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CONTENTS

Measuring Cognitive Level Using Interactive Map Among Secondary Students: A Quasi-Experimental Approach

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Abstract

Spatial thinking is essential because it encourages the human mind to visualize and stimulate cognitive thinking, thus improving higher thinking order (HOTS). Unfortunately, it was found that the geography syllabus taught in secondary school is lacking this vital element. Hence, this study aims to assess the student cognitive level using an interactive map among secondary students in Geography subject. This study was underpinned by the Social Cognitive Theory (SCT). The cognitive level was measured using Bloom Taxonomy cognitive domain from low to high order thinking skills, namely knowledge, comprehension, application and analysis. Data were collected using a one-group pretest-posttest quasi-experimental design. The interactive map has been used as an intervention for the study. Pre-test and post-test questions were distributed before and after the intervention. 31 students of Sekolah Menengah Kebangsaan Arau participated in this study. Data were analysed using a paired t-test analysis. The result reveals the significant difference between cognitive domains among students. The interactive map increases their knowledge and analysis ability among students. This study contributes to the empirical evidence to the literature of SCT in the context of spatial thinking studies among secondary students in selected geography topics.

Keywords: Spatial thinking, Bloom taxonomy, secondary students, geography, quasi-experimental

Introduction

Spatial Thinking

Spatial thinking is an approach in assessing the cognitive level, and it has been focused by several studies (Ghaffari, Jo & Currit, 2018; Utami & Zain, 2018; Verma and Estaville, 2018; Wise, 2018) due to the current advance geospatial technologies. Bednarz and Lee (2011) suggested that several elements need to be considered in developing the spatial thinking such as direction and position information, map layers and patterns, spatial relationship, three-dimensional (3D) visualization and map production. All these elements are integrated in geography study through maps, graphs, images, diagrams, models, and visualizations (Bednarz & Bednarz, 2008).

Geography and Spatial Thinking

Geography is a study of a physical characteristic of the earth, human activity, population distribution, resource, political and economic activities (Webster, 2015). Geography and spatial thinking are interrelated to make sure students understand the spatial patterns and processes in teaching and learning (Bednarz & Bednarz, 2008). In recent years, Geographical Information System (GIS) platforms are used to enhance the students' spatial thinking in both formal and informal education as well as incorporating the geospatial thinking into teacher preparation programs (Chun, 2010; Lateh & Muniandy, 2011; Lee &Bednarz, 2009; Mayalagu, Jaafar & Choy, 2018; Mustapa, Mokhtar, Wahab,

Shahidan and Arof, 2014; Webster, 2015). It is also able to increase exciting learning in the curriculum using the valuable GIS tool (Webster, 2015). Therefore, higher-order thinking skills (HOTS) as stated in bloom's taxonomy in different levels of human cognition such as synthesise, examine, interpret and assess knowledge should be evaluated to test the enhancement of skills through geospatial technologies. It is essential for geographers when dealing with a complex issue and critical analysis (Rankin, 2016).

Cognitive Level Assessment through Spatial Thinking Skill

Although it is vital to improve the spatial thinking skill by evaluating the HOTS, unfortunately, to assess the spatial thinking skill in different aspects such as spatial perception, orientation, visualization, and mental rotation, it is not easy (Charcharos, Tomai & Kokla, 2015). Charcharos, Tomai and Kokla (2015) declared that spatial thinking among young people had been neglected and various tests have been applied to evaluate the spatial thinking, and unfortunately, it is unsuccessful. Furthermore, most of the students in secondary level only study on map production and lack of skill in determination of location around the worlds (Kaya, 2018; Mustapa et al., 2014). Then, Collins (2018) suggested that geospatial technologies and traditional maps should be implemented together to develop spatial thinking skills. The question asked in this research is what types of element should be added in conventional maps to make it is more attractive and improving spatial thinking among students.

