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THE USE OF EXPLORATION PEDAGOGICAL TO FACILITATE EFFECTIVE TEACHING BY HANDS-ON ACTIVITY IN MATHEMATIC FOR VOCATIONAL EDUCATION

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Abstract
Teaching by hands-on activity is one of the strategies that can be implemented in teaching and learning process and is suggested to improve teaching method and students' understanding in Mathematics. This article illustrates the progress of this research in the development of validated framework. The study shows that students' understanding in Mathematics was among the primary challenge in pedagogic process in vocational education. In this case, the exploration pedagogical will be implemented to overcome these challenges. Therefore, this article proposed to find out the importance of implementation exploration pedagogical and concretize the factors of students' understanding and systematic plan of actions in producing the final research framework. Hannafin and Peck Model approach will be used in order to manage these objectives. It is expected the framework acts as an improver of the teaching by hands-on activity practices, including the possibility of gaining more advantages from the teaching by hands-on activity through correct methods and strategies.

INTRODUCTION

Malaysian education nowadays is moving forward to the 21st century learning (PAK- 21). In order to face these challenges, teaching strategies must be implemented in the different ways which align with the aim and the objective of the 21st century learning (PAK-21). One of the pedagogic process is application of teaching by hands-on activity because vocational students are visual learner where they pick to learn with graphics, images, maps and demonstrate by example to understand the content of Mathematics (Nordin & Ali, 2015). Therefore, it is indicated that teaching by hands-on activity is important in teaching Mathematics for vocational students due to its positive impact on developing the students' skills in solving the problems creatively. According to Chang et al (2015), to meet the 21st century learning challenges, hands on activity help in link the theory and practice as well as improve creativity of students in problem solving skills. However, the implementation of teaching by hands-on activity is disrupted by various challenges, such as ways to apply critical thinking in the teaching by hands-on activity (Sulaiman, 2012). Moreover, the awareness among teachers to implement this strategy also lack and requires longer time to be conducted in classroom (Clark, 2015; Costa & Domingos, 2016).

It was mentioned by Wheelahan (2010) that teaching by hands-on activity is the way vocational pedagogy is described but this strategy is effective when various pedagogies are diffused in the teaching by hands-on activity (Marley et al., 2010). The aims of this study are to develop further progress of the framework and this framework involves the application of exploration pedagogical to handle teaching by hands-on activity implemented in the teaching and learning process (Nordin & Ali, 2015). The next section discusses the importance of improving the teaching by hands-on activity strategy. Next, the key elements of the framework, which utilize the advantages of exploration pedagogical in teaching and learning process are discussed, followed by the proposed conceptual framework. The study continues with the research route and a conclusion of the study.

THE IMPORTANCE OF IMPROVING THE IMPLEMENTATION OF TEACHING BY HANDS-ON ACTIVITY

Although hands-on activity is common in Malaysia, but the implementation of this strategy is still slow and not implemented effectively. Teaching by hands-on activity is one of the teaching strategies that involves the process in gaining knowledge through experiences from the previous lesson and it is under the observation of the teacher. This strategy gives the opportunity for students to manipulate the existing object with the surrounding and make a relationship with the learning process in the classroom such as Mathematical set, using ruler, by relating to plants and shapes in Mathematics (Ekwueme et al., 2015). Teaching by hands-on activity contributes to a positive impact in the teaching and learning process. It is indicated by Wulandari et al. (2016)

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that hands-on activity is fit to increase the creativity of students in solving the problems and prompt the students to be engaged in the learning process through their previous experiences (Astawa, 2018).

Despite the benefits of teaching by hands-on activity, improvement must be done in teaching by conducting hands-on activity. Nonetheless, base on some issues on restraint of knowledge, ways of implementation and time constrain, further study is required on guiding teachers improving teaching by conducting hands-on activity. Furthermore, teaching by hands-on activity discovers the gap between the concept of knowing and the concept of application in problem solving in Mathematics by integrating the theory and practice (Yu et al., 2015). The study by Kholiq et al. (2017) indicates that the skill of problem solving can be increased by teaching by hands-on activity because Mathematics is an abstract knowledge and can be taught combining the manipulation of objects and symbols (Lydia et al., 2014). Thus, there is a significant in the scope for further study in improving the implementation of teaching by hands-on activity in the classroom.

