The Effectiveness of Science Learning with Authentic Approaches in Primary School[1]

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This study examined the effect of an authentic learning approach on academic achievement, attitudes toward life science, and retention in a primary school life science course. The study employed a quasi-experimental design and involved third-grade students from a primary school in Amasya during the 2021–2022 academic year. The study sample comprised 40 students, 20 in the experimental group and 20 in the control group. Data were collected using two instruments: the "Journey to the World of Living Beings Academic Achievement Test", which was developed by the researchers, and Akınoğlu's (2001) "Attitude Scale Toward Science". Data analysis was conducted using SPSS 25, employing descriptive statistics, t-tests, and repeated-measures ANOVA. The post-test results indicated that there was no statistically significant difference in academic achievement between the experimental and control groups after six weeks of authentic learning activities. However, the experimental group showed statistically significant improvements from the pre-test to the post-test, outperforming the control group on retention scores. By the end of the intervention, the experimental group had demonstrated significantly more positive attitudes towards science. The experimental group also showed greater retention of positive attitudes toward science. In contrast, both achievement and attitude scores in the control group declined on the retention test. Authentic learning improves attitudes towards science and success in third-grade science classes.

Keywords: Authentic learning approach; science education; primary school; achievement; attitude toward science.

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Introduction

Education can be defined as a planned and executed process designed to achieve specific objectives. During this process, individuals attempt to acquire various knowledge and skills (Fidan, 1996). The formal education process begins in primary schools. The knowledge gained by the students at this stage also influences subsequent steps. For this reason, the primary school level should be planned and executed as effectively as possible (Yaşar et al., 2000). The primary school process is multidisciplinary and is described as basic education (Yıldırım, 1996). Subject areas such as Life Studies, Turkish, Mathematics, Visual Arts, and Music are taught in relation to one another and as an integrated whole. This facilitates the internalization and assimilation of knowledge and skills.

One of these disciplines is science, which can be defined as the ability to make predictions about potential future events by systematically observing nature (Çepni, 2007). In other words, science involves the processes of making assumptions using scientific methods and testing these assumptions to obtain information (Doğru & Balkan Kıyıcı, 2005). The definition of science includes generalizations and determining principles. Moreover, science is a discipline that aims to predict by interpreting observations of the natural world, generalizing through empirical testing, and identifying underlying principles. Through science, individuals learn concepts, principles, and hypotheses, and understand the difference between their own views and scientific evidence. They can also grow up to think like scientists, conduct research, present creative ideas, and develop the information they have obtained (Yağbasan & Demirbaş, 2003). This course aims to teach students how to use scientific methods to obtain information rather than rote learning (Bozkurt & Olgun, 2005). Students who have mastered scientific methods will learn subjects in depth by taking an active role in their learning. Rather than transferring information to students, educators should facilitate their own learning.

Students often find science course content difficult because of the abstract concepts, the difficulty of visualizing them, and the multitude of relationships among them. The socioeconomic level of the family (Ker et al., 2023), motivation and self-confidence (Zhang et al., 2024), the school and classroom environment (Shen, 2024; Zhang et al., 2021), basic academic competencies (Zhu, 2021), and teaching methods (Tatar et al., 2016) are all factors that influence success in science. Even if students achieve good exam results, they may still fail to attain meaningful learning, in such cases, memorized information is quickly forgotten. Therefore, meaningful learning is more important than memorization. In approaches in which knowledge is constructed through understanding, students are actively engaged. To ensure the effectiveness of science education, curriculum studies have been conducted, and learning methods have been adjusted over time. Science curricula that aim to develop scientific literacy incorporate learning environments and pedagogical approaches that engage students in active learning experiences. However, student-centered constructivist approaches in science pose challenges to the lifelong application and retention of school-acquired knowledge. To succeed in the real world, students must be able to use their skills effectively. Rather than simply imparting knowledge, teachers and other adults should guide students through various methods and transform the learning environment into a natural space for them (Ministry of National Education, 2018). Therefore, schools should move away from being perceived as an artificial environment confined to four walls. They should integrate into society and the lives in which they participate. To eliminate this artificiality, the curriculum should be connected to real-world contexts. Reeves, Herrington, and Oliver (2002) emphasize authentic learning environments, arguing that cognitive realism is more important than the physical reality of real situations by engaging students with engaging and complex tasks. The concept of authentic learning is an educational strategy developed based on the master-apprentice relationship (Herrington, Oliver and Reeves, 2003). Authentic learning is grounded in Dewey's experiential learning and Vygotsky's social constructivism. Dewey (1916) states that learning is the restructuring of an individual's ideas through experiences. Socio-constructivist learning theories conceptualize learning as a constructive process that is embedded in context and shaped through social interaction and collaboration (Parker et al., 2013). According to Lasry (2006), Vygotsky's work on authentic learning focuses on the idea of a "lifelike" learning process stemming from our everyday experiences. In the authentic learning approach, which is based on the situational learning model in the socio-constructivist approach (Herrington & Parker, 2013), it is important to learn information and acquire skills through daily life contexts, as in situational learning (Collins, 1988). For learning to be meaningful, the learning environment must be the context itself (Brown et al., 1989). Donovan et al. (1999) state that authentic learning is an approach in which students associate the concepts gained through discussion, exploration and interpretation with the real world. It is a learning approach that incorporates authentic activities through diverse teaching methods (Gatlin & Edwards, 2007; Lombardi, 2007; Watters & Ginns, 2000). Authentic learning pertains to all approaches, including environment-based ones.

