

The Effect of Active Learning Techniques on Academic Performance and Learning Retention in Science Lesson: An Experimental Study*

Ahmet AYKAN¹ and Fevzi DURSUN²

Abstract

This paper investigated the effect of active learning techniques on academic performance and learning retention in the fourth-grade science course. This study adopted a quasi-experimental pretest-posttest control group design. Active learning techniques were applied in the experimental group, while the control group continued their routine education. The data were analyzed using a t-test. The results showed that the experimental group had higher academic performance and learning retention than the control group. Our results are consistent with the literature. Our experimental group participants had higher academic performance and learning retention than the control group participants. This suggests that active learning techniques enabled students to play a more active role in teaching/learning. Researchers should conduct longitudinal and mixed-design studies to understand the impact of active learning techniques more depth.

Received:

15 March 2022

Accepted:

25 March 2022

Published online:

25 March 2022

Keywords

Active learning,
Science education,
Academic performance,
Experimental study,

¹ Assist. Prof. Dr. Muş Alparslan University, Faculty of Education, Muş, Turkey, email: a.aykan@alparslan.edu.tr
ORCID: <https://orcid.org/0000-0002-8033-0821>

² Assoc. Prof. Dr. Tokat Gaziosmanpaşa University, Faculty of Education, Department of Educational Science, Tokat, Turkey, ORCID: <https://orcid.org/0000-0003-2103-8940>

* This study is an updated and improved version of a paper presented at the "27th International Educational Sciences" congress held in Antalya between 18 and 22 April 2018.

Introduction

Advances in science and technology have affected every sphere of life (Aykan & Yıldırım, 2021). Student-centered contemporary educational approaches have become important more than ever because they provide students with the opportunity to achieve learning in more effective, confident, and fun educational settings. Students take responsibility for their own learning and become more active individuals who learn by doing. The more active and engaged the students are, the more effective and permanent teaching the teachers achieve. Education systems aim to turn students into enthusiastic individuals who can access knowledge and construct it. Many countries have put constructivist teaching programs into practice (Aykan & Tatar, 2017). The constructivist teaching programs are based on the premise that students construct their own knowledge. Active learning helps students collaborate with peers, solve problems, be productive, and participate in their own learning. In other words, students who receive education through active learning techniques are more likely to learn by doing and living. Active learning allows students to play an active role in their own learning (Hendrickson, 2021) and enables teachers to lead their lessons like conductors. In active learning, teachers encourage students to take responsibility for their own learning and display democratic attitudes (Mattson, 2005; Robison, 2006). Active learning allows students to take responsibility for their own learning and develop self-confidence and self-efficacy (Arico & Lancaster, 2018).

Active learning involves numerous teaching techniques depending on the development level of students and the contents of courses. There are many active learning techniques, such as role-playing, snowball, marketplace, aquarium, poetry writing, conceptual caricature, etc. (Açıkgöz, 2009; Bellanca, 2008; Türksoy & Taşlıdere, 2016). These teaching techniques cater to students' needs and wants and help them gain learning experiences and take responsibility for their learning.

Research shows that active learning techniques positively affect academic performance (Bulut & Dursun, 2019;

Hendrickson, 2021; Jackson, 2002; Stephen et al., 2010; Van den Bergh et al., 2013). Philips (2005) found that active learning techniques helped students develop high-level cognitive skills and improve academic performance. Jackson (2002) reported that active learning techniques encouraged students to develop self-efficacy and a sense of success. Aydede & Matyar (2009) determined that active learning techniques contributed to academic performance and learning retention.

There is a small body of research on active learning in science courses. However, there is no research into active learning techniques in the "Lighting and Sound Technologies from Past to Present" theme within the scope of science courses. Therefore, this study aimed to determine the effect of active learning techniques on academic performance and learning retention in the "Lighting and Sound Technologies from Past to Present" within the scope of the fourth-grade science course. The main research question was, "How do active learning techniques affect academic performance and learning retention in the "Lighting and Sound Technologies from Past to Present" within the scope of the fourth-grade science course?" The sample consisted of 70 fourth graders divided into experimental and control groups. Active learning techniques were applied in the experimental group, while the control group continued their routine education. The subquestions are as follows:

- Is there a significant difference in academic performance between the experimental and control groups?
- Is there a significant difference in learning retention between the experimental and control groups?

