MINISTRY OF EDUCATION AND TRAINING
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ORGANAZING STEM EDUCATION ORIENTED SCIENTIFIC DISCOVERY ACTIVITY FOR 5-6 YEAR OLD PRESCHOOLERS

SUMMARY OF THE DISSERTATION

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The work was completed at **Ho Chi Minh City University of Technology and Education**

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INTRODUCTION

1. Reason for choosing the topic

Scientific discovery activity of 5-6-year-old preschoolers take a great and significance role with children's cognitive development and 21st century competencies, preparing children to enter primary school. However, in fact, the process of organizing scientific discovery activities for 5-6 year old preschoolers in kindergarten in Ho Chi Minh City has not really developed their compentencies. Organizing STEM education oriented scientific discovery activities (OSEOSDA) for preschoolers is considered one of the innovative approaches over the world.

In early childhood education, the content of scientific discovery activities contains content of exploring technology, knowledge and skills associated with practice, so that it will enhance the experience and practice for children, that is convenient for the implementation of STEM education to develop children's compentencies. Therefore, OSEOSDA for preschoolers that they can learn both integrated scientific knowledge from the fields of science, engineering, technology and mathematics and applying this knowledge in real (Ardianto & at all, 2019).

Currently, in Vietnam, there have been a number of studies on organizing scientific discovery activities for preschoolers, however, no large-scale studies have been conducted on OSEOSDA for preschoolers. Organizing STEM education oriented scientific discovery activities is an essential issue to be studied to help teachers' applying this process their teaching for 5-6-year-old preschoolers effectively. That is the reason why the author chose to implement the dissertation " Organizing STEM education oriented scientific discovery activities for 5 – 6 year old preschoolers".

2. **Objectives of the study:** Propose the process of organizing STEM education oriented scientific discovery activities (OSEOSDA) for 5-6-year-old preschoolers in kindergartens in Ho Chi Minh City in order to contribute to the development of children's scientific discovery competency.

3. **Objects and research subjects**

Research object: : STEM education oriented scientific exploration activities for 5 – 6 year old preschoolers.

Research subjects*:* The relationship between scientific discovery content and stem education topics.

4. Research hypothesis

If OSEOSDA for 5-6-year-old preschoolers follows the four-stage process: (1) selecting topics according to the orientation of STEM education, (2) building a STEM education oriented environment, (3) implementing the process according to the three learning phases (discovery, find out, design), (4) evaluating and adjusting the STEM education-oriented process, it will form and develop the scientific discovery competency of preschoolers.

5. **Research mission**

- Study the theoretical framework of OSEOSDA for 5-6-year-old preschoolers
- Assessing the current status of OSEOSDA for 5-6-year-old preschoolers in kindergartens in Ho Chi Minh City.
- Building the process of OSEOSDA for 5-6-year-old preschoolers.
- Pedagogical experimentation proves the effectiveness of the process of OSEOSDA for 5-6-year-old preschoolers in kindergartens in Ho Chi Minh City.

6. Limiting the scope of research

Limited time: The curent status survey: Semester 1 of the school year 2021-2022 (starting from September 2021); Experiment: 18 weeks of semester 1 of the school year 2022-2023.

Area limitations**:** Conducting a survey on the current status of a total of 27 kindergartens (of which 17 public kindergartens and 10 non-public kindergartens) in the central, new urban and suburban areas of 22 districts and cities in Ho Chi Minh City. Experimental implementation at 2 schools: TT kindergarten (Binh Tan District) and VA kindergarten (District 10) in Ho Chi Minh City.

7.**Research methods:** research documents, obbservation, questionnaire surveys, in-depth interviews, research educational products, experiments, data processing.

9. Contribution of the dissertation

- *Theoretically: 1/*The thesis has contributed to clarifying some basic concepts: scientific discovery activities, scientific discovery competency, STEM education orient, organizing of STEM education-oriented scientific discovery activities for 5 – 6 year-old preschooler. 2/The thesis proposes

the process of OSEOSDA for5 – 6 year-old preschooler, including 4 stages with 3 learning phases (discovery, find out, design) and can be used in practice.

- *On the practical side*: 1/Surveying the current status of the process of OSEOSDA for 5 – 6 year-old preschooler in 27 kindergartens in Ho Chi Minh City: advantages and limitations. 2/ From the theoretical and practical basis, the illustrative design applies the process of OSEOSDA for 5 – 6 year-old preschooler with two topics: Animal Hospital, Baby Fire Safety and Rescue Training Center, , which can be used as a reference for teachers.

10. Structures of the dissertation

In addition to the introduction, conclusions, recommendations and references, the dissertation has 5 chapters.

CHAPTER 1
LITERATURE REVIEW OF RESEARCH WORKS RELATED TO THE DISSERTATION TOPIC

1.1. Research on organizing scientific discovery activities for preschoolers

1.1.1. Researches on scientific discovery activities for preschoolers

1.1.1.1. Concepts and objectives of scientific discovery activities for preschoolers

The nature of the scientific discovery activities is conceived by educators in the world as well as in the country as providing basic knowledge about the natural, social, and surrounding world, which are activities for children to use their senses, thinking skill, cooperation skill, and problem-solving skill to explore, discover, and investigate things and phenomena, in order to satisfy their curiosity. Children's scientific discovery activities are defined by researchers in two sides: (1) children's scientific discovery activities are aimed to help children acquire pre-scientific knowledge about things and phenomena around them; (2) Children's scientific discovery activities develop to them cognitive skills and the 21st century competencies; (3) Children's scientific discovery activities create them opportunities to promote curiosity, positive awareness and interest in the world around them.

1.1.1.2. Researches on the content of preschooler's scientific discovery activities

Researchers defined children's scientific discovery competency to their abilities and skills. Some of scientists mentioned component children's scientific discovery competency competencies to their skills; some other authors refer to the structure of scientific discovery competency that including many competency's components such as capacity in knowledge, capacity in skills, capacity in attitudes.

1.1.2. Researches on organizing scientific discovery activities for preschooler

1.1.2.1. *Research on scientific discovery teaching models*: Based on teaching theory, it is possible to mention learning theories that affect the organization of scientific discovery activities. However, it must be affirmed that there are two theories that determine the nature of the organization of teaching and learning, namely the cognitism theory of Jean Piaget and the constructism theory of Vygotsky and Bruner.

1.1.2.2. *Research on the purpose, method and environment of organizing scientific discovery activities for preschooler*: About purpose and meaning, About teaching methods, building an environment for faculty discovery activities, process of assess scientific discovery activities, factors affect organization of scientific discovery activities for preschoolers, the process of organizing scientific discovery activities.

1.2. Research on STEM education

1.2.1. About the concept of stem education

There were many different concept of STEM education by educators. Firstly, the researchers mentioned defined STEM education is the subject. Secondly, some other researcher call it is the instruction. Thirdly, the concept of STEM education is mentioned that is a field and career. In early childhood education, the concept of STEM education is sugggested to a subject that exactly is practice activities and games (Challie & Britain, 2003; Tippett & Milford, 2017; Simoncini & Lasen, 2018). The STEM education was defined intergrate two or four STEM fields together that is the most appropriate concept to the age of the young children (Campbell, Jobling & Howitt, 2018).

1.2.2. Research on the role of STEM education in early childhood education

In early childhood education, Park & Associates (2017); Simoncini & Lasen (2018) analyzed a child used positive the basis science concept, knowledge and skills for children's future career in a STEM play that take an importance role in STEM education. Author Nguyen Thanh Hai (2019) of the book named STEM/STEAM Education from hands-on experience to creative thinking promotes the

role of STEM education in early childhood education from children's experience that they learn STEM knowledge and they feel that science is so surprise, interesting, closef and easy to do. With the article Integrating STEAM education for preschoolersthrough a literary project, Van Thi Minh Tu (2020) affirmed that integrating STEM (STEAM) in early education is an advaned education trend.

1.2.3. Objectives, contents and methods of STEM education

1.2.3.1. *About the goal:* According to scientists Bybee (2013); Annetta & Minogue (2016); Nguyen Thanh Hai (2019), the goal of STEM education for young children is to develop STEM literacy suitable for children.

1.2.3.2. About content: From STEM education experience in many developed countries, there are 3 science contents including physical sciences, life sciences, earth and space sciences.

1.2.3.3. About method : Discovery-based learning includes ways of learning such as problem-based learning (Brenneman & Associates, 2019; English & Moore, 2018), discovery learning (Bruner, 2006), curiosity-based learning, experiential learning (Dewey, 1929), project-based learning (Helm & Katz, 2001; Capraro, R. M., Capraro, M.M. & Morgan, J.R., 2013; Meier & Hendel, 2019; DeGennaro, 2012; MacDonell, 2007; Wan & Associates, 2020). According to the discovery-based learning approach, many researchers applied Bybee's 5E model (Bybee & colleagues, 2006) to organize STEM education activities for preschoolers such as Charlesworth (2016); Macdonald & Rafferty (2015); Nguyen Thanh Hai (2019); Dang Ut Phuong (2021).

1.2.4. About the STEM education process

There are 2 processes of organizing STEM education activities: scientific based learning process, engineering design process. These processes approach to child-center learning with the technological tools' assistance (Annetta & Minogue, 2016).

1.3. Research on organization of stem education-oriented scientific discovery activities for preschool children

- Research on the process of organizing of STEM education-oriented scientific discovery activities
- Research on the curriculum of organizing of STEM education-oriented scientific discovery activities
- Research on the content, pedagogical method of organizing of STEM education-oriented scientific discovery activities
- Research on environment of organizing of STEM education-oriented scientific discovery activities.