Authentic learning is inherently multidisciplinary, with students designing a container for a specific purpose while also performing tasks such as establishing rules, planning a budget, and resolving a crisis. This approach differs significantly from traditional classrooms, in which teachers impart subject-specific knowledge that students are expected to memorize and reproduce on tests. It encourages understanding through exploration and practical application. Lombardi (2007) describes the skills that students gain through authentic learning as follows: the ability to distinguish reliable information from unreliable information; the patience to engage with longer discussions; the ability to recognize relevant patterns in unfamiliar contexts; and the flexibility to work across interdisciplinary and cultural boundaries to generate innovative solutions. Authentic learning intentionally engages multiple disciplines, perspectives, learning styles, and habits of mind, and extends beyond content. Authentic learning is a process that involves real-life situations and is multidisciplinary. This approach is based on the acquisition of high-level skills, and engagement in inquiry occurs in a social environment supported by groups and experts. In this environment, students can control their own learning. The process starts with an authentic task and ends with an authentic activity and evaluation (Bektaş & Horzum, 2010; Lam, 2013; Rule, 2006). The authentic tasks set should require a multidisciplinary understanding of ill-structured problems and include the use of problem-solving skills such as critical thinking, analysis, and information synthesis (Knobloch, 2003).

The components of authentic learning that are essential in learning environments are authentic context, authentic activities, expert performance and process modelling, multiple roles and perspectives, collaboration, reflection, explicit expression, coaching and scaffolding, and authentic assessment (Herrington & Herrington, 2006). A*n authentic context* involves applying knowledge to real-life situations, and providing opportunities for research, thereby motivating learning. In such a context, a lesson is presented as a realistic problem that reflects the complexity of everyday life. Rather than presenting topics linearly through weekly lectures, the course provides students with access to information resources as needed. Authentic *activity* is appropriate for the daily activities of practitioners, rather than one that is only performed by experts (Brown et al., 1989). Such activities present real-life problems that require long time frames,and can be broken down into tasks and subtasks involving planning and implementation processes. They are well defined and relevant to daily life. They provide interdisciplinary and intersubjective integration, encourage collaboration and research, and offer opportunities to examine the task from different perspectives using diverse resources. They allow for reflection and are integrated into the evaluation process. They ensure diversity of results, discussion of solutions, and the creation of a product (Reeves et al., 2002). Authentic learning involves *expert performance and process modelling*,and requires a master-apprentice relationship. Expert performance enables students to observe how a practitioner would behave in a real-world situation. Process modelling supports meaningful learning. It also provides opportunities to access the thought processes of field experts and to understand the different levels of expertise and the stories they have learned from their experiences within their own social environments (Herrington et al., 2010). In authentic learning, *multiple roles and perspectives*, along with the social context, are incorporated into the learning process (Lombardi, 2007). In this process, students assume different roles while performing real-life related tasks; collaborative work and classroom presentations allow students to develop alternative perspectives (Herrington & Oliver, 2000) and interact with the perspectives of different professions (Brown et al., 1989). In authentic activities, students who take on different roles in subtasks gain diverse experiences, knowledge, and skills, leading to long-term learning. Authentic activities require *collaborative* work (Lombardi, 2007). By collaborating with peers and experts, students can learn about different perspectives on problem-solving through teamwork and develop strategies to consider (Bektaş & Horzum, 2010, Brown et al., 1989). *Reflection,* as a component of authentic learning, is the process by which a student reviews past learning experiences, analyzes their own performance, and identifies their strengths and areas for improvement (Collins, 1988). Reflection is more effective in collaborative and authentic learning environments; it supports the transfer of what has been learned to different situations and its reflection in daily life (Bektaş & Horzum, 2019). In authentic learning, *explicit expression* involves students sharing their experiences related to the authentic context, their problem-solving views, and their acquired knowledge (Bektaş & Horzum, 2019). It is important for students to present their views and knowledge regarding the authentic context, and to appropriately defend their proposed solutions and arguments (Herrington & Oliver, 2000). The teacher's role in authentic learning is to *coach and scaffold*. Coaching involves monitoring the student during the learning process and providing assistance when needed, while scaffolding is the process of providing support to the student as the task is completed, with teacher support gradually decreasing (Enkenberg, 2001). The teacher initially provides strong support, gradually reduces it, and eventually withdraws it. The goal is to increase the student's autonomy (Gibbons, 2015). *Authentic assessment* allows us to measure how authentic learning practices contribute to students' learning. Authentic assessment, which focuses on measuring the performance needed in daily life, allows for the acquisition of more meaningful knowledge in real-life situations while also developing problem-solving skills (Renzulli, 1997).

Innovative approaches seek to foster inquisitive minds among students, to provide guidance to teachers, and to encourage active engagement in school life. The PISA results, considered the most important indicators of 21st-century skills, show that traditional knowledge continues to be taught in schools. A collaborative teacher-guided approach should be implemented in authentic classroom contexts where students engage in real-life situations, and its effectiveness should be evaluated. Examining research on authentic learning reveals studies on social studies, science, mathematics, and foreign language teaching with middle school students (Aynas, 2018; Dunn, 2021; Erdoğan & Aydın, 2024; Karabulut, 2018; Önger, 2019), high school students (Akça & Ata, 2009; Domogen, 2023; Engström & Lennholm, 2024; Erdoğan & Alım, 2024), and university students (Gulikers et al., 2005; Gürdoğan & Aslan, 2016; Kaplan, 2018). There are few studies of authentic learning in science classes for younger age groups in primary schools. From this perspective, evaluating authentic learning activities in science classes would contribute to science education.

This study aimed to explore the effect of an authentic learning approach on achievement and attitude towards science in the third- grade science unit entitled "Journey to the World of Living Beings". The research question "What is the impact of the authentic learning approach on students' learning in the 'Journey to the World of Living Things' unit of the elementary school science course?" was addressed in this study. The sub-problems were as follows:

- Is there a significant difference between the pre-test and post-test achievement scores of the students in both the experimental and control groups?
- Is there a significant difference between the experimental and control groups in terms of their pre-test and post-test achievement scores?
- Is there a statistically significant difference between the groups in terms of their pre-test–post-test achievement gain scores?
- Is there a significant difference between the pre-test and post-test attitude toward science of the students in both the experimental and control groups?
- Is there a significant difference between the experimental and control groups in terms of their pre-test and post-test attitudes toward science?
- What is the effect of authentic learning practices on retention of achievement and attitudes toward science in groups?

