competence. information ability, aesthetic ability, and physical ability.

In addition to forming and developing core competencies, the general education program also contributes to discovering and fostering students' talents [13].

4. Establish a Facility Management Model

4.1. The Goal of the Model

To develop facilities to support STEM education-oriented natural science experiences. This is a necessary condition to ensure the quality of the experience. Improve and develop facilities to contribute to creating excitement and attracting students to actively participate in the experience process; create conditions for students to practice, form and develop their qualities and abilities.

4.2. Content and How to Implement the Model

4.2.1. Model Design

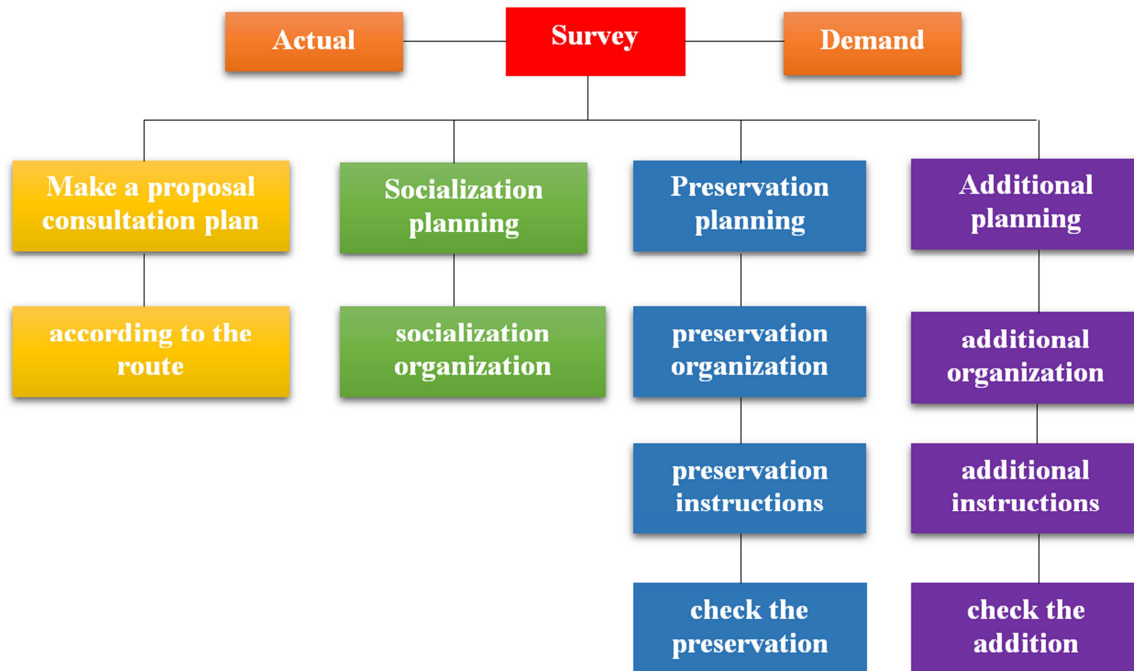


Figure 2. Model for developing facilities in the school.

4.2.2. Content

(i). Survey

The purpose of the survey is to help the principal understand the current situation of the school's facilities and the needs of teachers, mainly teachers of the Natural Science group, and teachers of Technology, Mathematics, and Informatics. Since then, the principal has taken measures to fully equip facilities to support STEM education-oriented natural science experiences. The survey includes:

- 1) Actual survey: The principal asked the professional team leaders, staff in charge of equipment, and staff in charge of facilities to report the actual situation of equipment, practical experiments, function rooms., classrooms, halls, tables and chairs, computer system, internet connection system, sound system, light, schoolyard conditions, landscape... The principal requires all departments in charge of facilities, to make a list of existing facilities, minimum necessary facilities, degraded facilities that need to be preserved, and propose additional facilities.
- 2) Demand survey: The principal asked the heads of the professional groups, especially the Natural Sciences group, to collect opinions from the teachers in the group about the current situation of existing facilities to meet the organization's requirements. Experiential activities in Natural Science subject to STEM education? From there, the professional team leader makes a plan to propose to the principal what types of facilities need to be added, and at the same time has a

plan to use and preserve those types of facilities.

