The Effects of Lego Based Educational Robotic Practices on Spatial Visualization and Mental Rotation Performance of Students

Sevde Taşdemir[1], Recep Çakır[2]

[1]Amasya University, Graduate School of Natural and Applied Sciences, Department of Computer Education and Instructional Technology, Turkey

[2]Amasya University, Faculty of Education, Department of Computer Education and Instructional Technology, Turkey

Abstract

As in many disciplines, technological developments are followed in order to keep up with the digital age in education-teaching processes. With the developing technology, new approaches and trends in education and training are emerging. In order to educate individuals who can read and write entrepreneurship and technology appropriate for 21st century skills, different education systems have been emerged. One of them is Lego-Based educational robotic applications. The aim of this study is to reveal the effects of Lego-based educational applications on students' spatial visualization and mental rotation skills. Research was conducted on 6th grade students at a private school in Amasya, Turkey, within the scope of information technologies courses. The research was conducted pre-test post-test with control group quasi-experimental design and 26 students participated. At the end of the study, there were differences in the measured variables between the groups. At the same time, there were statistically significant differences in mental rotation performance of students who took the course with Lego-based educational applications. Moreover, results show that there is significant difference between groups in spatial visualization skills of the students in favor of experimental group. In light of the findings of the study, it is recommended that this study conducted on different levels of student groups for longer periods.

Keywords: Lego based educational applications, spatial visualization, and mental rotation skills

1. Introduction

Developing technology has taken its place in educational process and has led to wide-ranging changes. According to Prensky (2001), the growing generations in the center of technology are called digital natives because of their predisposition to digital technology. According to Resnick et al. (2009), the new generation can use technology with ease of playing, instant messaging and social media. Although they can use all of these in a ready-made way, few can do their own animations and games. According to studies, a digital individual is not only using social media or using the internet for gaming and interacting, but also s/he can use these technologies for creating, constructing and interacting with a structure. Technological developments such as intelligent technological devices, 3D printers and the Internet of Things (IoT) have taken place in our daily lives with Industry 4.0. Educators and researchers tried to meet the demands by adapting these developing instant changes to education and training. In order to educate individuals who can read and write entrepreneurship and technology appropriate for 21st century skills, different education systems have been emerged in recent years. One of them is STEM education initiative combining different disciplines and activities. There has been a considerable number of recent studies on STEM education. In STEM education, science, technology, engineering and mathematics education are integrated in schools. The aim of this integrated education is to educate individuals who have 21st century skills, information literacy and can keep up with technology (Aslan-Tutak, Akaygün & Tezsezen, 2017). Within STEM education, robotic coding and coding activities in various dimensions are included.

In the 2016 reports of the International Society for Technology in Education (ISTE) coding skills ’were prioritized among the characteristics that should be available to individuals who are suitable for 21st century skills. Coding ability is one of the 21st century skills as a skill brought by logical reasoning (European Commission, 2016). With the developing technology, coding skills in business environments has become one of the most basic stones. Therefore, educating individuals with this skill constitutes one of the major steps in the education system. For this reason, countries have begun to develop training programs for coding education and have integrated coding training into their curriculum (Angeli et al., 2016). Similarly, the result of studies and projects conducted in Turkey, coding education in 2012 were included in the curriculum of information technology courses (TTKB, 2012).

With the inclusion of coding education in the curriculum, robotic coding emerged also as another process. Erbaş (2014) describes robotic coding as it is the approach that teaches robot construction by using programming and mechanics together. Through this approach, students gain the opportunity to observe how the code blocks they write and how they can directly edit their errors. In this way, educators aim to train individuals who have 21st century skills with robotic coding activities through the ability to read and write by teaching students by coding. Robotic is actually the process of programming and designing robots in mechanical, electronics and engineering fields. Robotic is used to provide students with a curriculum integrated with science and technology and to reduce technology to a learning environment and to integrate information into daily life to make them more meaningful. (Wood, 2003).