Method

Research Model

This study employed a quantitative research method. The impact of an authentic learning strategy on students' academic performance and attitudes towards science was investigated in a primary school science course using a quasi-experimental design. The purpose of an experimental design is to test the relationship among variables. In experimental studies, researchers can manipulate independent variables and control extraneous variables. Quasi-experimental designs use existing groups when random assignment is not possible. While not as robust as a fully experimental design, a quasi-experimental design still allows the independent variable to be manipulated and pre-test to post-test changes to be monitored (Büyüköztürk et al., 2019; Frankel et al., 2019). In the pretest–posttest control group design, both the experimental and control groups are measured before and after the intervention to determine the effect of the independent variable (Creswell, 2012). As with other quantitative research methods, generalizations are valid for the studied group, but not for the whole universe (Ekiz, 2015). In this study, a quasi-experimental pretest-posttest control group design was employed to determine the effectiveness of authentic learning. The experimental group was taught using authentic learning activities, while the control group was taught textbook activities. Before and after the implementation of the authentic learning activities, both groups were tested.

Research Sample

This study was conducted among third-grade students at a school in Amasya Province during the 2021-2022 academic year. The school, located in the city center and with multiple third-grade classes, was selected because of its middle socioeconomic status. Pretests were administered to all third-grade students to create two equivalent groups. The control and experimental groups were randomly assigned. The study began with 24 students in the control group and 23 students in the experimental group. Twenty students who participated in all activities and in both the pre- and post-tests, were selected from each group for the study.

Data Collection Tools

Data were collected using the “Journey to the World of Living Beings Achievement Test” and the “Attitude Scale Towards Science”.

The achievement test developed by Topal et al. (2022) was used. This test consisted of 34 questions. The test questions were prepared in a multiple-choice format. The test has medium difficulty, with item difficulty indices ranging from 0.60 to 0.92 and item discrimination indices ranging from 0.30 to 0.90. The reliability coefficient determined using the KR-20 formula was 0.92.

The “Attitude Scale Towards Science” was developed by Akınoğlu (2001). This scale has a five-point Likert structure with twenty items, and the Cronbach’s alpha was 0.89.

Implementation Process

The implementation process began after the official permissions had been obtained. First, pre-tests were conducted. Expert opinion was sought when planning authentic activities. Activities were designed to be completed within the scheduled time. The application took approximately six weeks. At the end of the activities, post-tests were administered. The Attitude Towards Science Scale and the achievement test were re-administered approximately eight weeks after the post-tests to assess retention.

The weekly activities are as follows:

Week 1: Observing living and non-living things / Let's discover the common characteristics of living things

Week 2: Growing my own plant / Creating a poster on the life cycle of plants

Week 3: Interviewing cleaning staff / Clean environment warriors

Week 4: How do we protect our natural and artificial environment? / Designing an artificial environment

Week 5: We are recycling / Preparing invitations

Week 6: Organizing a seminar on recycling

In practice, students were engaged weekly in authentic activities appropriate to the given scenario. These authentic tasks relate to daily life and activate students' skills in areas such as inquiry, discovery, decision-making, group work, collaboration, communication, and problem-solving (Horzum et al., 2019). Care was taken to ensure that the planned activities were authentic. These activities, supported by the teacher, involved group work, research, inquiry, material design, communication, and collaboration. After each stage, inferences were drawn to develop the students' thinking, communication, cooperation, and technical skills, and to make them aware of the real-life equivalents of what they had learned. To promote interaction and communication, the teacher divided the students into groups, ensuring a balanced distribution. The application process in the experimental group was planned as suggested by Mims (2003). In Stage I, s*tudents engage in inquiry*; they discuss an engaging scenario in small groups and in a broader class discussion, share the information they have gathered from class resources, Internet sources, and expert opinions. Under the teacher's guidance, the whole class acquires knowledge of the topic, develops various skills, and establishes connections with the world beyond the classroom (Herrington et al., 2003). Students are guided to explore problems in their environment, and their research requires access to various information sources; weekly activities are planned accordingly. For example, during the third week, they interviewed the school cleaning staff to learn about their duties and the challenges they faced. In Stage II, the *learning process* begins. Students work in groups, based on their Stage I research, to develop the materials needed for the project and to acquire technical skills. Students develop higher-order thinking skills and gain experience through participation in activities aligned with the course objectives. This learning process results in meaningful projects designed for audiences beyond the classroom, which are then shared with the community (Rule, 2006). For example, during the third week, the schoolyard was cleaned after an interview with the cleaning staff. In the fourth week, groups designed terrariums to serve as artificial environments. In Stage III, *communication* takes place once all projects have been completed and their products and outcomes have been shared with the community. In authentic learning, students' projects and experiences relate to the real world, so learning is shared beyond the classroom (Mims, 2003). For example, during the second week, the students cultivated plants and publicized the activity by creating a poster on the life cycle of living organisms for the school bulletin board. During the fifth week, after visiting a recycling centre, they prepared invitations and held a recycling seminar at the school. The teacher provided structured support throughout all these stages. Learning occurs through a process in which students engage in social discourse under the teacher's guidance, enabling them to continually question and to access information from diverse sources. A sample lesson plan for the activities is provided in the appendix.

