International Journal of Multimedia and Ubiquitous Engineering
Vol.10, No.11 (2015), pp.205-212
http://dx.doi.org/10.14257/ijmue.2015.10.11.20

The Effect of Space Perception Ability by Using Smartphone Applications on Elementary School Students in Republic of Korea

Hyoungbum Kim

[1#], Chungdae-ro, Seowon-Gu, Department of Earth Science Education, Chungbuk National University, Cheongju, Chungbuk, Republic of Korea

Abstract

With the recent advancements and developments of various media applying new computing technology, smartphone application contents are recognized as new educational media that can develop learners' space perception ability. Spatial perception ability (SPA) is a popular research subject that is being actively being studied among earth science education scholars using augmented reality. The purpose of this study is to investigate how an astronomy education program using smartphone applications improves 6th-grade students' space perception ability. Results suggest that the astronomy education program using smartphone applications effectively increased spatial perception and students' scientific attitudes. Through the results of the research, it was possible to know that the creative experiences using the smartphone applications was positively influential to the enhancement of the spatial perception ability and scientific attitude and problem solving ability of sixty 6th grade elementary school students.

Keywords: *Astronomy, Earth science, Smartphone, Space perception ability*

1. Introduction

Even though students continuously learn astronomy from elementary school to university, university students and teachers have various naive conceptions and difficulty learning correct scientific concepts [1]. This is because most students have trouble with space perception ability related to astronomy. Recently much astronomy-related research has focused on the relation between learners' space perception and scientific knowledge formation. Spatial perception is spatial sensibility, which is divided into spatial visualization and spatial direction [2]. Therefore spatial sensibility involves being able to hold a solid figure in one's mind and to remember its relative location and distance, which can help students learn effective space perception concepts through a systemic teaching method [3]. Spatial perception helps the learners to develop new knowledge especially when they possess the necessary meta-cognitive abilities. Metacognition or 'thinking about thinking' extend to a reflective 'thinking about feelings'.

Recently smartphone applications are recognized as new educational media expanding learner's experience by providing realistic information through a three dimensional video with a Virtual Reality and embodying learner's direct operating activity. Also due to the existence of multiple databases, it is now possible to save and process data and process space information through web browser. This study seeks to determine changes in elementary school students' spatial perception and scientific attitudes through an astronomy education program using smartphone applications.

ISSN: 1975-0080 IJMUE

2. Theoretical Background

2.1. Seasonal Change Unit in Astronomy

Astronomy curriculum is a difficult learning area for both students and teachers and much research has examined students' and teachers' astronomy-related misconceptions [4]. Especially, one research study demonstrated that only one elementary teacher, out of forty-nine, understood the scientific concept of the cause of seasonal change [5]. The seasonal change unit is abstract and hard to observe, which makes it difficult for students to understand. Callison and Wright [6] insisted that teaching spatial sensibility requires the use and understanding of materials because teaching astronomy requires the use of models.

2.2. Spatial Perception Ability

Spatial perception is spatial sensibility, which is divided into spatial visualization and spatial direction [2]. Spatial visualization involves psychologically operating and trans-shaping two-dimensional or three-dimensional objects and knowing the spatial direction prevents confusion about the form even if the direction of the object is changed. Many researchers so far have studied the spatial ability in a three-dimensional virtual space to solve a problem in face to face situation [7-8]. In turn, learners now get used to use computer technology showing positive participation and achievement in class.

Therefore spatial sensibility involves being able to hold a solid figure in one's mind and to remember it's relative location and distance and so on. Understanding the impact of spatial perception on astronomy conception can help teachers develop astronomy-related learning material and teaching strategies [9]. Despite the educational benefits recognized, spatial ability teaching and learning classes using smart phone application are rare in current classrooms. Especially the Earth science lesson requires the spatial ability since it is difficult for students to understand the concepts taught in class when they do not possess such ability.

2.3. Smartphone Application

In contemporary society, many people use spatial information and many studies have examined its use in education through the increased usage of smartphones [10]. Smartphone devices have a platform function with applications that enable people to find information through continuous Internet access. Also, smartphone applications expand learner's experience by providing realistic information through a three dimensional video with a Virtual Reality and embodying learner's direct operating activity. In the light of these educational technologies, smartphone applications let learners to participate in learning actively, to solve the problem in learning process and to facilitate learning. Therefore this function of smartphone devices can provide abundant and immediate learning resources to classrooms; help students improve their spatial perception; and enable students to investigate, collect, and analyze astronomical material.