1.4. Discussion and research questions

1.4.1 Discussion

Firstly, it is necessary to determine the nature, the objectives, content choice, pedagogical method and environment of organizing of STEM education-oriented scientific discovery activities suitable for children.

Secondly, STEM education is considered the current direction of education reform. STEM education in early chidlhood education is integrated education: the competency development goal, the content about physical science, life science, space science, active teaching and learning methods, informal and formal environment, scientific based learning process, engineering design process.

Thirdly, organizing of STEM education-oriented scientific discovery activities for children aged 5-6 should be approached to a micro perspective more suitable in Vietnam context.

1.4.2 . Research questions

Firstly, the basic concepts: 1/ The term scientific discovery activity is defined different ways by domestic and foreign scientists, but the concept of STEM education oriented scientific discovery activity has not been specifically conceptualized? 2/ The concept of STEM education also has different interpretations in many different contexts, so how is the orientation of STEM education in early childhood education conceived? 3/ How is preschooler's scientific discovery competency is understood to suit the characteristics of children aged 5-6 in Vietnam? 4/ No large-scale studies have been conducted on OSEOSDA for preschoolers in Vietnam. Therefore, it is necessary to develop the above concepts to supplement the theory of OSEOSDA for preschoolers.

Secondly, there is no specific theoretical framework to guide teachers on the OSEOSDA for 5-6-year-old preschoolers in kindergartens in Vietnam, so this theoretical framework should be developed.

Thirdly,it is nessesary to build the the appropriate process of OSEOSDA for 5-6-year-old preschoolers to aim to help teachers know how to organize to develop children compentence.

CONCLUSION OF CHAPTER 1

There were many perspectives and different aspects in research works on organizing STEM education oriented scientific discovery activities:

Firstly, the scientific discovery activities is conceptualized the process that a child has awareness about things and phenomena around him; the science content focuses on physical science, life science and earth and space science; scientific discovery activities help children develop thinking; children's scientific discovery competnecy is their ability to perform something. Researchers showed that organizing scientific discovery activities is approached the constructism theory; goal, teaching methods, environment is built positively.

Secondly, STEM education was studies on the concept, characteristics, objectives, content, process of organizing STEM educational activities for young children (science process and engineering design process).

Thirdly, the organizing STEM education oriented scientific discovery activities for preschoolers includes the process, programs, objectives, contents, methods, educational environment. Foreign and domestic research works on this organizing was studied on STEM plan, STEM plays, science experiments, experiential activities associated with the STEM fields in the internal and external classroom environment.

Chapter 2

THEORETICAL FRAMEWORK OF ORGANIZING OF STEM EDUCATION-ORIENTED SCIENTIFIC DISCOVERY ACTIVITIES FOR 5-6 YEAR OLD PRESCHOOLERS

2.1. Basic concepts

2.1.1. Scientific discovery activities

2.1.1.1.Scientific discovery: Scientific discovery of preschoolers is conceptualized considering and understanding the surrounding objects and phenomena, recognizing simple relationships between objects and phenomena with simple observation, memorization, classification and problem-solving skills to satisfy children's curiosity, curiosity and interest in the world around them, thereby children acquire new scientific knowledge and skills and scientific attitudes.

2.1.1.2.Scientific discovery activities: are the process a child observing, exploring, classifing, problem solving about the surrounding objects and phenomena, after that he is awareness new scientific knowledge of objects and phenomena, and he also recognizes the simple relationship of them things, to satisfy his curiosity, curiosity and interest in the world, thereby helping the child acquire new scientific knowledge and skills and scientific attitudes.

2.1.2. A child's scientific discovery competency (SDC): is the ability a child observing, exploring, classifing, problem solving about the surrounding objects and phenomena, recognizing simple relationships of things and phenomena and using his understanding of the object in different ways to satisfy the child's curiosity, curiosity and interest in the world, thereby helping the child acquire new scientific knowledge and skills and scientific attitudes.

2.1.3. STEM oriented education for children

2.1.3.1. *STEM* is an acronym for science, technology, engineering, mathematics.

2.1.3.2. *STEM education*: combines the science field with some or all fields of engineering, technology, mathematics into a lesson based on the connection between the themes and reality.

2.1.3.3. *STEM oriented education* is understood as the orientation of teachers to carry out an educational activity that combines the science field with some or all fields of engineering, technology and mathematics into a lesson based on the connection between the theme and reality that allows children to master in the learning process.

2.1.4. STEM education oriented scientific discovery activities (SEOSDA): are educational activities that combine the field of science with some or all fields of engineering, technology and mathematics into a lesson based on the connection between the theme and reality in the form of experience and practice, allowing a child observing, exploring, classifing, problem solving about the surrounding objects and phenomena, recognizing simple relationships of things and phenomena and using his understanding of the object in different ways to satisfy the child's curiosity, interest and

exciting about the surrounding world, thereby helping the child acquire new scientific knowledge and skills and scientific attitudes.

2.1.5. Organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers

2.1.5.1. Organizing: is a specific operation of the subject to conduct an activity in a certain manner and sequence in order to achieve the best effect.

2.1.5.2. 5-6 year old preschoolers: are children aged 5-6 who participate in the implementation of the preschool education program at the kindergarten.

2.1.5.3. Organizing STEM education-oriented scientific discovery activities for 5-6 year old preschoolers: is a process which teachers guide the integration and interlocking of educational activities that combine the field of science with some or all fields of engineering, technology and mathematics into a lesson based on the connection between the theme and reality in the form of experience and practice, allowing a child observing, exploring, classifing, problem solving about the surrounding objects and phenomena, recognizing simple relationships of things and phenomena and using his understanding of the object in different ways to satisfy the child's curiosity, interest and exciting about the surrounding world, thereby helping the child acquire new scientific knowledge and skills and scientific attitudes.

2.2. Framework of organizing scientific discovery activities for 5-6 year-old preschoolers

2.2.1. Cognitive characteristics of 5-6 year-old preschoolers

Children aged 5 - 6 have the ability to focus, pay attention longer, more sustainably, their memory is more intentional, so their ability to discover objects and phenomena is also better. At the age of 5 – 6 years, a new type of visual thinking appeared - schematic visual thinking and the elements of logical thinking (Nguyen Anh Tuyet et al., 2019). Intellectual activities such as observation, memory, thinking, reach a certain level to be able to acquire scientific knowledge easily, although it is not real scientific knowledge, but pre-scientific knowledge.

2.2.2. Elements of scientific discovery activities for 5-6 year-old preschoolers

2.2.2.1. Objectives of organizing scientific discovery activities for 5-6 year-old preschoolers: According to author Hoang Thi Phuong (2020b), the goals include:+ Providing children with the necessary simple and accurate knowledge system about near and familiar objects and phenomena around children; + Forming and developing in children the necessary cognitive capacities and social skills to help children detect problems, accumulate knowledge and solve simple situations occurring in life; + Educating the right attitude to the surrounding nature.

2.2.2.2. Contents of scientific discovery activities for 5-6 year-old preschoolers: The science contents in early childhood education programs in countries are implemented in three basic fields as physical science, life science, earth and space science (NRC, 2012, p.84; Moomaw, 2013; Butzow, C.M. & Butzow, J.M., 2000; Martin & Associates, 2014; Brunton & Thornton, 2014; Krogh & Morehouse, 2014; Hoang Thi Phuong, 2020b).

2.2.2.3. Methods of organizing scientific discovery activities for 5-6 year-old preschoolers: According to Nguyễn Thị Hòa (2019), Hoàng Thị Phương (2020), the method of organizing scientific discovery activities for preschoolers includes two groups of methods: Based on the source of information for children, there are three groups of methods to help children explore science: Group of visual methods (observation, use of visual materials), group of verbal methods (conversation, conversation, use of poetry, stories, puzzles); group of practical methods, experiences (experiments, games, exercises, creating educational situations. Based on the characteristics of children's or teachers' activities, the classification of method includes direct education impact method and indirect education impact method.

2.2.2.4. The form of organizing scientific discovery activities for 5-6 year-old preschoolers: To achieve the objectives and contents, organizing scientific discovery activities for 5-6 year old preschoolers in kindergartens is implemented through the following forms: Firstly, according to scale, including three forms of individuals, small groups and large groups. Secondly, according to the traditional form, there are teaching inside the classroom or outdoors. Thirdly, according to activities of children including learning activities, playing activities, sightseeing activities, labor activities and daily activities ((Hoàng Thị Phương, 2020b; Nguyen Thi Hoa, 2019).

2.2.2.5. Means of application in organizing scientific discovery activities for 5-6 year-old preschoolers: Some means used in the kindergarten: Using elements of the natural environment, using

objects, toys, artistic means. Each means has certain advantages in scientific discovery activities, so it is necessary to coordinate using means suitable for the purpose, content of organizing scientific discovery activities and age characteristics.

2.2.2.6. Environment of organizing scientific discovery activities for 5-6-year-old preschoolers: it is the physical environment (different playgrounds, supplies, toys in the classroom and outside the school yard) and the social environment (the atmosphere in the classroom)

2.2.2.7. Evaluating the organizing of scientific discovery activities for 5-6-year-old preschoolers: based on the objectives, contents, criteria and rating scales, evaluation methods and data collection methods.

2.3. Theory framework of on organization of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers

***2.3.1. The importance of organizing STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers*:** organizing STEM education-oriented scientific discovery activities helps children form and develop their ability to solve problems, cooperate, communicate, and work in groups. organizing STEM education-oriented scientific discovery activities helps children be excited, active and active in activities. (Katz, 2010; Chesloff, 2013; Campbell & Associates, 2018; Nguyen Thanh Hai, 2019; Hoang Thi Phuong, 2020).