The teacher taught the control group using the 2018 Ministry of National Education (MoNE) science curriculum textbook. As the 2018 science curriculum adopted an inquiry-based teaching approach, the activities in the textbooks were arranged accordingly. The researcher administered the pre- and post-tests to both groups during the same weeks, and they required approximately the same amount of time to complete.

Analysis of Data

The pre-test, post-test, and retention test scores of the achievement test and attitude scale used in the study were analyzed using SPSS 25 software. In the descriptive analysis, the "normal distribution of the data" was assessed. The skewness values for the achievement test ranged from -1.149 to -0.838. Kurtosis values ranged from -0.295 to 0.293. According to Tabachnick and Fidell (2013), skewness and kurtosis values between -1.5 and +1.5 indicate a normal distribution. The descriptive analysis of the attitude scale towards science revealed that the skewness values ranged from -0.218 to 0.387, and the kurtosis values ranged from -1.360 to -1.335. These values, which ranged from -1.5 to +1.5, indicated that the attitude scale scores were also normally distributed. Thus, the inferential analysis employed parametric tests. Because the data were normally distributed, the independent-samples t-test and repeated-measures ANOVA were performed. In quantitative research, effect size demonstrates the strength of conclusions drawn about group differences or variable correlations (Creswell, 2013). In this study, the effect sizes of the mean differences were calculated using Cohen's d and η^2. According to effect size coefficients, Cohen (1988) defined a minor effect as having a d value of 0.20, a medium effect as having a d value of 0.50, and a large effect as having a d value of 0.80 (Cohen, 1988). The eta-squared value is 0.01; minor level, 0.06 for an intermediate level, and 0.14 for a large level (Cohen, 1992).

Results

Results of the "Journey to the World of Living Beings Achievement Test"

The results of the independent samples t-test, which compared the pre-test and post-test achievement scores, are presented in Table 1.

When Table 1 was examined, the pre-test results did not differ significantly from one another (t_{38}=0.443, p> 0.05). Therefore, the groups were equivalent. Following the implementation, the means for the experimental ($\bar{x}$=28.50) and control ($\bar{x}$=27.40) groups were similar. According to the results obtained from Table 1, the post-test results also did not differ significantly (t_{38}=0.62, p>0.05). Cohen's d values also indicate small effects.

Table 1

Results of the t-test for the achievement test scores

	Group	N	$\bar{x}$	s	t	df	p	Cohen d
Pre-test	Control	20	25.00	5.03	0.443	38	0.660	0.13
	Experimental	20	24.20	6.96				
Post-test	Control	20	27.40	4.50	0.62	38	0.537	0.19
	Experimental	20	28.50	6.49				

A paired-samples t-test was used to examine changes in scores within groups. The results are presented in Table 2.

Table 2

Results of the t-test scores for the group's achievement scores

Group	Test	N	$\bar{x}$	s	t	df	p	Cohen d
Control	Pre-test	20	25.00	5.03	7.32	19	0.000*	0.50
	Post-test	20	27.40	4.50				
Experimental	Pre-test	20	24.15	6.96	8.22	19	0.000*	0.65
	Post-test	20	28.50	6.50				

*p<0.05

As can be seen in Table 2, the increases in the mean were significant for both the control group (t_{19}=7.32, p<0.05) and the experimental group (t_{19}=8.22, p<0.05). Both groups learned. Cohen's d values indicate moderate effect sizes. The mean score for the control group increased from

25.00 to 27.40, and the mean score for the experimental group increased from 24.15 to 28.50. An independentsamples t-test using compatibility ratios was conducted to compare pre- and post-test difference scores, and the results are presented in Table 3.