Method

This section addressed the research model, the study group, the scale development process, and the techniques used for data analysis.

Research model

This six-week study adopted a quantitative quasi-experimental pretest-posttest control group design to investigate the effect of active learning techniques on academic performance

and learning retention in the fourth-grade science course. The quasi-experimental pretest-posttest control group design is used to demonstrate a causal relationship between an independent variable and a dependent variable (Cohen et al., 2000). The experimental group received an education based on active learning techniques, while the control group received routine education. Both groups were administered a posttest at the end of the intervention and a retention test 15 days after the intervention.

Study group

The study population consisted of all fourth-graders of a primary school in the center of the Muş province in the spring semester of the 2015-2016 academic year. Before sampling, students from four classrooms were administered the academic performance test. Two classrooms with similar test scores were recruited into experimental and control groups. The sample consisted of 70 participants. The experimental group consisted of 35 participants (18 female and 17 male). The control group consisted of 35 participants (16 male and 19 female).

Data collection tools

The data were collected using a Science Performance Test. Four experts (two are experienced in science, one in curriculum

development, and the other in language) were consulted for content validity. The test was based on expert feedback and a literature review conducted by the researchers. A specification table was created to ensure content validity, and questions were prepared for each learning outcome. The test initially consisted of 35 questions. A pilot study was conducted with 20 fifth-graders. Ten questions were removed from the test based on the pilot study results.

Data analysis

Both experimental and control groups were administered a pretest, posttest, and retention test. The data were analyzed using the Statistical Package for Social Sciences (SPSS) at a significance level of 0.05. Normality was tested using the Shapiro-Wilk test, normal Q-Q plot, and skewness coefficient (+1 to -1). The results showed that the data were normally distributed. Therefore, parametric tests were used for analysis. The groups were compared using an independent group t-test and a dependent group t-test.

Findings

The experimental group received science classes through active learning techniques. The control group received no intervention. Pretest, posttest, and retention test scores were compared using an independent sample t-test. The results are presented in tables.

Table 1.
Pretest scores

	N	X	Sd	t	p
Control group	35	61.83	10.90	-0.043	.965
Experimental group	35	61.94	11.07		

The experimental and control groups had a mean pretest score of 61.94±11.07 and 61.83±10.90, respectively. There was no significant difference in pretest scores between the experimental and control groups (t= -0.043; p>0.05).

Table 2.
Control group pretest-posttest scores

Control group	N	X	Sd	t-test	
				t	p
Pretest	35	61.83	10.90	-15.795	0.000
Posttest		72.69	9.96		

The control group had a significantly higher posttest score (72.69±9.96) than the pretest score (61.83±10.90) (t= -15.795; p<0.05).

Table 3.
Experimental group pretest-posttest scores

Control group	N	X	Sd	t-test	
				t	p
Pretest	35	61.94	11.07	-15.638	0.000
Posttest		78.05	7.96		

The experimental group had a significantly higher posttest score (78.05 ± 7.96) than the pretest score (61.94 ± 11.07) ($t = -15.638$; $p < 0.05$). Posttest and retention tests were compared using a t-test. The results are presented in tables.

Table 4.
Posttest scores of control and experimental groups

Posttest	N	X	Sd	t-test	
				t	p
Control group	35	72.69	9.96	2.491	.015
Experimental group	35	78.05	7.96		

The experimental group had a significantly higher mean posttest score (78.05 ± 7.96) than the control group (72.69 ± 9.96) ($t = -2.941$; $p < 0.05$).

Table 5.
Retention scores of control and experimental groups

Posttest	N	X	Sd	t-test	
				t	p
Control group	35	63.54	8.48	-5.247	.000
Experimental group	35	73.37	7.13		

The experimental group had a significantly higher mean retention score (73.37 ± 7.13) than the control group (63.54 ± 8.48) ($t = -5.247$; $p < 0.05$).