2.3.2. STEM education for preschoolers

2.3.2.1. STEM education-oriented early childhood education: child-centered education, integrated education, competency development education

2.3.2.2. Characteristics of STEM education for preschoolers

- Integrative STEM education (Moomaw, 2013).
- STEM education is practical, experiential, problem-solving.
- STEM education aims to develop skills of the 21st century for children
- Technology-connected STEM education
- STEM education fosters interest in STEM careers

2.3.2.3. Objectives of STEM education for preschoolers: Developing specific competencies in integrated activities in the STEM fields for children aged 5-6; developing 4Cs competencies in the of the 21st century competencies; Cultivating exciting and interest in STEM careers.

2.3.2.4. STEM education content for preschoolers: Science: The science element describes the skills that children use to learn and acquire knowledge about the sciences (Children's home society of California, 2016). Technology: Cohen & Waite-Stupiansky (2020) use a lowercase “t” and a capital “T” to refer to technology factors for children aged 5-6:1/ t = learning how to use technology (Children choose and experience technology socially); 2/ t = learning with technology (Children use technology as a tool to learn about STEM fields); 3/ T = learning about technology (Children are creators and creators of media). Engineering: Engineering is both the design and manufacture of products created by children and a problem-solving process. Engineering uses knowledge of science, mathematics and technological tools (Honey et al., 2014). Mathematic Children use units of measurement, numbers, and charts to solve tasks and problems of science (Children's home society of California, 2016).

2.3.3. Characteristics of organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers

2.3.3.1. Organizing of STEM education-oriented scientific discovery activities for preschoolers is the process of organizing theme integrated educational activities.

2.3.3.2. Organizing of STEM education-oriented scientific discovery activities for preschoolers exploit children's experiences in practical and experiential activities.

2.3.3.3. Organizing of STEM education-oriented scientific discovery activities for preschoolers focuses on problems solve activities system and relate to the reality of children's lives

2.3.3.4. Organizing of STEM education-oriented scientific discovery activities for preschoolers focuses on the interaction between teachers, children, and environment:

These characteristics are shown flexibly and intertwined in STEM education-oriented scientific contracts. Maybe 3-4 features are shown in one activity, there are also activities with only 1-2 features shown.

2.3.4. Element of organizing STEM education-oriented scientific discovery activity for 5-6 year-old preschoolers

2.3.4.1. Objectives of organizing STEM education-oriented scientific discovery activity for 5-6 year-old preschoolers: Forming the competency to consider and exploring the characteristics of things and phenomena; forming the competency competency to recognize simple relationships of things and phenomena and solve simple problems; forming the competency to demonstrate understanding of objects in different ways.

2.3.4.2. Content of organizing STEM education-oriented scientific discovery activity for 5-6 year-old preschoolers: The content of life science includes activities for children to learn about some parts of the human body, the animal world, the plant world, some natural phenomena, some professions in society. Organizing content of the physical plan includes organizing for children to learn about objects. Organizing content of earth and space science including agriculture for children to learn about infertility, planet, earth.

2.3.4.3. Methods of organizing STEM education-oriented scientific discovery activity for 5-6 year-old preschoolers: Method must be suitable for the level of development of the child, oriented to the " Zone of Proximal Development" (Martinez, 2017; Çetin, Bilican, & Ücgul, 2020; Truong Thi Xuan Hue, 2014; Nguyen Thi Hoa, 2019), towards the interest, active participation and self-reliance of children in the activities. Teachers should combine many different teaching methods in the process of organizing activities, each method has a certain advantage of helping children in the learning process: observation method, conversational method, experimental method, using game method, project based teaching method, problem-solving method, exploratory teaching method, experiential learning method.

2.3.4.4. Form of organizing STEM education-oriented scientific discovery activities for for 5-6 year-old preschoolers:The organzing is organized in diverse forms: formal learning forms including school activities (school hours), play activities (in the corners), outdoor activities; informal learning forms including festivals, sightseeing activities; home learning forms.

2.3.4.5. Means used in the organizing STEM education-oriented scientific discovery activities for for 5-6 year-old preschoolers: organizing STEM education-oriented scientific discovery activities for for 5-6 year-old preschoolers should be equipped with means, tools and materials including: Real objects, bulk materials, pictures, models, movies, diagrams, experimental tools, measurement tools, discovery tools, science books, computers, interactive tablets, tablets, electronic software including powerpoint, liveworksheet, quizzi, google assistant applications.

2.3.4.6. Environment for organizing STEM education-oriented scientific discovery activities for for 5-6 year-old preschoolers:The material environment in the organizing STEM education-oriented scientific discovery activities for for 5-6 year-old preschoolers is: STEM classrooms, visual facilities, laboratory equipment and learning materials, loose parts suitable for 5-6 year-old preschoolers (Wahyuningsih & colleagues, 2020). STEM classrooms are classrooms equipped with teaching equipment system, marrkerspace for designing, experiment, tinkering, creating, testing...

2.3.4.7. Evaluating the organizing of STEM education-oriented scientific discovery activities for 5-6 years old preschoolers: According to Campbell, Jobling and Howitt (2018), evaluating STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers through the assessment of children's learning outcomes with three forms: diagnostic assessment, formative assessment and summative assessment.

2.3.5. Process of organizing STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers

2.3.5.1. Knowledge acquisition process of 5-6 year-old preschoolers

The process of organizing scientific discovery activities takes place according to the stages of the process of acquiring children's knowledge: (1) surveys, (2) concept formation, (3) applications; thereby taking place from determining the title of the topic → determining the purpose → preparing → to learn how to proceed (Hoang Thi Phuong, 2020b).

2.3.5.2. Some processes for organizing STEM education-oriented scientific discovery activities for preschoolers

According to Dang Ut Phuong (202), the structure of organizing STEM education-oriented scientific discovery activitie is designed by one or two or both scientific discovery learning process (Harlen & Qualter, 2004; van Drie & van Boxtelc, 2007; Brunton & Thornton; 2010; Cohen & Waite-Stupiansky, 2020; Hong & associates, 2020); or engineering design process(Bagiati & associates, 2010; Contant & associates, 2010; Honey & associates, 2014; Stone-MacDonald & associates, 2015;

Jolly, 2017; English & Moore, 2018; Cohen & Waite-Stupiansky, 2020, Chu Thi Hong Nhung & associates, 2021). Thus, the organizing STEM education-oriented scientific discovery activities for preschoolers includes both tasks: The first task of science discovering and finding out a scientific knowledge; The second task apply scientific knowledge to discover and invent a simple product by children's abilities. Therefore, ensuring the optimal for children's learning should be based on these two processes, the implementation phase of the STEM education-oriented education process for 5-6 year-old preschoolers is proposed by the author: Phase 1 - Discovery based on the 4-step discovery spiral process of Brunton and Thornton (2010) promotes children's active discovery; Phase 2 – Find out based on the 5-step process of Contant & associates (2018) Teachers create opportunities for children to organize, organize data and interpret discovered data, helping to discover scientific concepts; Phase 3 – Engineering design: The 4-step EDP process of Stone-MacDonald & associates (2015, p.12) gives children the opportunity to both scientific discovery and practice using scientific knowledge to create products.

2.3.6. Affecting of factors to the organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers

2.3.6.1. Objective factors: including the educational environment and the number of children in each classroom

2.3.6.2. Subjective factors: including the preschool teachers' organizing STEM education-oriented scientific discovery activities competency, and the individual activity factor of preschoolers.

2.4. Assess the scientific discovery competency of 5-6 year-old preschoolers

2.4.1. Scientific discovery competency structure of 5-6 year-old preschoolers

The early childhood education program defines scientific discovery competency of 5-6 year-old preschoolers, including the element of competency (Ministry of Education and Training, 2021) (Table 2.1).

Table 2.1. Competency for scientific discovery of children aged 5 - 6

Element of competency	Express
1. Competency to consider and understand the characteristics of things and phenomena	Curious to explore and discover the surrounding objects and phenomena
	Use and coordinate the senses to observe, examine and discuss things and phenomena
	Observe, compare, predict, comment and discuss when doing experiments and using simple tools
	Gather information about the subject in a variety of ways
	Classify objects according to different signs.
2. Competency to recognize simple relationships of things and phenomena and solve simple problems	Be able to comment on the simple relationship of things and phenomena.
	Solve problems simply in different ways.
3. Competency to demonstrate understanding of the subject in different ways	Comment and discuss the characteristics, differences and similarities of the observed objects.
	Demonstrate understanding of the audience across different activities

2.4.2. Mechanisms for formation and development of scientific discovery competency of 5-6-year-old preschoolers

Based on developmental psychology, according to Dinh Thi Tu & Phan Trong Ngo (2007), the mechanism of formation and development of of scientific discovery competency of 5-6-year-old preschoolers: scientific discovery competency is set up and develops through the process of understanding social experience – history turns into personal experience; scientific discovery competency is formed and developed through the process of interaction between the child and the outside world. Scientific discovery competency is formed and developed according to the mind-entry mechanism, transforming from external actions to internal actions. The effectiveness of that process is assessed based on the children's scientific discovery competency.