Although the mean difference scores for the experimental group's pre-test and post-test were 4.35 and 2.40, respectively, for the control group, the difference for the experimental group was judged to be significant (t_{38}=-3.131, p<0.05). The effect size of the authentic learning approach on the difference scores was 0.99. As this value was greater than 0.80 (Cohen, 1988), it is evident that the effect was substantial.

Table 3

Results of the t-test for the difference scores

Group	N	x̄	s	t	df	p	Cohen d
Control	20	2.40	1.46	-3.131	38	0.003*	0.99
Experimental	20	4.35	2.37				

*p<0.05

3.2. Result of attitude towards science

An independent samples t-test was used to compare pre-test and post-test attitude towards science; the results are presented in Table 4.

Table 4

Results of the t-test for attitude towards science scores between groups

	Group	N	x̄	s	t	df	p	η^2
Pre-test	Control	20	53.95	22.37	0.96	38	0.340	0.30
	Experimental	20	60.45	20.31				
Post-test	Control	20	58.35	22.18	2.60	35.73	0.013*	0.82
	Experimental	20	74.65	17.15				

*p<0.05

According to Table 4, the control group’s pre-test attitude towards science score (x̄=53.95) was lower than the experimental group’s (x̄=60.45). However, this difference was not significant (t_{38}=0.96, p>0.05). Therefore, the two groups were equivalent in their attitudes toward science. Based on the pre-test mean differences, the effect size is small.

When post-test scores attitude toward science were compared, the control group's mean score was $\bar{x}$=58.35, while the experimental group's mean score was $\bar{x}$=74.65. This difference in scores was significant ($t_{35.73}=2.60$, $p<0.05$). The effect size (Cohen's d) was 0.82. Cohen (1988) states that values above 0.80 greatly affect effect size calculations. There is evidence that authentic learning meaningfully affects students' attitudes toward science subjects.

To evaluate changes in attitudes toward science within groups, a paired-samples t-test was used. Table 5 presents the test results.

Table 5

Results of the t-test for within-group attitude towards science scores

Group	Test	N	x̄	s	t	df	p	Cohen d
Control	Pre-test	20	53.95	22.37	2.45	19	0.024*	0.19
	Post-test	20	58.35	22.17				
Experimental	Pre-test	20	60.45	20.31	3.97	19	0.001*	0.74
	Post-test	20	74.65	17.15				

*p<0.05

As shown in Table 5, post-test scores were higher than pre-test scores. These increases in the mean were significant in both groups (control group, $t_{19}=2.45$, $p<0.05$; experimental group, $t_{19}=3.97$, $p<0.05$). Both groups developed positive attitudes towards science. An examination of the effect sizes revealed a small effect in the control group and a medium effect in the experimental group. The authentic learning approach had a significant impact on the students' attitudes towards science.

Results of retention test

Retention tests were administered to student groups to ascertain the impact of the research using the authentic learning approach on students' knowledge retention. The results of the descriptive analysis are presented in Table 6.

Table 6

Achievement test scores of groups

Group	N	Pre-test x̄	Post-test x̄	Retention x̄
Control	20	25.00	27.40	25.20
Experimental	20	24.15	28.50	28.85

According to Table 6, the control group's retention-test score was lower than its post-test score. The mean scores for the pre-test and retention test were comparable. In the experimental group, post-test and retention-test scores were similar, whereas in the control group, retention-test scores were lower than the post-test scores. The results of the repeated-measures ANOVA, which was used to analyze these differences, are presented below.

Table 7

Pre-test, post-test, and retention test repeated measurements ANOVA results

Group	Source of variance	Sum of squares	df	Mean of squares	F	p	Significant Difference	η²
Control	Measurement	70.933	2	35.467	28.64	0.000*	2-1, 2-3	0.60
	Error	47.067	38	1.239				
	Total	118.000	40					
Experimental	Measurement	274.233	2	137.117	54.41	0.000*	1-2, 1,3	0.74
	Error	95.767	38	2.520				
	Total	370.000	40					

*p<0.05 1:pre-test 2: post-test 3: retention test

Additionally, it was noted that the results of the pre-test, post-test, and retention-test for the control group differed significantly ($F_{2.38}$=28.64, p<0.05, η^2=0.60). However, the results of the retention test (25.20) and the pre-test (25.00) did not differ significantly. Performance on the post-test exceeded performance on the retention test. This demonstrated that the learning achieved by the control group was not sustained. Cohen's d indicated a medium effect size.