(ii). Suggestion Consultation

- 1) Making a plan to advise and propose: this plan aims to propose to superiors for financial support to equip more facilities for the school; contribute to creating conditions for teachers to organize teaching and educational activities to meet the requirements of the 2018 General Education Program. At the same time, adequate physical conditions are favorable conditions for organizers to organize. Organizing activities to experience Natural Science subject to STEM education orientation.
- 2) However, the proposed consultation plan is highly dependent on the locality's objective conditions and general financial situation. Therefore, the implementation of the proposed advisory plan takes time and follows the allocation schedule of the education sector and relevant departments.
- 3) Therefore, when the school is not equipped with facilities, the school needs to have a temporary arrangement and arrangement plan, creating maximum conditions for teachers to complete their teaching and educational tasks in the year. learn. Especially the compulsory educational activities in the 2018 General Education Program prescribed.

(iii). Socialize

- 1) Making a socialization plan: determining the goal is to coordinate support and advocacy sources from sponsors, benefactors, study promotion associations, parents'

unions, local companies, and businesses desks, sister units to receive financial support, conditions for visiting experiences, and equipping some necessary facilities for educational-oriented natural science experience activities. STEM. However, the organization and implementation of the socialization plan need to comply with legal documents on the work of educational socialization.

- 2) Organize the implementation of socialization according to the time, place, content, composition, and method of organization stated in the plan. The implementation of socialization must have a practical meaning and the right purpose is to support educational activities that bring benefits to students, contributing to the formation and development of their capacity. For STEM education-oriented natural science experiences, companies, factories, businesses, and farms support the STEM experience environment (science, technology, engineering, math) learning), creating conditions for students to have access to modern machinery and equipment, with science and technology applications at the campus to help them expand their knowledge and vision. The sponsors, the study promotion association support in terms of funding to organize the experience session; Students' parents support transportation, create favorable conditions in terms of time, and provide spiritual support for the children to complete the report of natural science experience activities in the direction of STEM education. After each activity, the principal reports the results of socialization publicly, transparently, and clearly before the school's pedagogical council; in which it is necessary to clearly state the effectiveness of socialization in bringing about the development of educational quality through the organization of educational activities.

(iv). Preservation of Facilities

- 1) Making a preservation plan: to build up plans to preserve existing equipment, teaching aids, and facilities, which can be used longer, promoting more effective functions. The principal assigns the management and preservation of teaching materials to specialized groups to coordinate with school equipment staff. In, the Natural Science team is responsible for preserving, maintaining, cleaning, and proposing to the principal when it is necessary to repair teaching materials and equipment in Natural Science; promptly meet the needs of using equipment and teaching aids to serve lessons and experience activities of Natural Science subject to STEM education.
- 2) Organize and maintain facilities, including propaganda for teachers, staff, and students to carefully and properly use each type of equipment, teaching aids, and machinery. Staff in charge of equipment rooms and function rooms need to closely supervise from use to storage and preservation of all kinds of facilities, practical experiments, and teaching aids. The leader of

the Natural Science group needs to have a plan to preserve all teaching and learning equipment in the subject of Natural Sciences (Physics, Chemistry, Biology), to meet the requirements of experiments, and visual models, and organize other educational activities. Which, for the STEM education-oriented natural science experience, in addition to the provided teaching aids, there are also teaching equipment and supplies made by teachers and students themselves through applied science (Physics, Chemistry, Biology), technology, engineering, and mathematics. Those are STEM educational products from implementing STEM lessons in Natural Science and organizing STEM experience activities in Natural Science. Therefore, organizing the preservation of facilities is also the task of encouraging and mobilizing teachers to design recycled products for teaching materials; realize savings in the procurement of short-term equipment; strengthen the sending of teachers and equipment staff to training in the use of modern equipment to optimize the use of equipment and avoid incorrect procedures that cause equipment damage.

- 3) Directing the maintenance of facilities is the common responsibility of all teachers, staff, and students in the school. The principal directs each department in charge to have a plan to preserve all kinds of facilities according to the list of schools that have been enumerated. Particularly, the Natural Science group is in charge of preserving all provided facilities, equipment, teaching aids, and self-made teaching aids in the subject of Natural Sciences (Physics, Chemistry, Biology). The leader of the natural science group is responsible for proposing to the principal when necessary to repair machinery and equipment in service of teaching and experiential activities.
- 4) Inspection of the maintenance of facilities must be carried out regularly to detect damaged equipment, teaching aids, and means that need to be promptly repaired or liquidated to supplement. The departments perform the inspection, then propose to the principal the remedial measures.