2.4.3. Criteria and scale of scientific discovery competency of 5-6-year-old preschoolers

2.4.3.1. Criteria for assessing the competency for scientific discovery of 5-6-year-old preschoolers

Table 2.2. Criteria for assessing the competency for scientific discovery of 5-6-year-old preschoolers

Criterion 1 Ability to consider and understand the characteristics of things and phenomena		
Indicator	Express	Level
1.1. Curious to explore and discover surrounding objects and phenomena	Children do not know how to ask questions about things and phenomena	1
	Children only know how to ask questions about the characteristics of things and phenomena	2
	Children know how to ask questions about characteristics, the process of developing things, the process of taking place	3
	Children know how to ask questions about characteristics, the process of developing things, the process of taking place and the relationship question	4
1.2. Coordinate the senses to observe, consider and discuss things and phenomena	Children use touching, seeing, smelling, hearing, and tasting actions to recognize outstanding features of things and phenomena	1
	Children use their senses to consider and recognize outstanding features of things and phenomena	2
	Children use sensory coordination to consider the characteristics of things and phenomena	3
	Children use a combination of different senses to observe, consider and discuss the characteristics of things and phenomena	4
1.3. Do experiments and use simple tools to observe, compare, predict, comment and discuss	Children do not know how to do simple experiments with the help of adults to observe and learn about the subjects	1
	Children know how to do a simple experiment with the help of adults to observe and learn about the object	2
	Children know how to do experiments and use simple tools to observe, compare, predict	3
	Children know how to do experiments and use simple tools to observe, compare, predict, comment and discuss	4
1.4. Collect information about the subject in various ways	Children do not know how to collect information about the object in a variety of ways such as looking at books, pictures, and talking about the object	1
	Children collect information about the object in different ways: see the teacher's suggestions such as looking at books, pictures, and talking about the object	2
	Children collect information about the subject in a variety of ways: looking at books, pictures, comments and, chatting.	3
	Children collect information about the subject in a variety of ways: books, pictures, videos, conversations, and discussions	4
1.5. Classify objects according to different signs.	The child does not yet know how to classify objects according to a prominent sign	1
	Children know how to classify objects according to a prominent sign	2
	Children know how to classify objects by one or two cues.	3
	Children know how to classify objects according to different signs.	4
Criterion 2 Competency to recognize simple relationships of things, phenomena and simple problem solving		
Indicator	Expressionism	Level
2.1. Recognize the simple relationship of things and phenomena.	Children do not recognize the simple relationship of familiar things and phenomena when asked	1
	Children only recognize a few simple relationships of familiar things and phenomena when asked	2
	Children can comment on some simple relationships of things and close phenomena	3
	Children can observe the simple relationship of things and phenomena	4
2.2.Simple problem solving in different ways.	Children do not know how to solve simple problems	1
	Children use a few (possibly inappropriate) ways to solve a simple problem	2
	Children use appropriate ways to solve simple problems	3
	Children know how to solve simple problems in different ways.	4
Criterion 3 Competency to demonstrate understanding of the subject in different ways		
Indicator	Expressionism	Level
3.1. Comment and discuss the characteristics, differences and similarities of the observed objects.	Children only knew how to describe 1-2 prominent signs of the subjects observed with the teacher's prompting.	1
	Children only knew how to describe the salient signs of the objects observed with the teacher's prompting	2
	Children can comment and talk about the characteristics, differences and similarities of the observed objects.	3
	Children can comment and discuss the characteristics, differences and similarities of the observed objects	4

3.2. Demonstrate understanding of the subject through different activities	Children do not yet know how to show their understanding of the object through different activities such as play contract, music, shaping...	1
	Children know how to express some observations through different activities such as playing activities, music, shaping...	2
	Children can show some understanding of the object through different activities such as playing activities, music, shaping...	3
	Children can show their understanding of the object through different activities such as playing activities, music, shaping...	4

2.4.3.2. Competency scale for 5-6 year-old preschoolers

The effectiveness of the organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers is based on the percentage of children in the class who achieve the level ofcompetency. Evaluate each child based on the performance of each criterion and indicator. Scores are calculated according to 4 specific levels: Level 1 - Attempt: 0 points; Level 2- Progress: 1 point; Level 3 - Good: 2 points; Level 4 - Very good: 3 points. On the 4-level Likert scale, the distance between levels is:$k = \frac{n-1}{n} = \frac{4-1}{4} = 0{,}75$; level 1 has an average score between 0 and 0.75 points; level 2 has an average score between 0.76 and 1.50 points; level 3 has an average score between 1.51 and 2.25 points; m stern 4 has an average score between 2.26 and 3.00 points; we have a total score of 3 criteria with 9 indicators, the lowest is 0 points and the highest is 27 points. The level of customer service competence of children aged 5 – 6 is calculated according to the total score of 9 criteria, specifically as follows:

Level 1 – Attempt (children scored from 0 to 6.75): children from none to less than 25% of the signs and indicators of the evaluation criteria

Level 2 – Progress (children score from 6.76 to 13.50 points): children have from 25% to less than 50% of the signs and indicators of the evaluation criteria

Level 3 – Good (children score from 13.51 to 20.25 points): children have from 50% to less than 75% of the signs and indicators of the evaluation criteria

Level 4 – Very good (from 20.26 to 27 points): 75% - 100% of the signs and indicators of the evaluation criteria are observed.

CONCLUSION OF CHAPTER 2

From the results of the theoretical research, can be confirmed that:

Firstly, the organizing of STEM education-oriented scientific discovery activities is considered as an education reform in the way of guiding the children in the process of learning. STEM education for children includes integration, practice, experience, practical problem solving, technology connection, nurturing STEM career interest.

Secondly, the element of a STEM education-oriented scientific discovery activities includes: 1/the goal of providing children with a system of simple knowledge in STEM fields, developing in children the scientific discovery competencies and 4Cs competencies, and forming scientific attitudes; 2/ The content is deep into the fundamental scientific knowledge, integrated with other fields of STEM to solve the discovery task.

Thirdly, organizing of STEM education-oriented scientific discovery activities is the process of child-centered education, integrated education, and the use of positive teaching methods through experiential and practical activities for children to solve practical problems in life, create conditions for children to be active in activities, explore and discover knowledge in the field of STEM on their own based on the mobilization of available experience and problem-solving, help children excited in activities, interest in STEM careers, and develop scientific discovery competency for children.

Fourthly, organizing of STEM education-oriented scientific discovery activities should be implemented according to a learning process of discovery, find out, and design to help children both conduct scientific research and engneering design and create products.

Fifthly, it is necessary to ensure the implementation conditions such as the competency of teachers to organize STEM education-oriented scientific discovery activities, preschoolers' individual activities, the educational environment and the number of children in a class. These factors have a mutual, reciprocal relationship. Therefore, it is necessary to coordinate the above factors in the process of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old children in preschools.

CHAPTER 3
CURRENT STATUS OF STEM EDUCATION-ORIENTED SCIENTIFIC DISCOVERY ACTIVITIES FOR 5-6 YEAR OLD PRESCHOOLERS AT KINDERGARTENS IN HO CHI MINH CITY

3.1. Overview of the survey

3.1.1. Survey purpose: Test current stastus of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers at kindergartens in Ho Chi Minh city.

3.1.2. Survey content: Current status of the level of scientific discovery competency of 5-6-year-old preschoolers at kindergartens; current stastus of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers at kindergartens**.**

3.1.3. Location, subjects and time of the survey

3.1.3.1. *Subjects and locations of the survey:* 319 teachers, 45 managers, 262 children aged 5-6 in 27 kindergartens distributed in 3 clusters of central urban areas, new urban areas, suburban areas in 22 districts and cities of Ho Chi Minh City

3.1.3.2. Survey period: From September of the school year 2021-2022

3.1.4. Survey methods and tools:

- *Survey method by questionnaire:* survey 45 managers, 319 teachers by opinion polls for managers, opinion polls for teachers to study the situation of teachers organizing STEM -oriented education for 5-6 year old preschoolers.
- *Interview method:* interview 7 managers, 10 teachers who are directly teaching grade 5-6-year-old to collect direct opinions of managers and teachers to supplement data for the survey method with questionnaires and observation methods.
- *Observation method:* Observe 30 scientific discovery activities of teachers in 27 schools
- *Methods of researching educational products:* studying 30 annual education plans, monthly education plans of teachers of aged 5-6 children classes, children's activity products (pictures, work results, experimental results,...); 262 personal records of 5-6 year old preschoolers in order to learn the topics in the teachers' plans, the level of development of science and technology of children.
- *Data processing methods:* Synthesis and analysis of observation and interview content. Description of the Cronbach' Alpha indices, mean, standard deviation, Anova test by mathematical formula and SPSS statistical software .

Reliability of the questionnaire scale:

Table 3.1. Confidence coefficient of each question in the manager and teacher questionaire

Questions	Content	Method	Form	Means	Effect Factors	Process	Importance, organizing level, integrating level, effectiveness of orgarnizing
Cronbach's alpha = 0.813	.688	0.861	0.858	0.879	0.936	0.835	906

3.2. The current status of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers

3.3.1. Awareness of managers and preschool teachers on the importance of organizing STEM education-oriented scientific discovery activities

The survey results show that the percentage of managers think that the organizing of STEM education-oriented scientific discovery activities is very important (Mean = 4.69), while the teachers' opinions are at an important level (Mean = 4.16 in the range of 3.41-4.20 is an important level). However, there are still 2.2% of teachers who think that it is not important (7/319), less important (36/319). Reasons: the direction document must be applied, only the application is encouraged, so many schools have not applied; the school has not trained all teachers in the school on organizing of STEM education-oriented scientific discovery activities for preschoolers; difficulties in finding references to quality, easy-to-understand and reliable organizing of STEM education-oriented scientific discovery activities; the school has not equipped qualified facilities according to STEM

education characteristics; the number of children in a large class is difficult to organize according to the interests of all children in the class.