Students in the experimental group showed a significant difference in their pre-, post-, and retention-test results ($F_{2.38}$=54.41, p<0.05, η^2=0.74). However, the post-test (28.50) results and retention-test (28.85) results did not differ significantly. This indicated that the effect of authentic learning practices on student success persisted. To understand the extent of this effect, the η^2 value was considered. The value of η^2=0.74 for the experimental group in this data set indicates a large effect of authentic learning on retention.

Table 8

Attitudes towards science scores of groups

Group	N	Pre-test x̄	Post-test x̄	Retention-test x̄
Control	20	53.95	58.35	55.35
Experimental	20	60.45	74.65	74.80

A one-way repeated-measures ANOVA was conducted to examine the effect of implementation on students' attitudes towards science retention. Table 8 presents descriptive results; Table 9 presents ANOVA results.

Table 9

Pre-test, post-test, and retention-test repeated measurements ANOVA results

Group		Sum Of Squares	df	Mean Of Squares	F	p	Significant Difference	Ƞ²
Control	Measurement	202.133	2	101.067	4.18	0.019*	2-3	0.18
	Error	918.533	38	24.172				
	Total	1120.666	40	125.239				
Experimental	Measurement	2717.233	2	1358.617	15.71	0.000*	1-2, 1-3	0.45
	Error	3286.767	38	86.494				
	Total	6004.000	40	1445.111				

*p<0.05 1: Pre-Test 2: Post-Test 3: Retention-Test

When attitudes towards science scores were compared between the two groups, mean scores on the pre-test, post-test, and retention-test differed. While the retention score in the control group decreased relative to its post-test score, the retention score in the experimental group was slightly higher. A significant difference was observed between the post-test and retention test scores in the control group. ($F_{2.38}$=4.18, $p<0.05$, η^2=0.18). The mean score on the attitude towards science scale decreased from 58.35 to 55.35, and its effect size was smaller than that of the experimental group. This indicates that a lasting change in attitudes towards science could not be achieved in the control group. Analysis of the experimental group's scores revealed a significant difference between the pre-test and both the post-test and retention test scores ($F_{2.38}$=15.71, $p<0.05$, η^2=0.45). However, the difference in scores between the post-test ($\bar{x}$=74.65) and the retention-test ($\bar{x}$=74.80) was not significant. These results suggest that the authentic learning approach helped students retain their attitudes toward science. A value of $\eta^2=0.45$ indicated that authentic learning had a significant effect on retention.

Conclusion

This study investigated the impact of an authentic learning approach on third-grade students' performance in the science unit titled "Journey to the World of Living Beings". The variables academic achievement, attitude towards science, and retention were discussed.

Initially, the study examined whether the authentic learning method affected students' academic performance. No significant differences were observed between the pre-test and post-test scores in either the experimental or the control group. Within-group pretest-posttest comparisons also indicated that learning had occurred. Student achievement increased in both groups. There are also studies in which authentic learning did not lead to a significant difference in post-test scores compared to the control group (Nachtigall et al., 2022; Yılmaz & Ortak, 2021). These findings contradict those of other studies, which found that the authentic learning approach leads to a significant difference in student achievement (Aydın & Savaş, 2019; Aynas, 2018; Gürgil, 2018; Hwang et al., 2021; Kearney & Shuck, 2006; Nas, 2020; Tutal, 2023). Research shows that authentic learning is more effective than the traditional approach. The teacher in the control group, who adhered to the inquiry-based learning strategies outlined in the 2018 science curriculum, was also effective. In traditional methods, teaching is teacher-centered, and students occupy passive roles. However, in inquiry-based teaching, students are active participants in a teacher-guided process, which increases student success. However, examination of the pretest-posttest difference scores revealed a significant advantage for the experimental group, which received authentic learning. The significant difference indicates an effect of authentic learning on success, and the large effect size supports this finding. In their meta-analysis study, Nachtigall et al. (2022) stated that most of the examined studies (f=18) indicated a high effect size for authentic learning.