THE MAIN COMPONENT OF THE FRAMEWORK

Three key elements are suggested in build up the framework which utilize advantageous exploration pedagogical in the teaching by hands-on activity. The elements which are critical thinking, procedural knowledge and exploration pedagogical are criticising the different ideas, understanding the concept by doing and problem solving by hands-on activity (Nurhidayati, 2017). Exploration pedagogical are based on Theory of Constructivism (TC), which support the student-centred teaching (Novianti et al., 2016). From this theory, exploration pedagogical points the student as the active explorer and teacher act as a facilitator for them (Susilawati et al., 2017). In response of these elements above from the TC, the correlated questions are addressed, and the element is integrated in the framework namely as the outcome of the exploration pedagogical. The TC questions are displayed in Table 1.

Table 1 : TC questions and main components

No	TC Question	Main Component	References
1	What to criticise?	The influence of critical thinking	(Cottrell, 2017; Suparman et al., 2018; Ulger, 2018)
2	How to understand?	The procedural knowledge	(Pirttimaa et al., 2017; Rittle-Johnson & Schneider, 2015)
3	How to solve the problem?	Appropriate exploration pedagogical	(Nuraida, 2017; Sari, 2015; Susilawati et al., 2017)

THE INFLUENCE OF CRITICAL THINKING

DEVELOPING CRITICAL THINKING

In this 21st century of learning, critical thinking is the dominant thinking skills that is an important part of learning (Suparman et al., 2018). Critical thinking is an important ability in making assumption, find out concealed values, prejudge evidence and evaluating conclusions (Myers, 2003). The skills is rooted from the process of reflective thinking while making the decision of believed act or something completed (Ennis, 2013). Moreover, critical thinking is also an important skill in fostering thinking skill of students (Hashemi, 2011). All of the critical thinking skills are developed in teaching by hands-on activity (Arends, 2012). This perception is contradict with the ideas of Cottrell (2017)who argued that there are many challenges in developing critical thinking skills such as lack of ability, personal and emotional reasons and needed more persistence in the time constrains to develop and improve critical thinking skill (Cottrell, 2017). Ulger (2018) proposed the solution overcoming these challenges by practicing students with the nonroutine problems on problem solving processes. During this process, students are easier to think creatively and critically by considering the rules which help students to gain knowledge and understand the characteristics of objects. Overall, these studies proved that the critical thinking is the part in exploration pedagogical that can be implemented in teaching by hands-on activity.

APPLICATION OF CRITICAL THINKING

Previous studies found that critical thinking can be developed by an active progressive learning approach and student-centered as students are able to create own knowledge based on the real problematic world in learning process (Hmelo-Silver, 2007). The application of problem-based in teaching process can increase the vocational students' skill in high order thinking (Suprapto et al., 2017). It is also supported by Wulandari et al. (2016) that problem solving increases students' creativity. Hands-on activity in teaching allows students to solve problems and take part in the learning process (Rillero & Camposeco, 2018). Teachers also need to change the teaching strategies from teacher-centered to student-centered by plan, and design the teaching and learning process to train students' critical thinking (Fuad et al., 2017).

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Other than that, Dewey (1938) mentioned that interactive hands-on activity in teaching encourages students to have creative solution through observation and use the principle of learning (Thuneberg et al., 2018). At the concrete operational stage, this creative solution is very crucial (Piaget, 2006). Although hands-on activity is often linked with science subject and influence on students' achievement (Caglak, 2017), while Zulnaidi and Zamri (2017) highlight that in Mathematics, procedural steps must be focused because a significant mediator between conceptual knowledge and students' achievement in Mathematics is a procedural knowledge (Zulnaidi & Zamri, 2017). For example, by using art of shape in Mathematics, students learn on how to find the volume of the object. They learn in finding the volume based on the doing activity by using ruler, calculator and the correct formula (Ekwueme et al., 2015). Nevertheless, these critical thinking could be applied by focusing on the implementation of teaching by hands-on activity. Thus, teaching by hands-on activity has become one of the platforms to improve teaching strategies in the classroom.

THE PROCEDURAL KNOWLEDGE

Procedural knowledge is a term that is considered as the knowledge of procedure. A procedure is a step, and applying sequences to achieve the goal (Rittle-Johnson & Schneider, 2015). This knowledge is the best practices because it creates a good interaction between teachers and other students (Pirttimaa et al., 2017). By using procedural knowledge, teacher will conduct the teaching by hands-on activity through strategies, skills of construction and action (Manandhar, 2018). For example, in solving the problems by hands-on activity, a sequence of action must be taken and followed by solving steps until the exact solution or goal is accomplished (Rittle-Johnson & Schneider, 2015). This is agreed by Wes Maciejewski (2016) that procedural knowledge is an appropriate procedure to provide solution to a Mathematical task. Procedural knowledge also give more advantages which can make connection with all senses and provide hands-on experience in solving problems and give better understanding of the knowledge (Pirttimaa et al., 2017). The findings show that procedural knowledge is related to each other and contain the chains of actions which can develop understanding in Mathematics (Wes Maciejewski, 2016).