3.3.2. Current status of defining the goal of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers***:*** Currently, Ho Chi Minh City preschool teachers has not defined the competency development goal, especially the scientific discovery compentencies, most teachers often determine that the main organizing goal is to provide knowledge for children. At the same time, the goal of developing technological competency for children has received little attention from teachers, because they do not know how to form and develop this competency for children.

3.3.3. Current status of choosing the content of organizing of STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers

The selected content has not shown diversity, creativity, traditional topics. The content has not linked and integrated of science contents with mathematic, technology and engineering; and has not connect with the current educational trend**.**

In summary, the current status of choosing the content of organizing of STEM education-oriented scientific discovery activities is still confusing the awareness and practice of choosing content with STEM education signs in the teaching and learning activities of teachers. Therefore, it is necessary to have instrution on topic selection and building a STEM education-oriented scientific discovery contents.

3.3.4. Current status of using the method of organizing STEM education-oriented scientific discovery activities for 5 - 6 year-old preschoolers: the current science scientific discovery activities in classes are still designed and organized as a traditional activities: teachers are stable, make excited, introduce lessons, organize for children to observe and learn. In tradition organizing, children usually mimic teachers' sample, teachers combine with some questions to learn the object, she close the problem and finally organize games for children to consolidate. The teaching methods used are less likely to provoke children to explore, teachers use experiential learning methods but give children less opportunities to do it themselves and be self-reliant in the experience, so that children can apply knowledge in the fields of science, mathematics, and engineering, further limiting the field of technology to solve cognitive tasks, thereby construct knowledge by themselves.

3.3.5. Current status of using the form of organizing scientific discovery activities for5 - 6 year-old preschoolers***:*** The strength is that all teachers take advantage of the forms of scientific discovery, the limit is that teachers who have not connected these forms of activities with each other to let children discover the scientific content of the topic, the connection's the advantages of this form into other forms will help children integrate the knowledge and skills of many activities in many fields into scientific discovery.

3.3.6. Current status of using the means of organizing STEM education-oriented scientific discovery activities for 5-6-year-old preschoolers in kindergartens: The strength is teachers use diversionary means. However, the limitations are that the means of discovery tools, photo books, photo albums, computers, interactive tables, tablets, electronic software have not been fully exploited by teachers.

3.3.7. Current status environment of organizing STEM education-oriented scientific discovery activities for 5-6-year-old preschoolers: Kindergartens can design and build according to STEM topics but many shools misunderstood as STEM education-oriented environment to be organized in a separate STEM room.

3.3.8. Current status of applying the process of organizing STEM education-oriented scientific discovery activities for 5-6-year-old preschoolers: Teachers organized STEM education-oriented scientific discovery activities for 5-6-year-old as same as the traditional process: teachers are stable and exciting; teachers provide scientific knowledge samples for children; teachers give children to practice, review the knowledge they have just provided; teachers let children share by repeating after the teacher concludes the knowledge. Teachers have not applied any process to organized STEM education-oriented scientific discovery activities for 5-6-year-old .

3.3.9. Current status impact level of factors to ***organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers***

The results of quantitative and qualitative surveys show that objective and subjective factors all have an impact on organizing of STEM education-oriented scientific discovery activities for 5-6 year-

old preschoolers. This result poses a requirement when organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers must pay attention to these conditions.

3.3. Current status of scientific discovery competency of 5-6-year-old preschoolers: Evaluate scientific discovery competency of children, there was no child at the level-Attempt, but the rate of level- Very good was very little (5/262), with much concentration at the level-Improve (177/262). The Mean score of children in the cluster of urban areas is level-Good; while the mean score of children in the cluster of new urban and suburban areas is the level-Improve. Children's scientific discovery competency is not significantly different in the male and female groups. Children limit element of scientific discovery competency related to using of language to comment, discuss or express their understanding.

3.4. Generall assessment

3.4.1. Strengths: Managers and teachers have standard and above-standard qualifications to receive and direct the renovation of teaching in organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers. Young children are always interested in participating in scientific discovery activities.

3.4.2. Limitations

Firstly, the objectives of OSESDA for 5-6 year-old preschoolers are aimed at developing the competency but teachers defined the objectives according to the structure of knowledge, skills, attitudes and show the incompletely structure. At the same time, the goal has not paid attention to technology factors and directed the interest of children to the profession in the field of STEM.

Secondly, the content of OSESDA for 5-6 year-old preschoolers is still discrete, not integrating science with STEM fields in knowledge system, to help children understand the topic deeply and have the right child-centered perspective; The content is sometimes not associated with reality, not from what children need, children have not been able to apply STEM knowledge to explore and solve problems; The content has not directed children to be interested in STEM careers.

Thirdly, the teaching methods of OSESSDA for 5-6 year-old preschoolers are actively methods but teachers have not yet promoted the positivity of children and created opportunities for children to integrate knowledge in different fields into the discovery of scientific knowledge.

Fourthly, the form of OSESDA for 5-6 year-old preschoolers has not connected between the forms of implementing a topic, outdoor activities yet; teachers have not taken full advantage of to let children experience.

Fifthly, teachers use a variety of teaching means in OSESDA for 5-6 year-old preschoolers, but teachers have not fully exploited many opportunities for children to experience and use modern technologies.

Sixthly, SEOSDA for 5-6 year-old preschoolers were organized as same as the traditional teacher-centered process.

Seventh, the child's SDC focuses on level 2 - Improve.

3.4.3.Causes of the limitations

STEM education is an innovative approach in organizing of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers in order to develop children's compentency and direct them to be interested in STEM careers initially. However, teachers have not been formally trained and approached.

There is a lack of reference resources in Vietnamese, teachers mainly learn online, leading to teachers not knowing how organizing of STEM education-oriented scientific discovery activities effectively.

In addition, due to the lack of facilities to create a STEM education environment, many preschools have not organize STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers yet. Two important factors for preschools to apply are STEM education content and STEM education environment.

In addition, SDC of children is not high level because children are not really free and active in the activities; their skills are not usually trained, children do not have much experience; Teachers have not take opportunity for children to comment, discuss and propose ideas to solve problems, children expressed their understanding and shared it together, so children have been habit that received results from teachers.

CONCLUSION OF CHAPTER 3

The managers and teachers are experienced, qualified, and wish approach innovate teaching methods. In fact, in teaching, teachers have organized a STEM education-oriented scientific discovery activity for 5-6-year-old preschoolers through experiential and experimental activities. However, due to the confusion between the goals and contents of STEM integration, and the lack of access to documents on the organization of STEM education-oriented scientific discovery activity, teachers do not know how to organize STEM education-oriented scientific discovery activity for5-6-year-old preschoolers.

The survey results also show that the organizing competency of teachers, individual activities of children, the educational environment and the large number of children clearly affect organizing a STEM education-oriented scientific discovery activity for 5-6-year-old preschoolers.

Based on the survey results of the above situation, it is necessary to develop the process of organizing a STEM education-oriented scientific discovery activity for 5-6-year-old preschoolers at kindergartens so that teachers can have a scientific basis, mastery, clear understanding, clarity and application in kindergartens.

CHAPTER 4
ORGANIZING STEM EDUCATION-ORIENTED SCIENTIFIC DISCOVERY ACTIVITIES FOR 5 – 6 YEAR OLD PRESCHOOLERS

4.1. Principles of building the process of organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers

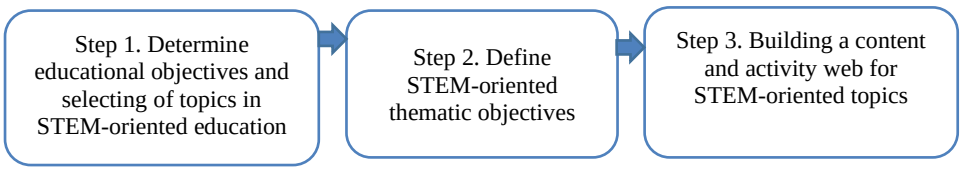
- The principle ensures that it is consistent in the educational objectives of the current early childhood education program and the STEM education objectives and contents
- Principles to ensure that scientific discovery content is associated with STEM fields
- The principle of promoting active activities for children

4.2. Process of organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers

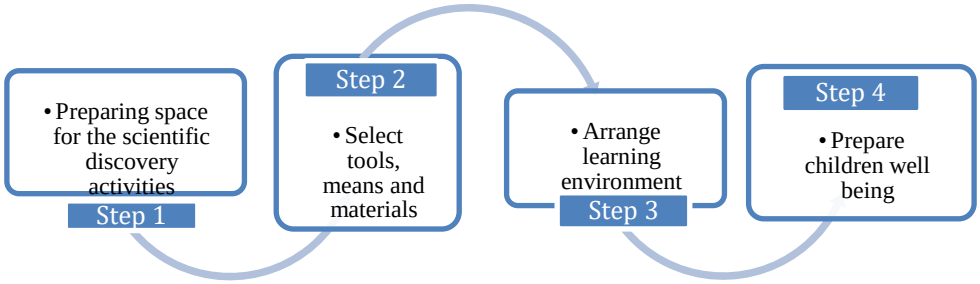
Based on the STEM education characteristics in early childhood education, the process of organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers, and from the current status of organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers in early childhood education in Vietnam, the author proposes the process of organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers including 4 stages: (1) Determining educational objectives and selecting and building topics of organizing STEM education-oriented scientific discovery activities for children, (2) Building an environment of organizing STEM education-oriented scientific discovery activities, (3) Implementing process of organizing STEM education-oriented scientific discovery activities according to three learning phases (discovery, find out and design), (4) Evaluating and adjusting of STEM education-oriented scientific discovery activities for 5-6 year old preschoolers.

