Introduction

People explore the world through visions. In daily life, people need the ability to identify objects or positions in way-finding. They also make decisions by judging information from the outside world infused with figures or images, such as driving transport vehicles or designing one. Spatial ability is even highly related to scientific learning interests and abilities. According to current researches, the development of spatial ability has a positive correlation with individuals' visual thinking experience (Lee & Wong, 2014; Lin & Chen, 2016). The richer of the individuals' visual thinking experience, the stronger the spatial inference ability they have (McKim, 1972). Various examples from the real world, such as architects, sculptors, and artists, have outstanding spatial ability (Gardner, 1983; Sanchez & Wiley, 2014). In addition, spatial ability involves the representation, storage, and processing of knowledge of the spatial properties of objects, such as location, movement, extent, shape and connectivity. The spatial ability highlights the importance in laparoscopic surgery (Armstrong, de Ribaupierre, & Eagleson, 2014; Tendick et al., 2000), which is consistent with the view that the ability to mentally manipulate an object in three dimensions is highly related to the initial acquisition of surgical technical skill (Brandt & Davies, 2006; Lufler, Zumwalt, Romney, & Hoagland, 2012). Thus, one may be inspired to learn that this ability could be improved through training and learning. This study aims to design and develop a digital game-based training system, as supported by the relevant literature review and the new development of technology, to enhance one's spatial ability. Moreover, the study is also drawn to further explore and discuss on the subject of whether the engagement in the digital game-based spatial ability training system could elevate students' interests in the field of biomedicine.

Related Work of Spatial Ability

Studies showed that past experiences affected individual's spatial ability. Planning and strategic design improved individual's spatial ability (Cohen, 1985; Holley & Dansereau, 1984; Zavotka, 1985). Researchers also proposed that three-dimensional and two-dimensional computer simulation graphics are effective in improving learners' thinking and spatial ability (Lee & Wong, 2014; Jansen, Lange, & Heil, 2011;

McCormack, 1988; Urhahne, Nick, & Schanze, 2009). Recent researches showed that digital games could be applied as a teaching tool in classrooms (David, 2012; Lin & Chen, 2016; Rosas et al., 2003; Yang & Chen, 2010). Feng, Spence, and Pratt (2007) believed that spatial attentional capacity and a higher-level spatial function may be improved simultaneously by appropriate training. In addition, digital games may create a new learning culture that better corresponds with students' habits and interests (Prensky & Prensky, 2007).

Definition and Types of Spatial Ability

Many scholars believed that the theory of space intelligence plays an important role in the field of human intelligence (Lee & Wong, 2014). Some interpreted the term of space intelligence as a sense of space. Since its definition still remained uncertain, the term of spatial ability would be applied in this study instead. Thurstone put emphasis on the presumption that space is an ability to remember a spatial image in one individual's mind in order to reverse, transfer, or rotate the image to a new target location, which enables researchers to conduct and study (Linn & Petersen, 1985; Jiang, 1995). Gardner (1983) believed that the core of spatial ability is based on the accurate perception of the world, as well as the original perception with conversion and modification of one individual to facilitate and rebuild the concept of visual experience (Clements & Nastasi, 1992; Quaiser-Pohl, Geiser, & Lehmann, 2006; Wu, 2004). Additionally, Linn and Petersen (1985) highlighted the presumption that spatial ability is one perception of space, characterization, and ability of management, which includes the following elements, spatial visualization, spatial orientation, and mental rotation (see Figure 1 and Figure 2). This is not only a type of conversion in ability oriented, but it is also known as a recall of non-verbal information skill. Although the observations of spatial ability are slightly different as made and defined by scholars, its concept is roughly the same, including the findings of rotation, perspective, and transformation in mind.

This study indicates four essential elements of spatial ability as the following:

1. Spatial mental rotation: When an object's position changes, students are still able to identify its characteristics, such as the DNA of bacteria, through mental manipulation.

2. Spatial conversion: Students can convert 2D to 3D images via mental manipulation. Even though 3D image technology is better improved, it is still dependent upon the observers' mental ability to do spatial conversion in general.