When the studies related to robotics are examined, it is seen that it is an element combines and enrich the technology in the education environment (Koç, Şenol & Böyük, 2015). In particular, different projects and researches are conducted on educational robotics in many countries. The studies about robots in the world and in our country are generally carried out within the scope of workshops and projects (Witherspoon, Reynolds & Copas, 2004; Mauch, 2001; Çavaş & Huyugüzel Çavaş, 2005; Gennari, Dodero & Janes, 2012; Koç Şenol & Böyük, 2015).

The applications made with robotics put students at the forefront of designing, programming skills with entertaining and educational activities. Moreover, mathematical thinking skills, scientific process skills, coding skills, problem solving and reflective thinking skills of students are developing through the robotic applications (Fidan & Yalçın, 2012). In this context, the aim of this study is to investigate the effects of Lego based educational robotic applications on students' spatial visualization and mental rotation skills.

In this study, it was focused on mental rotation and spatial visualization skills of secondary school students, unlike similar practices in the literature. Spatial Visualization Skills, 2-D and 3-D objects and the movement of parts of these objects in space is defined as the ability to revitalize the new situations in the mind (Contero, Naya, Company, Saorin & Conesa, 2005; Yildiz and Tuzun, 2011). Mental rotation ability is defined as the ability to visualize the revival of visual stimuli. According to Yıldırım and Tüzün (2011), the use of cutting-edge technology in learning environments has led to the study of the effects of the methods used to develop spatial ability.

2. Method

In this study, the effects of Lego based robotic applications and block based coding program scratch on the students' spatial visualization and mental rotation skills were investigated. In this sense, a quasi experimental study was conducted with pretest - posttest control group. In the control group, Scratch applications were applied in coding instruction and Lego based robotic applications were applied in the experimental group. The study was carried out with sixth grade secondary school students and 26 students participated in the study. The experimental application period lasted 8 weeks in the information and technology course. Spatial visualization test and mental rotation test were used as data collection tools.

The spatial visualization test was developed by Winter, Lappan, Phillips and Fitzgerald (1989) for the Middle Grades Mathematics Project and translated into Turkish by Yildiz and Tuzun (2011). The test consists of 15 questions. There are 5 answers to each question. The test questions generally include questions about the right, left, front and back views in addition to the isometric views of the structures formed from unit cubes.

Mental rotation test was developed by Peters et al. (1995) and translated into Turkish by Yildiz and Tuzun (2011). The test consists of a total of 24 questions. The quality of each problem is the same and has 4 options. It is based on finding a new version of a shape created from unit cubes that will occur when the shape is rotated in different directions and at different angles

3. Conclusion (TNR 14pt., bold)

According to the results of the study, it is seen that both groups showed an increase in mental rotation and spatial visualization skills in post-test results. When the experimental and control group post test results were analyzed, it was seen that the experimental group students increased their spatial visualization skills more than the control group students. But this increase is not statistically significant. On the other hand, it is noteworthy that there was a significant difference in posttest results between the experimental group students and the control group students in favor of experimental group in terms of mental rotation skills. It is seen that there are studies involving different applications related to spatial visualization and mental rotation in the literature. For example, Yıldız (2009) investigated the effect of 3D virtual environment and concrete material use on spatial visualization and mental rotation skills. After experimental study, there was a difference in favor of experimental group in terms of spatial visualization test results, but no difference was found between groups in terms of mental rotation test results. Similarly, Yıldız and Tüzün (2011) concluded that there is a statistically significant increase in spatial visualization performances of students in a 3D virtual environment and in the use of materials. However, there was a significant increase in the use of material environment in terms of mental rotation skills, whereas the increase in 3D virtual environment was not significant. When the studies in the literature are examined, it can be seen that there are studies showing that students improve their spatial visualization and mental rotation performances in technology supported applications.