4.2.1. Phase 1: Determining educational objectives, selecting and building topics for STEM education-oriented scientific discovery activities

Phase 1 is conducted in the following 3 steps:

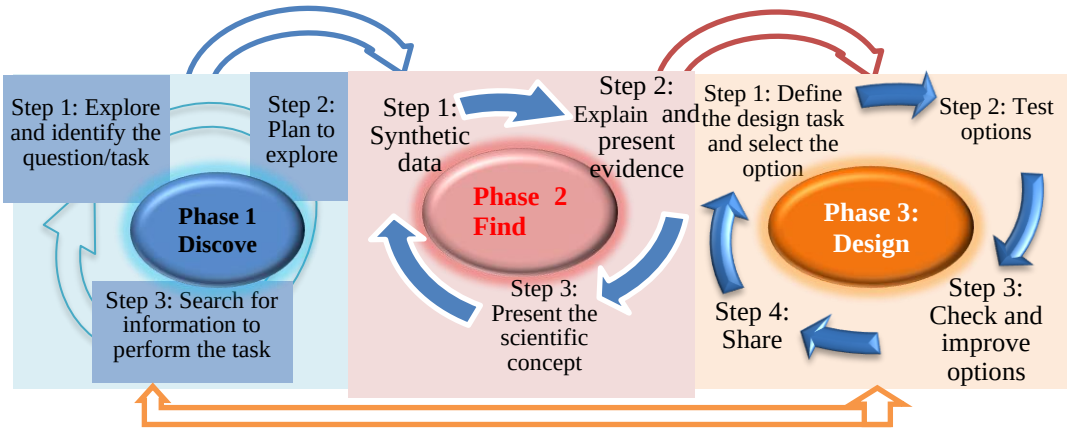


4.2.2. Phase 2: Building an environment for organizing STEM education-oriented scientific discovery activities: is conducted in 4 steps



4.2.3. Phase 3: Implementing STEM education-oriented scientific discovery activities

The implementation phase of the STEM education-oriented scientific discovery activities process is conducted according to 3 learning phases, each step in each phase has a certain meaning to help children discover and shape themselves under the teacher's leadership and organizing .



4.2.4. Phase 4: Evaluating and adjusting of STEM education-oriented scientific discovery activities for 5-6 year old preschoolers

4.3.4.1. Evaluating of STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers: Evaluating the effectiveness of the organizing STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers based on: formative assessment (everyday) and summative assessment (end of a semeter). Teachers let children comment on their result, children draw their own experience and make better improvements in the next activities.

4.3.4.2. Adjusting STEM education-oriented scientific discovery activities for 5 – 6 year old preschoolers

4.3. Illustration of STEM education-oriented scientific discovery activities for 5-6 year-old preschoolers: Subject: Baby Fire Safety and Rescue Training Center

Phase 1: Selecting and building STEM education-oriented scientific discovery activities

Step 1: Determine educational objectives and selecting of topics in STEM-oriented education

Fire Safety and rescue is a problem associated with the practice that children often encounter in daily life, which is part of the content of some familiar occupations in the Early Childhood Education Program.

- Activities in the topic are directed at the interaction of children with each other, between children and teachers.The topic directed children to care and love Firefighters.

Step 2: Define the topic objective

Table 4.1. Integrated STEM Knowledge Objectives

Science	Mathematics	Engineering	Technology
Children presented the firefighter's duties Children presented and commented that the fire	Children take measurements to know the amount of water, the level	Children apply science and mathematic	Children presented the firefighting and rescue procedures of firefighters

triangle formed the fire and the skills to prevent fire Children describe the structure and functions of fire engines	of fire is large – small, measure and count the materials to solve the problem	knowledge to create products (fire truck)	Children use tools, technological equipment, and processes from simple to complex Children describe fire escape procedures

Step 3. Building topic contents and activities

No.	Contents	Activities
1	Fire and combustion	Exploration of fire and combustion
2	Causes of fire	Problem solving situation about the cause of fire
3	Firefighters' Duties	Firefighter play
4	One day as a firefighter	Experiences as a firefighter at the Fire Safety and Rescue Police
5	Fire truck design	Practical activities for making fire truck
6	Fire escape skills	Schoolyard escape experiences

Phase 2: Building a physical environment for the topic: Step 1: Prepare the activity space; Step 2: Select tools, means and materials; Step 3: Arrange the learning environment; Step 4: Prepare your child's mind.

Phase 3: Implementing STEM education-oriented scientific discovery activities in three learning phases: The STEM education-oriented scientific discovery activities is illustrated in a sample of lesson plan: Lesson plan No. 1: Topic: Fire and Combustion

1. Objective

- Learn SDC: Children raise the benefits and harms of fire, children recognize that the fire triangle forms the burning of fire
- Problem-solving SDC: observing, asking questions, collecting information, making predictions, proposing plans, drawing comments and conclusions Children know how to handle and prevent fires
- Show SDC: Children are eager to learn, cooperate, exchange and agree with friends

2. Preparation

3. Proceeding

Phase 1: Discovery

Step 1: Explore, identify questions / tasks

Activity 1: Learn about fire

Step 2: Plan to discover: Teacher divides the children into groups, then instructs the children to discuss and assign the task of finding out the information posed by the question: "How do you find out when the fire started and when did it become a fire?", task 1 is where the fire came from; task 2 is when the fire started.

Step 3*:* Search for information to perform the task

Teachers organize for children to investigate and learn about the benefits and harms of fire. Children watch video and pictures, books about their mothers cooking by the fire, pictures of people warming up by the fire...

Question for children:

- Where did you see the fire? (children can answer to see the fire from the cooking gas stove, from lighting the birthday cake candle, from the charcoal grill, from the lighter, from burning dry leaves,etc.)
- What do you see the fire doing for us?

Fire offers us humans many benefits but can also be dangerous.

Children shared with each other to classroom spaces to gather information

Phase 2: Find out

Step 1: Search for information to perform the task

Activity 2: Fire test

Step 2: Explain and present evidence

She asked the children questions to draw conclusions:

“What do I have to do to burn the candles?” (The child can answer whether the candle is on fire if the candle's heart fails to catch the fire lit by the child)

“Why did you light the candle with a lighter but the candle went out?” (Children may respond that the candle did not burn due to the absence of air)

“What do we need for the fire to take place?”

The first fire that takes place, you need flammable substances, which are things with flammable materials such as candles, what other flammable materials do you think? (wood, paper, plastic, cloth,...). Next, there is fuel, you need heat, which is anything that catches fire and gives off heat, and when you light it, you light it from a lighter to light a candle. Finally, you need oxygen, which is the gas in the air for us to breathe, when you use the glass to face the burning yellow candle, without oxygen, the candle will go out. It is called burning matter, oxygen and heat are the burning triangle for the burning to begin.

Step 3: Present the scientific concept

Teachers let children compare and draw knowledge by describing fire when there are 3 elements of the fire triangle where fire, oxygen and heat take place.

3. Design

Step 1: Define the design task and select the option

Activity 3: Children handle situations to prevent fires

Children plan to design a fire triangle diagram: Find and select the types of diagrams shown/ Select tools to make the diagram/ Select images for the elements of the fire triangle

Step 2: Check the selected option

Teacher supports groups of children to discuss and choose of implementation options:+ Design fire triangles, vertical diagrams, horizontal diagrams, closed diagrams/+ Design diagrams on hard paper, thin paper or on the board/+ How to make diagrams: with sticker cards, drawing pictures and coloring,

The children proceeded to make a map with the option

Step 3: Check and improve

Teachers will come to each group to observe and support children to comment and compare the diagrams of the group of children. The teacher helps the child to receive the diagram that is not reasonable and instructs the child to correct the diagram or to be able to redo the new diagram.

Step 4: Share

Activity 5 Child presenter

She plays the role of a firefighter who will educate people about fire, fire triangles and how to prevent fire. She had the children discuss in groups and the group presented the group's solutions.

Phase 4: Evaluating and adjusting

Evaluating: Teachers observe each child participating in the activity according to the signs of each criterion and indicator. Teachers observe the behavior of each child and use the child assessment tool and mark the appropriate level of each sign and indicator.

Table 4.3. Evaluation sheet of sciencetific discovery competency of 5-6 year old preschoolers in the topic of Baby fire safety and rescue training center