3. Research Design and Methods

This study researched the change of students' spatial perception and scientific attitudes after the 'seasonal change' unit was taught the astronomy education program using smartphone applications to sixty 6th grade elementary school students in Chungcheongbuk-do during the second semester of 2014. The astronomy teaching program [11] focused on learning 'seasonal change' using smartphone applications is shown in Table 1.

Table 1. The Astronomy Teaching Program Focused on Learning 'Seasonal Change' Using Smartphone Applications

Stage	Class	Class name	Application use
Fun science	1/9	What will change according to season?	Season application
Lab. experience	2~3 /9	What kind of relationship will be a length and a temperature of heliometer altitude and the shadow and it peels?	Application using smartphone camera technology by clinometer
	4/9	What according to season will do a heliometer culmination altitude different?	
	5/9	What temperature according to season different?	Thermometer application
	6/9	What kind of relationship peels time and the temperature which come to float year which will be with season?	Sundial application, Sun compass application
	7/9	What will make the alternative source of season and it peels?	
Organizing knowledge	8/9	How it will arrange the contents which it learns into about the change of season?	Sundial application
Willing to be a scientist	9/9	How it will try to make the sundial time which is the possibility of knowing the change of season?	

Also, Figure 1 is an example of method to find meridian transit altitude from a smartphone application. Especially, teaching spatial sensibility requires the use and understanding of materials because teaching astronomy requires the use of models [6].

Figure 1. An Example of Method to Find Meridian Transit Altitude Using a Smartphone Application

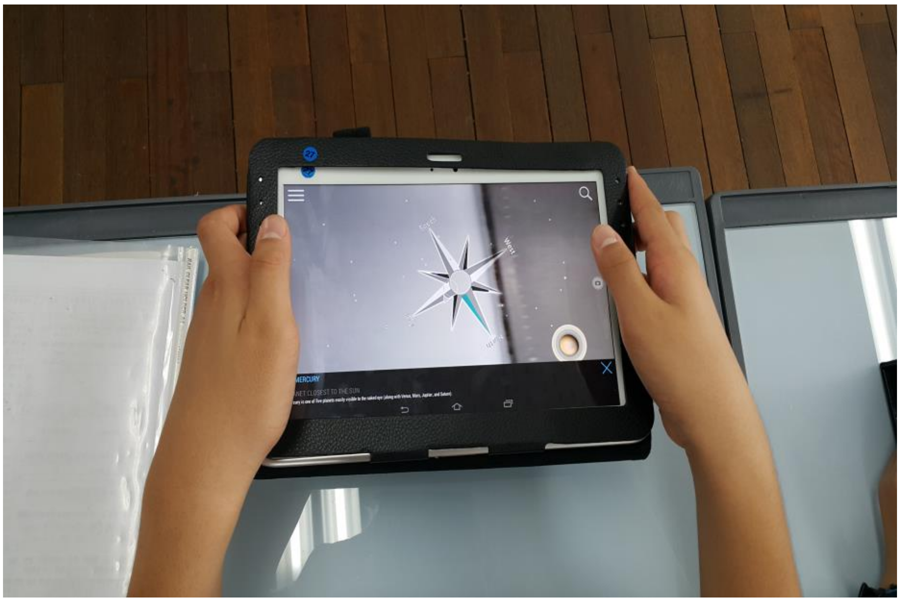

Figure 2. An Example of Method about how it will arrange the Contents which it learns into about the Change of Season with a Smartphone Application

In addition, the seasonal change unit is abstract and hard to observe, which makes it difficult for students to understand. Therefore, this study used a smartphone application to know how it will arrange the contents which it learns into about the change of season. An example of method about a smartphone application approach used in this study is shown in Figure 2.

In this way, the spatial perception test and scientific attitude test were conducted as pre-tests and were conducted again after the creative experience activity using a smartphone device as a post-test, which took 30 minutes and each question was one point. Also the spatial conception test used in this research consisted of 20 questions: 10 planar figure questions measured the complanation of a solid figure and the construction of a plane figure and the another 10 wood block questions measured to recognize plane drawings visually and count the number of wood blocks among the aptitude test questions developed by KTC (Korean Testing Center). The test took 20 minutes and each question was worth 5 points. The validation method of the contents about the spatial perception test was used by experts' review used in an investigating tool in general research by asking questions to the researcher using a simple checklist [12]. The researchers who participated in the review were 3 experts who work in science education, 2 of whom were doctors and 1 of whom were in the middle of the doctor's course. This procedure enables experts to evaluate the accuracy of the research process and results because it gives an inter-rater reliability of the study [12]. The number of questions by sub-elements of spatial perception can be seen in Table 2.