In 8-week Lego-based robotic applications in this study, an increase on students' spatial visualization skills and mental rotation skills have been observed. Lego-based educational robot applications can be included in the curricula and more efficient results can be obtained. Lego-based robotic applications have attracted attention recently in educational applications. Robotic applications and programming education are gaining importance especially for 21st century skills. Therefore, it is recommended that such practices be applied in different student groups and for longer periods of time.

References

Angeli,C., Voogt, J., Fluck, A., Webb, M., Cox, M., Malyn-Smith, J., & Zagami, J. (2016). A K-6 computational thinking. *Educational Technology & Society, 19*(3), 47-57.

Aslan-Tutak, F., Akaygün, S. & Tezsezen, S. (2017). Collaboratively Learning to Teach STEM: Change in Participating Pre-service Teachers’ Awareness of STEM, *H. U. Journal of Education 32*(4) 794-816.

Contero, M., Naya F., Company P., Saorin J. K., & Conesa J. (2005). *Improving visualization skills in engineering education. IEEE Computer Graphics and Applications (5)* 24-31

Çavaş, B. & Huyugüzel-Çavaş, P. (2005). *Technology based learning: ‘’Robotics club’’*. AB-2005, Gaziantep Üniversitesi, Gaziantep.

Erbaş, S. K. (2014). Basic robotic applications and the status on computer-aided design education *Journal of Research in Education and Teaching, 3*(3) 304-312.

European Commission (2016). Coding - the 21st century skill. Retrieved from https://ec.europa.eu/digital-single-market/coding-21st-century-skill

Fidan, U. & Yalçın, U. (2012). Lego Nxt training Kit. *Afyon Kocatepe University Journal of Sciences* 12, 1-8.

Gennari, R., Dodero, G. & Janes, A. (2012). Junior university workshops for children. *Proceedings of 3rd International Workshop Teaching* Robotics, *Teaching with Robotics Integrating Robotics in School Curriculum*, Trento, Italy.

Koç-Şenol, A., & Büyük, U. (2015), Science and technology laboratory applications supported by robotic: Robolab, *Turkish Studies*, 10(3), 213-236.

Mauch, E. (2001). Using technological innovation to improve the problem-solving skills of middle school students: educators' experiences with the Lego Mindstorms robotic invention system. *The Clearing House*, *74*(4), 211-213.

Peters, M., Laeng, B., Latham, K., Jackson, M., Zaiyouna, R., & Richardson, C. (1995). A redrawn vandenberg and kuse mental rotations test: Different versions and factors that affect performance. *Brain and Cognition*, 28, 3958.

Prensky, M. (2001). Digital natives, digital immigrants. *On The Horizon*, 9(5), 1-6.

Resnick, M., Maloney, J., Monroy-Hernández, A., Rusk, N., Eastmond, E., Brennan, K., Kafai, Y. (2009). Scratch: Programming for all. *Communications of the ACM*, 52(11).

TTKB. (2012). *Bilişim teknolojileri ve yazılım dersi (5, 6, 7 ve 8. sınıflar) öğretim programı*. Ankara: MEB.

Winter, J. W., Lappan, G., Phillips, E., & Fitzgerald, W. (1986). *Middle grades mathematics project: Spatial visualization.* New York, NY: Addison-Wesley

Witherspoon, T. K. Reynolds & Copas G. (2004), Building bricks for an online global community of practice, *World Conference on Educational Media and Technology*, Lugano, Switzerland

Wood, S. (2003) Robotics in the classroom: A teaching tool for K- 12 educators, *Symposium of growing up with science and technology in the 21st century*, Virginia, ABD.

Yıldız B. (2009) The effects of using three-dimensional virtual environments and concrete manipulatives on spatial visualization and mental rotation abilities. Unpublished Master Thesis, Hacettepe University, *Turkey, Ankara.*

Yıldız B. & Tüzün H. (2011). Effect of using three-dimensional virtual environments and concrete manipulatives on spatial ability. *H. U. Journal of Education, 41*, 498-508