Discussion

This study investigated the effect of active learning techniques on academic performance and learning retention in fourth-graders within the scope of the science course. The results showed that the experimental group had higher academic performance and higher learning retention than the control group. In other words, active learning techniques improved students' academic performance and learning retention in the science course.

Our results are consistent with the literature (Aydede & Kesercioğlu, 2012; Freeman et al., 2014; Sivan, et al., 2010; Türksoy & Taşlıdere, 2016). Meltzer & Thornton (2012) found that active learning techniques helped students achieve learning retention. Freeman et al., (2014) focused on experimental studies on active learning and reported that active learning techniques improved students' academic performance in science, math, and engineering courses. Hendrickson (2021) determined that active learning techniques helped students develop self-efficacy.

Türksoy & Taşlıdere (2016) found that students who received an education based on enriched active learning techniques had a higher posttest score than the pretest score. Aşıroğlu (2018) reported that active learning techniques improved students' academic performance and learning retention in science lessons. They added that the experimental group participants who received an education based on active learning techniques had significantly higher learning retention than the control group. This is consistent with our result. Research in general shows that active learning techniques stimulate a sense of discovery, make learning more meaningful and permanent, help students develop individual learning skills, and encourage them to access and use information (Erdoğan et al., 2018; Kalem & Fer, 2003; Lantis, et al., 2010; Simelane & Dimpe, 2011; Sivan et al., 2010).

Our results are consistent with the literature. Our experimental group participants had higher academic performance and learning retention than the control group participants. This suggests that active learning techniques enabled students to play a more active role in

teaching/learning. Active learning techniques allowed the experimental group participants to express themselves and present creative ideas and made them more interested and enthusiastic about the science course. It was also observed that active learning activities encouraged even those with little interest in the science course to participate in the activities and made them more self-confident.

Conclusion

This six-week experimental study investigated the effect of active learning techniques on academic performance and learning retention. The experimental group took part in active learning in the "Lighting and Sound Technologies from Past to Present" theme within the scope of the fourth-grade science course, while the control group received routine education. The experimental group had higher academic performance and higher learning retention than the control group.

Limitations and Recommendations

Implications for further research

Researchers should conduct longitudinal and mixed-design studies to determine the effect of active learning techniques on academic performance and learning retention regarding the science course. Researchers should also focus on other courses (math, Turkish, etc.) and investigate the impact of active learning techniques on academic performance and learning retention. Further research is warranted to better understand how active learning techniques encourage students to develop 21st-century skills. There should be more research into the effect of active learning techniques on self-confidence, self-efficacy, motivation, and a sense of responsibility.

Limitations

This study had two limitations. First, the sample consisted only of fourth-graders. Second, the study focused only on one theme within the scope of the fourth-grade science course.