Therefore, this study focused on lower secondary students on the current geography learning assessment using an interactive map. The interactive map was made using GIS technique that includes the spatial thinking elements. Furthermore, the cognitive level of the students was determined through the use of the interactive map, namely cognitive, comprehension, application and analysis. HOTS was known to be achieved if students can acquire the analysis level in the level of the cognitive. This study is essential to develop higher-order thinking students based on their human cognitive levels. Also, this approach can help the students to solve a problem or give spatial reasoning.

Methodology

Underpinning Theory

This study is underpinned by Social Cognitive Theory (SCT) by Albert Bandura (Bandura, 2001). SCT explains the interactions of human factors based on personal factors, environment and continuous behaviour in a learning setting. In other words, SCT claims that people learn based on their experiences, the observation of others, as well as the results of those actions. For this study, SCT explains students used their own experience to use the traditional map and interaction maps in their learning. The interactive maps offer a different view of presenting the content, hence giving a new experience to them.

Context of the Study

The objective of this is to access whether the use of the interactive map increases the cognitive level among geography students. The cognitive level was tested using test scores based on pre-test and post-test questions. The levels of the cognitive level are classified as knowledge, comprehension, application and analysis developed based on the standard school level cognitive levels as approved by the geography teacher in the respected school. The tests scores were compared at the end of the sessions.

Participants of this study

The selection of study area is Sekolah Menengah Kebangsaan Arau, placed at Jalan Besar Arau, Perlis. The area was chosen due to the easy access that closes to the Universiti Teknologi MARA, Perlis branch. Furthermore, the geography teacher of SMK Arau was able to give full commitment to assist the tests among the students.

Development of Interactive Map

An interactive map was enhanced from the existing geography textbook and was developed using the Geographical Information System (GIS) technique. The GIS platform is used to integrate all spatial layers such as rainfall, country boundary, temperature and climate, and finally, the map was generated

as output in WGS84. All the spatial elements, such as symbol, colour, density, and pattern, were adopted in the proposed interactive map.

Design and Validity

This study employed a quasi-experimental, non-randomized, two groups with pre-test and post-test design. Firstly, students attended geography learning using traditional maps. The cognitive levels were controlled using the test specification table. The validity issues have been carefully observed and employed based on a suggestion made by Creswell and Guetterman (2019) on participation, procedure and treatment.

Methods of data analysis

Data were analysed using Statistical Package for the Social Sciences (SPSS) using a paired t-test.

Results

To test the hypotheses of this study, we analysed the data using a paired t-test. The result indicates that there is a significant difference between pre-test and post-test for assessment ($t = 2.879$, $p < 0.05$) where the mean value for post-test results is higher than the mean value for pre-test results. The result also shows a significant difference for knowledge ($t = 7.448$, $p < 0.001$) and analysis ($t = 3.950$, $p < 0.001$) cognitive level among students where the mean value for post-test are higher as compared to the mean value for the pre-test. However, this study does not provide enough evidence to support the significant difference between pre-test and post-test for comprehension and application level.

Discussion, conclusion, and recommendations

This study explains the theory of SCT in by using spatial thinking through the interactive map in the geography subject among lower secondary students. Students learned through their own experience with the interactive map. From there, students interacted with the instructors who facilitated them to use the map. At the same time, students discussed among their friends in class to improve their understanding. The learning experience with the interactive map triggered the interactions with students as the individuals, the different learning environment and the learning continues with the discussion with their peers.

The results of this study suggested that the interaction map able to help to promote their cognitive levels. The significant difference in overall results and the cognitive knowledge level show that this map improves the learning ability among students. Moreover, a significant difference reported for the analysis level, indicating that students achieve the HOTS through the map. The insignificant results for comprehension and application suggested the improvement need to be made when designing the assessments. For future studies, we recommend that the questions used a test specifications table to control the development of the assessments, but the similarity of the questions needs to be reviewed. Overall, we can conclude that spatial thinking can improve the cognitive level among students in the context of learning geography in secondary schools. More studies need to be conducted to explore how this interactive map is better used to support the relevant topics in the subject.

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