(v). Additional Facilities

- 1) Making supplementary plans: to supplement the missing minimum equipment, teaching aids, and facilities to meet the teaching and educational needs of teachers for the General Education Program. 2018; at the same time, supporting educational activities to form and develop students' quality and capacity. In particular, the Natural Science team is responsible for making plans to add practical experimental equipment, visual aids, virtual experiments... (Physics, Chemistry, Biology), contributing to supporting STEM education-oriented natural science experiences.
- 2) Organizing the addition of facilities that need to be done regularly and promptly adding the minimum necessary means, equipment, and teaching aids to serve

the teaching and educational process of the school. The principal assigns specific tasks to each department to make a plan to check the missing means, equipment, and teaching aids and make an additional list suitable to the practical conditions of each department and the school. In, the Natural Science team is responsible for making an additional list of experimental facilities, equipment, teaching aids, models, chemicals, etc., at least for visual experimentation, and practical experiments and meet the needs of organizing experiential activities for the subject of Natural Science.

- 3) Directing the addition of facilities for the wrong parts to promote the process of perfecting the system of means, equipment, and visual teaching aids to promptly meet the needs of teachers in the process. teaching and education. In particular, the addition of adequate facilities is a favorable condition for teachers to well organize educational activities in schools. The principal directs the head of the Natural Science group to supplement the necessary facilities, means, and equipment to teach Natural Sciences (Physics, Chemistry, Biology) in each lesson and experiential educational activities. In addition to STEM education-oriented facilities, the leader of the Natural Science team should proactively propose to the principal all kinds of means and equipment to support scientific research activities (Physics, Chemistry, etc.) Science, Biology), application of technology, engineering, and mathematics (STEM) towards perfecting the organization of natural science experience activities in the direction of STEM education.
- 4) Check the addition of facilities to review the progress of implementation, and check the adequacy of the means, equipment, and teaching aids to meet the minimum requirements for teaching and learning activities. teacher education. The leader of the Natural Science team is in charge of checking whether the addition of facilities for Natural Science subjects (Physics, Chemistry, Biology) is adequate and continuing to propose to the Principal to implement the process. next addition.

4.3. Model Execution Conditions

- 1) The principal needs to be familiar with the legal regulations on finance, the principles of construction, and the recommendations on facilities suitable to the type of school and the general development of the education sector. The principal needs to have a plan to prepare funding for experiential activities in general and STEM education-oriented natural science experiences in particular and include it in the internal spending regulations and announcements. before the pedagogical council and approved the cadres and civil servants conference at the beginning of the year.
- 2) The principal needs to understand the regulations on educational socialization, the operating principles of

the parent-student union, and the principle of mobilizing sponsors and other social organizations. Principal establishes good, long-term relationships; building credibility and trust with the educational force outside the society to take advantage of material and spiritual support to serve well the activities of experiencing natural science subject to STEM education orientation in particular and activities. general education activities of the school.

- 3) The principal needs to know the list of the school's existing facilities and equipment to serve as a basis for checking the current status and having an appropriate preservation orientation. In addition, teachers and students need to have a sense of responsibility in preserving school property; maintaining facilities, equipment, and teaching aids; bringing into play the usefulness of each type of equipment, and using the correct functions and operation to prolong the life of equipment and teaching aids.
- 4) Principals need to understand the needs of teachers to use facilities to plan and organize the implementation of supplementing the missing facilities, suitable to the financial conditions of the school and practical to contribute. on the quality of natural science experiences in the direction of STEM education. On the other hand, the principal can promote the creativity and dynamism of teachers and students through the design and manufacture of do-it-yourself teaching aids and equipment; serving the process of experiencing natural Science subject to STEM education.

5. Conclusion

Based on the proposed model, the principal needs to have a long-term, medium-term, and short-term plan in forecasting the situation and developing a plan to develop facilities to support educational activities, educational activities, and activities. STEM education-oriented experience in Natural Science. Besides advising and proposing to superiors, the principal should promote the role of educational socialization; encourage and encourage teachers, staff, and students to have the spirit of public protection, and use economically all available means, equipment, and teaching aids. The principal regularly checks the expired facilities, liquidates, and promptly replenishes essential facilities for students to practice, experience, experiment, and test models. Thus, the proposed physical infrastructure development model has practical significance in supporting STEM experiences in Natural Science in schools in Vietnam.

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