Competency	Criteria	The child's learning task	Rating levels:
1. Competency to consider and discover the characteristics of things and phenomena	Curious to explore and explore the surrounding objects and phenomena	Children know how to ask questions about fire such as: color, heat-generating properties, benefits and harms of fire, conditions for formation of fire, connection of fire triangle into fire	***Very good:*** The child is able to ask all the questions about fire ***Good:*** Children asked all kinds of inquiry questions about fire except for connection questions ***Improve:*** The child can ask inquiry questions about color characteristics, properties of fire ***Attempt***: The child has not asked the type of inquiry questions about the

			color characteristics and properties of fire
	Coordinate the senses to observe, consider and discuss things and phenomena	Children use a combination of different senses: Sight to recognize the color of fire Touch to sense heat Smell to smell when a fire burns with different materials	***Very good:*** The child is able to coordinate all the senses to explore fire ***Good:*** Children can use 2 or more senses to explore fire ***Improve:*** Children can use 1 or more senses to explore fire ***Attempt:*** Children do not know which senses to use to explore fire
Competency to consider and understand the characteristics of things and phenomena	Do experiments and use simple tools to observe, compare, predict, comment, and discuss	Children know how to test the fire and know how to make a plan to predict the fire triangle, compare, comment and discuss the formation of fire thanks to the 3 elements of oxygen, heat and materials.	***Very good:*** Children make their own prediction diagrams and do their own fire test, compare and discuss to draw conclusions about the fire triangle ***Good:*** Children do fire experiments, know how to make predictive diagrams at the wrong time, do not know how to discuss and draw conclusions ***Improve:*** Children do fire tests with the support of teachers, know how to make incorrect prediction diagrams, do not know how to discuss ***Need to try:*** Children do fire experiments with the support of teachers but do not know how to make predictive diagrams, do not know how to discuss
Competency to consider and understand the characteristics of things and phenomena	Gather information about the subject in a variety of ways	Children gathered information about fire by looking at books, pictures, videotapes, google assistant (interactive board/computer), chatting and discussing	***Very good:*** Children gather information, talk and discuss fire on their own ***Good:*** Children are self-gathering, chatting, and not yet able to discuss fire ***Improve:*** Children collect information about fire with the help of teachers ***Need to try:*** Children do not know how to collect information about fire with the help of teachers
	Classify objects according to different signs.	Children classified incendiary and non-flammable materials according to material	***Very good:*** Children classify incendiary and non-flammable materials according to the materials ***Good:*** Children classify flammable and non-flammable materials according to 2-3 materials ***Improve:*** Children classify flammable and non-flammable materials according to 1 material ***Attempt:*** Children have not classified flammable and non-flammable materials by material
2. Competency to recognize	Be able to comment on the	Children commented on the	***Very good:*** Children commented on the 3 elements of the burning triangle

simple relationships of things and phenomena and solve simple problems	simple relationship of things and phenomena.	3 elements of the fire triangle (oxygen, heat, materials) forming the burning of fire	(oxygen, heat, materials) forming the burning of fire ***Good:*** Children commented that 2 out of 3 elements of the fire triangle (oxygen, heat, materials) form the burning of fire ***Improve***: Children commented that 1 of the 3 elements of the fire triangle (oxygen, heat, materials) form the burning of fire ***Attempt:*** Children have not yet commented on 1 of the 3 elements of the burning triangle (oxygen, heat, materials) forming the burning of fire
	Solve problems simply in different ways.	Children know how to remove one of the 3 elements of the fire triangle to prevent fire in different ways	***Very good***: Children can eliminate the 3 elements of the fire triangle (oxygen, heat, materials) that form the burning of fire in many different ways. ***Good:*** The child can eliminate the 3 elements of the fire triangle (oxygen, heat, materials) forming the fire in an appropriate way ***Improve:*** Children eliminate the 3 elements of the fire triangle (oxygen, heat, materials) that form the fire in a few ways (may not be appropriate) ***Attempt:*** The child has not or only removed the 3 elements of the fire triangle (oxygen, heat, materials) that form the fire in an inappropriate way.
3. Competency to demonstrate understanding of the subject in different ways	Comment and discuss the characteristics, differences and similarities of the observed objects.	Children know how to comment and discuss how to do a fire test, how to prevent fire. Children know how to do a fire experiment, how to prevent fire to their friends	***Very good:*** Children know how to comment and discuss how to do a fire test, how to prevent fire. Children show themselves how to do a fire experiment, how to prevent fire to friends ***Good:*** Children know how to comment and discuss how to do a fire test, how to prevent fire. Children know how to do a fire experiment, how to prevent fire to their friends is not enough ***Improve***: Thanks to the help of teachers, children can comment and discuss how to do the fire test, how to prevent the fire, children know how to present how to do the fire test, how to prevent the fire to friends ***Attempt:*** Children do not know how to comment and discuss how to do the fire test, how to prevent the fire, children have not presented how to do the fire test, how to prevent the fire to friends
3.Ability to demonstrate understanding	Demonstrate understanding of the audience	Children show an understanding of fire in social	***Very good:*** Children show an understanding of fire in social

of the subject in different ways	across different activities	emotional skills activities, shaping activities, math activities,etc.	emotional skills activities, shaping activities, math activities,etc. ***Good:*** Children show some understanding of fire in social emotional skills activities, shaping activities, math activities,etc. ***Improve:*** Children show external observation of fire in social emotional skills activities, shaping activities, math activities,etc. ***Attempt:*** Children have not shown external observation of fire in social emotional skills activities, shaping activities, math activities,etc.

* Adjustment: Not all criteria can be formed and developed in a topic of an activity. Teachers need to consider and evaluate the level of achieved and unachieved components to make adjustments in the following activities of the topic.

CONCLUSION OF CHAPTER 4

The process of OSEOSDA for 5-6 year old preschoolers is built based on the science discovery learning process of Brunton and Thornton (2010), Constant et al. (2015), the engineering design process of Stone-MacDonald et al. (2015) for 5-6 year old preschoolers. The process consists of 4 specific stages: 1) Determining educational objectives and selecting and building topics of organizing STEM education-oriented scientific discovery activities for children, (2) Building an environment of organizing STEM education-oriented scientific discovery activities, (3) Implementing process of organizing STEM education-oriented scientific discovery activities according to three learning phases (discovery, find out and design), (4) Evaluating and adjusting STEM education-oriented scientific discovery activities,.

The process is developed based on the cognitive characteristics of 5-6-year-old preschoolers, suitable for the context in Vietnam. The process is an important contribution of the thesis in terms of theory to help teachers apply the STEM education-oriented scientific discovery activity for 5-6 year old preschoolers at kindergartens. In addition, chapter 4 also applied the process of organizing STEM education-oriented scientific discovery activity for 5-6-year-old preschoolers to organize 2 topics: Aninmal Hospital, Baby Fire Safety and Rescue Training Center.

CHAPTER 5
PEDAGOGICAL EXPERIMENT ON THE PROCESS OF ORGANIZING STEM EDUCATION-ORIENTED SCIENTIFIC DISCOVERY ACTIVITIES FOR 5-6-YEAR-OLD PRESCHOOLERS

5.1. Experimental organizing

5.2.1. Purpose: Pedagogical experiment aims to determine the scientific and feasibility of the organizing STEM education-oriented scientific discovery activity for 5-6-year-old preschoolers.

5.2.2. Content, object, time

5.2.2.1. *Content and time:* experiment on two topics: Aninmal Hospital, Baby Fire Safety and Rescue Training Center.

Testing time: from February 2022 to November 2022

5.2.2.2. *Subjects:* experiment was conducted on 40 children aged 5-6 of VA kindergarten (District 10) and 66 children aged 5-6 of TT public kindergarten (Binh Tan District).

5.2.3. Empirical progress and assessment tools

5.2.3.1.Experimental process:

Phase 1: Experimental preparation: Step 1: Build an impact experimental program; Step 2: Determine assessment criteria and assessment tools; Step 3: Select the control and experimental groups; Step 3: Train teachers to participate in the process of organizing STEM education-oriented scientific discovery activity

Phase 2: Experimental implementation: Step 1: Survey the input of the control group and the experimental group with 5 measurement exercises; Step 2: Organize the implementation of activities according to the experimental plan; Step 3: Evaluate pedagogical experimentation by 5 measurement exercises.

Phase 3: Data processing of quantitative and qualitative experimental results: Step 1: Processing statistics, analyzing and describing experimental results; Step 2: Conclusion on the effectiveness of experiment through analysis and comparison before and after experiment.

5.2.4.1.Assessment tools: Exercises to measure the child's SDC before and after experiment; Evaluation sheet of the child's SDC.

5.2. Experimental Results

5.2.1. Input measurement results

Table 5.1. Results of the score of the control groups and the experimental groups

Group	Quantity	Mean	Std.
Control	53	14:07	13.93
Experiment	53	2.93	3.24

Levene test value F = 0.36>0.05 has no difference in variance between the two groups of control and experiment, value Sig.=0.55> 0.05 has no significant difference in the competency of the experiment group compared to the control group. T-test analysis: We see that the Sig. (2-tailed) = 0.817> 0.001 is greater than the significance level α = 0.05, which means that the children's ability level, the learning quality of the control and experimental groups are similar, suitable for conducting pedagogical experiments.

5.2.2. Output measurement results (after pedagogical impact)

5.2.2.1. Results of scientific discovery competency of the experimental group and the experimental group after graduation

Table 5.2. Total score of the control and experimental groups after the experiment

Results	group	Quantity	Mean	STD.	Levene's test		T-test		
					F	Significance level (Sig.)	t	Degree of freedom	Significance LevelSig. (2-tailed)
Before the test	Control	53	14:07	2.9	36	550	232	104	0.817
	experiment	53	13.93	3.2					
After the test on topic 1	Control	53	14-32	3.0	57	452	-7.231	104	0.000
	experiment	53	18:52	2.8					
After the test on topic 2	Control	53	14,85	3.1	0.01	.900	-9,489	104	0.000
	experiment	53	20.66	3.1					

Looking at Table 5.2, analysis and testing of 2 independent samples T-test after experiment: We see that the Sig. (2-tailed) = 0.000 < 0.001 is less than the significance level α = 0.05, this means that rejecting the hypothesis H_0: OSEOSDA for children in the normal way does not help the control group children to develop SDC, accepting the hypothesis H_1: OSEOSDA for children according to the proposed process, the results of children's SDC increase markedly. The Mean value between the control group reached 14.85 points is a level- Good, and the experiment group with an Mean score of 20.66 points is a level- Very good. Therefore, after the experiment, the results of the experiment group were higher than those of the control group. Comparing the previous round of experiment, after experiment, the Sig. (2-tailed) of after experiment had been different (Sig. (2-tailed) < Sig. α) while before experiment there was no difference (Sig. (2-tailed)=0.817>0.001); the Mean of the experiment group after each topic increased higher.