APPROPRIATE EXPLORATION PEDAGOGICAL

Exploration is one of the approaches based on theory of constructivism (Novianti et al., 2016). This approach helps to identify the idea and argument through open question until students understand the knowledge and solve the problems (Nurhidayati, 2017). Pedagogy is defined as a strategy, technique and method which make the teaching and learning process (Mamat, 2017). The approaches which are used in teaching and learning process (Maaruf & Siraj, 2011; Shahaimi & Khalid, 2015), include that the teacher act as a facilitator while the students act as an active explorer in teaching and learning process (Susilawati et al., 2017). Therefore, in this article, exploration pedagogical can be concluded as the approaches and exploration method which give an opportunity explorer to understand the concept in Mathematic through the different ideas from each other based on the theory of constructivism.

In order to solve the problems in Mathematics, by combining the component of critical thinking and procedural knowledge, students will be competent to solve the problems and understand the concept in Mathematics through the exploration pedagogical process (Sari, 2015). Students learn to explore their previous knowledge and relate with the new knowledge to form an argument of different ideas (Nurhidayati, 2017) by enlisting their critical thinking during the process of understanding (Budi & Sunarno, 2018). In order to gain the knowledge, conducting activity in learning process will improve understanding among the students (Nuraida, 2017). Teaching by hands-on activity allows students to apply and follow the procedural knowledge in the teaching and learning process. Through hands-on activity, students have an opportunity to explore their understanding by employing sequence step to learn new knowledge and increase their level of memorizing (Marley et al., 2010). This is because when the brain and hands-on activity are parallel, the brain memorizes effectively.

CONCEPTUAL FRAMEWORK

The aims of this study are to develop a framework which utilizes the advantages of exploration pedagogical towards teaching by hands-on activity. This framework is produced by involving the development of critical thinking, the procedural knowledge and the relevant exploration pedagogical. Figure 1 shows the conceptual framework, in which the foundation of the study is using the framework and theory with incorporating the procedures of the model development. In Figure 1, the fundamental theory of the study is Theory of Constructivism, while the guideline framework are Critical Thinking Framework and the Procedural Knowledge Framework.

THE RESEARCH ROUTE

Hannafin and Peck Model approach was applied in this research. Pratomo and Irwan (2015) categorised the research route into three phases. Phase 1 is known as need analysis, phase 2 is known as design and phase 3 is known as development and implementation.

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Meanwhile, to identify the success of each phase, evaluation and assessment will be done in every phase by using data collection such as survey, and the results from the collected data will be used as a mold to develop a product. The process is repeated until the objective is achieved. Its means the three phases must undergo the process of evaluation and assessment to avoid any typical error (Christopher, 2016).

Phase 1: Needs Analysis

For the first phase, need analysis is used to identify the needs of exploration pedagogical in teaching by hands-on activity. The need analysis should be done in the teacher context and environment of school before proceeding to the design and implementation phase. The first phase is the critical part because it determines the construction of the framework. The learning outcome and objectives also must be analysed in this phase. All of the challenges and issue in the classroom is analysed detailed to identify the needs of exploration pedagogical in teaching and learning process. The process is continued by making an evaluation towards the outcome of the needs analysis before undergoing the second phase that is the designing phase (Hannafin & Peck, 1988).

Phase 2: Design

The design phase is used to transfer the information in the first phase in the physical form that can be used in the process of application exploration pedagogical in the teaching by hands-on activity. In this phase, analysis of the subject is applied. It is included in the content to be delivered by the teacher in the classroom. The used of exploration pedagogical in teaching by hands-on activity is analysed by conducting the analysis towards the steps in teaching process in the lesson plan. The analysis should be done on teaching aids, which are suitable to be used in the hands-on activity. After all of the analysis has been done, this phase is evaluated before continuing to the next phase of developing and implementation (Hannafin & Peck, 1988).

Phase 3: Develop and Implementation

The third phase is developing and implementing the exploration pedagogical in teaching by hands-on activity. In this phase, the delivering of the content of knowledge is very important. The students will explore and conduct the hands-on activity under the teachers' guidance to understand the concept of Mathematics. Through this phase, the teacher must ensure that the hands-on activity achieves the learning outcomes and the understanding of knowledge is occurred in two-way interaction between students and teacher, and also students with the students.

The evaluation phase refers to the evaluation process. Hannafin and Peck Model focuses on the evaluation and repetition process involved in all the three phases as mentioned above. The evaluation can be a formative and summative assessment, respectively. Formative assessment is the continuous assessment during the learning process while summative assessment is the evaluation that happened at the end of the lesson (Pratomo & Irawan, 2015).