Table 2. The Number of Questions Regarding Spatial Perception by Sub-Elements

Sub-contents	Question	Number
Two-dimensional rotation	1, 2, 3, 6	4
Three-dimensional rotation	4, 5, 7	3
Reflection	8, 9	2
Finding solid body	10, 11, 15, 16, 17	5
Number of blocks	12, 13, 14	3
Figure inference by pattern	18, 19, 20	3
Total of sub-contents		20

The scientific attitude test used in this study was TOSRA (Test of Science-Related Attitudes) developed by Fraser [13], which has 7 sectors and each sector has 10 questions. Cronbach's alpha showed that the inter-item consistency was 0.643～0.901. The sectors and questions of the scientific attitude test can be seen in Table 3.

Table 3. The Sectors and Questions of the Scientific Attitude Test

scientific attitude	Question	Number	Cronbach's α
Attitudes of scientific inquiry	3, 10, 17, 24, 31, 38, 45, 52, 59, 66	10	.861
Social implications of science	1, 8, 15, 22, 29, 36, 43, 50, 57, 64	10	.728
Normality of scientist	2, 9, 16, 23, 30, 37, 44, 51, 58, 65	10	.643
Enjoyment of science class	5, 12, 19, 26, 33, 40, 47, 54, 61, 68	10	.901
Science attitudes	4, 11, 18, 25, 32, 39, 46, 53, 60, 67	10	.732
Career interest on science	7, 14, 21, 28, 35, 42, 49, 56, 63, 70	10	.847
Leisure interests on science	6, 13, 20, 27, 34, 41, 48, 55, 62, 69	10	.813

4. Results and Discussions

This study researched the change of students' spatial perception and scientific attitudes after the 'seasonal change' unit was taught the astronomy education program using smartphone applications to sixty 6th grade elementary school students. First, a paired samples t test was used to interpret the results and determine whether there was a statistical significance between the pre-test score and post-test score. The results are shown in Table 4.

Table 4. Response Values of the Categories of the Spatial Perception Test

Category	*N*	*Pre-test mean*	*SD*	*Post-test mean*	*SD*	*Paired samples t test P*
Two-dimensional rotation	60	6.01	3.16	10.17	3.19	.001**
Three-dimensional rotation	60	5.67	2.34	9.92	2.98	.000**
Reflection	60	3.25	2.41	3.42	2.35	.159
Finding solid body	60	11	2.01	11.33	2.23	.045*
Number of blocks	60	4.33	3.11	4.50	3.41	.157
Figure inference by pattern	60	2.67	2.52	8.01	2.48	.000**

By analyzing the t test of pre-test and post-test of spatial perception, it was determined that all of the sub-elements except for 'Reflection' and 'Number of blocks' were statistically significant. Also the pre-test scores of 'Reflection' and 'The number of blocks' was 3.25 and 4.33 and the post-test scores of these variables was 3.42 and 4.50, showing that each average score increased. This result means that students' spatial perception improved as a result of the astronomy education program using smartphone applications.

Therefore, smartphone applications expanded learner's experience by providing realistic information through a three dimensional video with a Virtual Reality and embodying learner's direct operating activity. This is in the same vein with the process of changing concept in defining and modifying knowledges in certain contextual situation of reasoning [14]. In other words, this function of smartphone devices can provide abundant and immediate learning resources to classrooms; help students improve their spatial perception; and enable students to investigate, collect, and analyze astronomical material.

Second, a paired samples t test was used to figure out the significance between the pre-test and post-test of scientific attitude and the results are shown in Table 5.

Table 5. Response Values of Categories of Test of Science-Related Attitudes

Category	*N*	*Pre-test mean*	*SD*	*Post-test mean*	*SD*	*Paired samples t test P*
Attitudes of scientific inquiry	60	4.18	1.65	4.73	1.66	.004**
Social implications of science	60	4.35	1.75	4.77	1.86	.001**
Normality of scientist	60	4.00	1.43	4.18	1.59	.132
Enjoyment of science class	60	4.01	1.42	4.33	1.61	.014*
Science attitudes	60	4.93	0.58	5.93	1.13	.000**
Career interest on science	60	4.60	1.63	4.75	1.61	.038*
Leisure interests on science	60	3.53	0.73	5.20	0.98	.000**

As a result of examining the change of scientific attitude after the ‘seasonal change’ unit was taught the astronomy education program using smartphone applications to sixty 6th grade elementary school students: as shown by the t test of scientific attitude test in Table 5, all sub-elements except for ‘Normality of scientist’ are statistically significant. It was found that the creative experiences of the astronomy education program using smartphone applications were helpful for enhancing the scientific attitude. Especially, ‘Normality of scientist’ listed the lack of understanding the case of scientist as a difficulty of experience in science class. This result shows that the astronomy education program based on smartphone applications impacts scientific attitudes and shows that spatial perception is related to scientific attitudes.