References

- Açıköz, K. Ü. (2009). Active learning. (11. edition). *Biliş*.
- Aricò, F. R., & Lancaster, S. J. (2018). Facilitating active learning and enhancing student self-assessment skills. *International Review of Economics Education*, 29, 6-13. <https://doi.org/10.1016/j.iree.2018.06.002>
- Aşıroğlu, S. (2018). The effects of active learning activities applied in science and technology course to students' success and permanence levels. *Current Research in Education*, 4(1), 1-19. Retrieved from <https://dergipark.org.tr/tr/pub/crd/issue/36372/379077>
- Aydede, M. N., & Matyar, F. (2009). The effect of active learning approach in science course on the achievement and retention of learning. *Kastamonu Education Journal*, 17(1), 137-152. Retrieved from <https://www.tused.org/index.php/tused/article/view/112>
- Aydede, M. N. & Kesercioğlu, T. (2012). The effect of active learning applications on students' self direct learning skills. *Hacettepe Üniversitesi Faculty of Education Dergisi*, 43, 37-49. Retrieved from <https://dergipark.org.tr/en/pub/hunefd/issue/7795/102010>
- Aykan, A., & Tatar, M. (2017). Competency level of secondary school teachers about the constructivist approach. *Anemon Muş Alparslan University Social Sciences Journal*, 5 (2), 381-395. <https://doi.org/10.18506/anemon.287791>
- Aykan, A., & Yıldırım, B. (2021). The integration of a lesson study model into distance STEM education during the COVID-19 pandemic: Teachers' views and practice. *Technology, Knowledge and Learning*. <https://doi.org/10.1007/s10758-021-09564-9>
- Bellanca, J. A. (2008). 200+ Active learning strategies and projects for engaging students' multiple intelligences. (2. edition). *Corwin*.
- Bulut, A. & Dursun, F. (2019). The active learning model of class 7 students and their impacts on critical thinking tendencies teacher opinions. *Journal of History School*, 12 (XL), 12-31. <http://dx.doi.org/10.14225/Joh1624>
- Cohen, L., Manion, L., & Marrison, K. (2000). *Research methods in education*. (5. edition). *Routledge*.
- Erdoğan, D. G., Uyanık, G. K., & Güngören, Ö. C. (2018). An examination of postgraduate theses written about active learning. *Sakarya University Journal of Education*, 8(1), 111-125. <https://doi.org/10.19126/suje.346975>
- Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H. & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings National Academy of Sciences*, 11(23), 8410-8414. <https://doi.org/10.1073/pnas.1319030111>
- Hendrickson, P. (2021). Effect of active learning techniques on student excitement, interest, and self-efficacy. *Journal of Political Science Education*, 17(2), 311-325. <https://doi.org/10.1080/15512169.2019.1629946>
- Jackson, J. W. (2002). Enhancing self-efficacy and learning performance. *Journal of Experimental Education*, 70(3), 243-254. <https://doi.org/10.1080/00220970209599508>
- Kalem, S., & Fer, S. (2003). The effect of the learning environment created with the active learning model on the learning, teaching and communication process. *Educational Sciences Theory & Practice*, 3(2), 433-461.
- Lantis, J. S., Kille, K. J., & Krain, M. (2010). The state of the active teaching and learning literature. In R. A. Denmark (Ed.), *The international studies encyclopedia in*. Wiley-Blackwell.
- Mattson, K. (2005). Why "Active Learning" can be perilous to the profession. *Academe*, 91(1), 23-26. <https://doi.org/10.2307/40252732>
- Meltzer, D. E., & Thornton, R. K. (2012). Resource letter ALIP-1: Active-learning instruction in physics. *American Journal of Physics*, 80(6), 478-496. <https://doi.org/10.1119/1.3678299>
- Philips, J. M. (2005). Strategies for active learning in online continuing education. *The Journal of Continuing Education in Nursing*, 36 (2), 77-83. <https://doi.org/10.3928/0022-0124-20050301-08>
- Robison, D. F. (2006). Active learning in a large enrollment introductory biology class: problem solving, formative feedback and teaching as learning. (Unpublished doctoral dissertation). Brigham Young University.
- Simelane, S., & Dimpe, D. M. (2011). Clicker technology: The tool to promote active

- learning in the classroom. In R. Corchero (Ed.), *Education in a technological world: communicating current and emerging research and technological efforts* (pp. 83-98). Spain: Formatex Research Center.
- Sivan, A, Leung, A. W, Woon, C., & Kember, D. (2010). An implementation of active learning and its effect on the quality of student learning. *Innovations in Education & Training International*, 37(4), 381-389. <https://doi.org/10.1080/135580000750052991>
- Stephen, C., Ellis, J., & Martlew, J. (2010). Taking active learning into the primary school: A matter of new practices? *International Journal of Early Years Education*, 18(4), 315-329. <https://doi.org/10.1080/09669760.2010.531916>
- Türksoy, E., & Taşlıdere, E. (2016). Effect of instruction enriched with active learning techniques on 5th grade students' academic achievement and attitudes towards science technology course. *Journal of Kırşehir Education Faculty*, 17(1), 57-77. Retrieved from <https://dergipark.org.tr/en/pub/kefad/issue/59448/854032>
- Van den Bergh, L., Ros, A., & Beijaard, D. (2013). Teacher feedback during active learning: Current practices in primary schools. *British Journal of Educational Psychology*, 83(2), 341-362. <https://doi.org/10.1111/j.2044-8279.2012.02073.x>