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The use of exploration pedagogical (EP) to facilitate effective teaching by hands-on activity (THOC) in Mathematic for vocational education

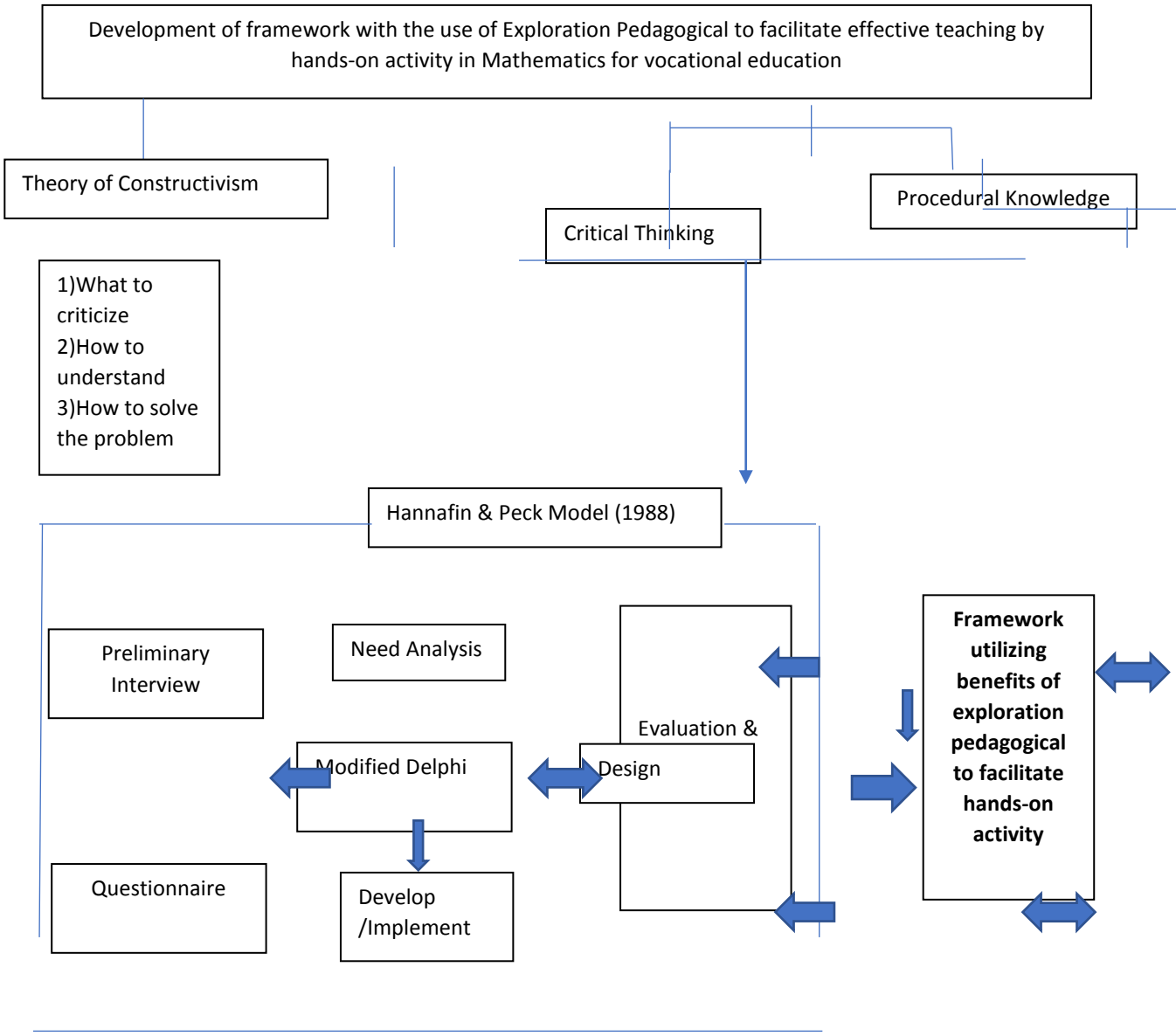

Figure 1 : The Conceptual Framework

CONCLUSION

The development of education is continuous with the growth of the country. The education level of vocational education should be enhanced since this provides opportunity to the students to further their study and involve in the field work. Therefore, an improvement in teaching strategies should be taken as it will give a good impact to make the students understand in their Mathematics learning process. The teaching by hands-on activity should implement the exploration pedagogical. For this reason, the framework will boost more techniques and methods of transfusing the concept of teaching by hands-on activity and obtain the benefits of hands-on activity through the exploration pedagogical towards the teaching strategies for vocational education.

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