Results of the sciencetific discovery competency of the control group before and after the experiment

Bảng 5.3. T-test results of the control group's score before and after the experiment

Control group		Quantity	Mean	Std.	Correlations	Sig.
Pair 1	Before the experiment	53	14:07	2.9	946	0.000
	After the experiment on topic 1	53	14-30	3.0		
Pair 2	After the experiment on topic 1	53	14-30	3.0	0.978	0.000
	After the experiment on topic 2	53	14,85	3.1		

Looking at Table 5.3, through testing the sample in pairs of T-tests on SPSS, the Mean scores of the control group before and after the experiment on 2 topics did not deviate far from each other, almost equal, the standard deviation also showed that the comparison scores in pairs were all concentrated around the Mean score of 10, of the Mean score. The coefficient Sig. = 0.000 < α = 0.05, there is a statistically significant difference in the probability, we accept hypothesis H_1, reject hypothesis H_0, the process of OSEOSDA for children after the experimental process affects to change children's SDC in an increasing direction. The points before and after the test of the group were most concentrated at a level-Good, followed by the level-Improve. The score after the topic 2 test is different but not much compared to the score before and after the topic 1 test. This proves that the current organization of teachers before has not had an effective impact on children's competency. The author concludes that there is a correlation between how OSEOSDA for children affects the development of children's SDC.

Results of scientific discovery competency of the experimental group before and after the experiment

Table 5.4. Testing the results of before and after testing of the experimental group

Experimental group results	Testing an independent sample T				
	Mean	Std.	T-test	Degree of freedom	Significance level Sig. (2-tailed)
Before the test	13.9	3.2	31.2	52	0.000
After the Experiment on topic 1	18.5	2.8	46.7	52	0.000
After the Experiment on topic 2	20.6	3.1	47.1	52	0.000

The measurement results of the experimental group before and after testing in Table 5.4, the Mean score increased after each topic. Testing an independent sample T-test showed that the coefficient Sig. (2-tailed) reached 0.000< 0.05, with a significance level α=0.5%, meaning that the test came to reject H_0, accept H_1, show that this is a positive correlation, the child's competency has improved. Correlation coefficients of 0.951 and 0.969 show the reliability to confirm the correlation of the process of OSEOSDA for children related to the child's SDC. The previous test score was only concentrated in two level – Improve and Attempt, without a level- good and very good, accounting for the most proportion of the average level. The score after the test of topic 1 is only focused at the level- Improve, good and very good, there is no level-Attempt, the score after the test of topic 2 increases the number of children to reach the level-good and very good than in topic 1; There is clearly a difference in the level before and after the test. This proves that the way in which the OSEOSDA according to the proposed thesis process effectively impacts the competency of children.

5.2.3. General conclusions

Before the pedagogical experiment, the SDC of children in the control group and experiment group were equivalent. The main teaching methods are teacher-centered methods, the teaching content has not fully integrated the subject knowledge, discrete lessons, the main forms of organizing are learning activities, group and individual activities, the teaching methods are used such as observation methods, visual materials, explanation methods, and practical methods. As a result, the surveyed children have not actively explored, many children have not done it themselves, drawn their own conclusions, shared with each other in the process of participating in the experience, children do not understand the integrated relationship in the STEM careers in practice.

After the pedagogical experiment, through the OSEOSDA process, teachers are able to apply positive teaching methods into teaching such as inquiry teaching methods, problem-solving methods,

experimental methods, experiential learning methods, project teaching methods... through experiential, hands-on activities, children can investigate, explore, do, create, communicate and share ideas, creating children interested in learning, exploring, and actively learning. At the same time, the process proposed by the thesis also makes it easy for teachers to choose content that integrates a STEM topic to explore scientific knowledge to provide children and teachers with an understanding of how OSEOSDA with appropriate means and teaching aids that are not expensive, solving the previous challenges of teachers when they want OSEOSDA. At the same time, teachers understand the role of "scaffolding" of teachers, the subjective role of children in STEM education-oriented CSOs. In summary, the application of the process of organizing scientific discovery activities in the direction of STEM education for children aged 5 - 6 has been effective in developing competency for children, solving the research problems set out in the thesis.

CONCLUSION OF CHAPTER 5

The dissertation's experiment is conducted the process of OSEOSDA for 5-6-year-old children through the lesson plan of 2 topics of STEM oriented education for 5-6-year-old children.

The results of the input measurement show that the SDC of the two groups are similar and eligible to conduct impact experiments.

The outputs (after pedagogical impact) are statistically different in the intermediate scores of the two experiment and control groups with 95% reliability. The process of OSEOSDA for 5-6 year old preschoolers, ensuring reliability, being statistically significant, can expand the number of children and be applied in teaching practice. Quantitative research results have proved the empirical hypothesis, the research hypothesis of the topic both theoretically and practically. However, due to the limited experimental time, the number of experimental samples is not much, so the reliability is not high, the upcoming research direction needs to expand experimentally on a large scale.

CONCLUSION AND RECOMMENDATION

1. Conclusion

Up to now, there have been many works on the organizing of STEM oriented education activities for preschoolers, and the organizing of scientific discovery activity for preschoolers. However, these studies have not yet researched how organizing of STEM oriented education scientific discovery activity for preschoolers, according to a specific process. This is the gap in the research that has been exploited, supplemented and clarified by the author in the overview and theoretical basis of the dissertation.

The results of the theoretical framework show that: 1/ the goal develop children's competency, integrate content with the STEM fields . 2/The OSEOSDA for 5-6 year old preschoolers is the thematic, child-centered education organizing to enhance the positivity, initiative and creativity of children, create opportunities them to explore scientific knowledge and skills, apply that knowledge to solve problems in life.3/ The OSEOSDA for 5-6 year old preschoolers needs to clearly define the objectives, content, methods, forms, means, and build a STEM education-oriented educational environment to help teachers access, apply appropriately and effectively in practice.

The practical results in 27 kindergartens in Ho Chi Minh City have limitations such as: When OSEOSDA for 5-6 year old preschoolers, teachers identify the objectives and contents of integrated scientific knowledge in STEM fields, active teaching methods have not been utilized for children to apply knowledge and skills in STEM fields, there is no process to organize OSEOSDA for 5-6 year old preschoolers.

Based on the results of theoretical and practical research, it is necessary to develop the process of OSEOSDA for 5-6 year old preschoolers, so that teachers can easily apply and implement them in practice. On the basis of theory, practice and principles, the author proposes the process of OSEOSDA for 5-6 year old preschoolers with progress stage including discovery, find out and design in order to promote the initiative and creativity of children, promote the development of children'SDC.

Experimental results of OSEOSDA for 5-6 year old preschoolers process in 18 weeks on 20 children aged 5-6 at VA preschool (District 10) and 33 children aged 5-6 at TT preschool (Binh Tan District) in Ho Chi Minh City. Ho Chi Minh City in terms of statistics shows that the process has ensured reliability, is statistically significant, proves the research hypothesis of the thesis.

2. Recommended

2.1. For educational researchers

The results of the survey on the OSEOSDA for 5-6 year old preschoolers in kindergartens were conducted at 27 public and non-public kindergartens in Ho Chi Minh City. Therefore, it is necessary to conduct in other provinces and cities across the country.

This study has proved the effectiveness of the OSEOSDA for 5-6 year old preschoolers in 4 stages with 3 learning phases (Discovery, find out and design) through pedagogical experiments on 2 topics for children aged 5-6. The author hopes to continue researching and implementing the OSEOSDA process in the design of the teacher's education plan on a wider scale with a larger and more universal sample size.

It is necessary to consider expanding the research to build a STEM education-oriented thematic, design a lesson plan to apply 4 phases with 3 learning phases (Discovery, find out and design) of the process, to form a resource for teachers to use in the school year to bring the highest results in the OSEOSDA and develop to 5-6-year-old preschoolers'SDC.

2.2 For preschool teachers

From this study, it can be considered to apply this process to the OSEOSDA such as the math activity, the draw and shaping activity, the literary activity.

Teachers need to improve their own competency of OSEOSDA in annual professional training, or they can learn from their colleagues togather. Teachers need to proactively and actively foster and train their own competency in innovating the method of designing lesson plans, identifying teaching items, using positive teaching methods, using diverse forms of organization of activities, conducting assessment of children's SDC regularly, and at the same time changing their cognitive thinking about the role of supporting and helping children to create opportunities for children to demonstrate the subjective role of the process of participating in activities, actively creating knowledge for themselves.

LIST OF PUBLISHED SCIENTIFIC RESEARCH RELATED TO THE DISSERTATION

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2. Bui Thi Giang Huong &Vo Thi Ngoc Lan. 2023 Applying Stone-Macdonal's engineering design process in organizing STEM education-oriented scientific discovery activities for 5-6-year-old preschoolers. *Journal of Education, 23 (3),* 25 -30.
3. Bui Thi Giang Huong. (2022). The current status of school administrators and teachers awareness of STEM education activies at preschool level in Ho Chi Minh City. *Proceeding of 2nd Ha Noi Forum on pedagogical and education sciences. Vietnam National University Press*, Ha Noi.
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5. Bui Thi Giang Huong. (2022). Designing the process of organizing STEM education-oriented scientific games for 5-6 year-old preschoolers. *National Scientific Conference The role and trends of the field of technical pedagogy in the digital era. Ho Chi Minh city University of Technology and Education.*
6. Bui Thi Giang Huong. (2022). Measures to formulate problem-solving competency for 5-6-year-old children through scientific discovery activities. *Journal of Education and Society, Special Issue (5, period 1),* 117 – 122.
7. Bui Thi Giang Huong, Tran Hong Nhu Le. (2021). problem solving competency of 5-6-year-old preschooler in scientific discovery activities. *Science Journal of Saigon University, 78 (8),* 78-84.