5. Conclusions

This study researched the change of students’ spatial perception and scientific attitudes after the ‘seasonal change’ unit was taught the astronomy education program using smartphone applications to sixty 6th grade elementary school students in Chungcheongbuk-do during the second semester of 2014. The conclusions based on results and discussions are as follows. First, the astronomy education program using smartphone applications effectively increased spatial perception. Using learning material in daily life also resulted in improved spatial perception. Also the astronomy education program using smartphone applications resulted in an increase in students’ interest and understanding. Second, the astronomy education program using smartphone applications effectively resulted in an increase in students’ scientific attitudes. Through the results of the research, it was possible to know that the creative experiences using the smartphone applications was positively influential to the enhancement of the spatial perception ability and scientific attitude and problem solving ability of sixty 6th grade elementary school students. Also, it was possible to know that the experiences of the education program using smartphone applications were helpful for the enhancement of collaborative learning ability as well as the development of affective domains. In particular, spatial perception was shown to be very important in astronomy and to have an impact on scientific attitude. In this way, using smartphones in astronomy education can help students develop correct astronomic conceptions and positive scientific attitudes.

According to this research, the astronomy education program using smartphone applications was verified to improve spatial perception and scientific attitudes. Therefore, smartphone applications let learners to participate in learning actively, to solve the problem in learning process and to facilitate learning.

References

[1] K. J. Schoon, "Misconceptions in the earth sciences: A cross-age study", Proceedings of the 62nd Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, March 1-April 1, **(1989)**.
[2] M. G. McGee, "Human spatial abilities psychometric studies and of the cause of seasons", Journal of Research in Science Teaching, vol. 33, **(1979)**, pp. 553-563.
[3] M. Barnett, "Using virtual reality computer models to support student understanding of astronomical concepts", Journal of Computers in Mathematics and Science Teaching, vol. 24, **(2005)**, pp. 333-356.
[4] P. D. Sadler, "Misconceptions in astronomy", Proceedings of the second international seminar on misconceptions and educational strategies in science and mathematics, Ithaca, NY, July **(1987)**, pp. 422-425.
[5] R. K. Atwood and V. A. Atwood, "Pre-service elementary teachers' conceptions of the causes of seasons", Journal of Research in Science Teaching, vol. 33, **(1996)**, pp. 553-563.
[6] P. L. Callison and E. L. Wright, "The effect of teaching strategies using models on preservice elementary teacher' conceptions about Earth-Sun-Moon relationships", Proceedings of the National Association for Research in Science Teaching, Atlanta, GA, April 15-18, **(1993)**.
[7] A. B. Alice, "Spatial ability and earth science conceptual understanding", Journal of Geoscience Education, vol. 53, **(2005)**, pp. 402-414.
[8] S. Ocklenburg, M. Hirnstein, M. Hausmann and J. Lewald, "Auditory space perception in left- and right-handers", Brain and Cognition, vol. 72, **(2010)**, pp. 210-217.
[9] K. Lee and J. O. Lim, "Acquisition of 9th grade students' conception of earth's rotation according to individual difference of the spatial sensibility", Journal of Korean Earth Science Society, vol. 31, **(2010)**, pp. 267-275.
[10] K. Pyun, "Design and implementation of constructing and utilizing an attendance book based on smartphone apps", Journal of the Korea Contents Association, vol. 14, **(2014)**, pp. 14-23.
[11] "Ministry of Education", Science and Technology, Editor, Elementary School Guide Book for Teacher, Kumsung Publishers, Seoul, **(2010)**.
[12] Y. S. Lincoln and E. G. Guba, "Paradigmatic controversies, contradictions, and emerging confluences", In N. K. Denzin, and Y. S. Lincoln (Eds.), Handbook of qualitative research Thousand Oaks, CA: Sage, **(2000)**, pp. 110-128.
[13] B. J. Fraser, Editor, "Test of science-related attitudes (TOSRA)", Australian Council for Educational Research, Melbourne, **(1981)**.
[14] A. A. diSessa, "Toward an epistemology of physics", Cognition and Instruction, vol. 10, **(1993)**, pp. 105-225.

Author

Hyoungbum Kim, he received M.S degree in Earth & Environmental Science from Seoul National University and Ph.D. degree in Earth Science Education from Korea National University of Education. He had been a collaborator from Ottawa University and post-doctoral process researcher of UQAM, Canada in 2014. Currently, he is currently a professor in Chungbuk National University, Korea. His current research interests include Science and Multimedia Education, Teacher Education, National Science Curriculum of Korea.