Analysis of the attitudes towards science scores indicated that there was no statistically significant difference in the mean pre-test scores between groups. However, the post-test scores on attitudes towards science showed a statistically significant difference in favor of the experimental group. The effect size indicates that authentic learning practice has a significant impact. Within-group pretest-posttest comparisons also showed that authentic learning significantly influenced attitudes towards science. Arslan et al. (2020) stated in their study that there was a significant increase in students' attitudes towards science and a moderate effect. Murtaqiatusholihat et al. (2023) found that a curriculum designed with authentic learning principles effectively increased prospective teachers' academic success, attitudes, and self-learning abilities. The authentic learning approach fosters positive attitudes towards the various subjects, including science (Aynas & Aslan, 2021; Karabulut, 2018); social studies (Baştürk, 2019; İneç, 2017; Yıldırım & Ortak, 2021a), life sciences (Özyılmaz & Gürdoğan Bayır, 2024), foreign language (Karakoç, 2016), and Turkish (Hamurcu, 2016). Erdem and Kaf (2023) conducted a meta-analysis of 23 studies and found that authentic learning had a moderately significant effect on attitudes by subject area, but not by educational level. Authentic learning activities increase students' motivation and interest in the course (Gürdoğan, 2014; Masood, 2013; Zohoorion, 2015). They are adaptable and relevant to daily life, increasing students' interest in the subject.

The retention analysis showed that the authentic learning approach contributed positively to students' retention of knowledge. Between the post-test and the retention test, the success score in the control group decreased from 25.20 to 24.40, while in the experimental group it increased from 28.50 to 28.85. The effect sizes of the retention test were also greater in the experimental group. It can be assumed that authentic learning strengthens the placement information in long-term memory by relating it to real life, presenting meaningful, contextual, and application-oriented tasks, and encouraging active participation and deep processing (Hussain et al, 2016; Yıldırım & Ortak, 2021). Uyanık (2016) examined the effect of the learning cycle, while Akıllı and Kıngır (2021) examined high-level teacher questioning, and Uyanık and Uyanık (2024) examined quantum learning. These studies reported decreased knowledge retention in the control group. Nachtigall et al. (2022) stated that, of the 50 studies on authentic learning that she examined, the majority had a large cognitive effect, eight had a medium effect size, nineteen had a low effect size, and seven had no effect or a negative effect. Differences in effect sizes observed in studies of authentic learning are explained by learning designs that do not fully include authentic components. To achieve the goals of authentic learning, it is important to organize the learning environment in terms of originality, provide students with opportunities to work collaboratively by presenting them with real-life problem scenarios, and consider all the elements determined for this purpose (Herrington et al., 2003). In this study, students participated in out-of-school field trips and engaged in active learning activities such as preparing posters, inviting guest speakers to the classroom, and growing plants. The process was planned with authentic components in mind, such as expert performance, structured support, collaboration, and the explicit expression of and reflection on what had been learnt. They initially learned through research aimed at solving real-life problems. Teacher support and guidance were provided, where necessary, to reinforce the subject matter through additional methods. Student retention improved as a result of these authentic learning experiences.

An analysis of students' attitudes towards science showed that with the authentic learning approach, they effectively maintained their attitudes. The moderate effect size in the control group indicates that the change in attitude was short-lived, suggesting that learning was limited to the school context and was not truly internalized. It is indeed known that attitudes do not change with short-term studies (Osborne et al., 2003). However, there are studies showing that authentic learning can increase and maintain positive attitudes towards science over time (Aynas & Aslan, 2021; Gündoğan & Güntekin, 2018; Özyılmaz & Gürdoğan Bayır, 2024). Recognizing the relationship between classroom learning and daily life may have increased motivation and positive attitudes toward science. Connecting authentic activities with real-life contexts encourages active student participation, responsibility, intrinsic motivation, and belief in their ability to complete tasks successfully. Furthermore, collaborative work has a positive impact on learning outcomes, social interactions, communication skills, and commitment to the lesson (Herrington et al., 2003).

Authentic learning helps students understand scientific topics and fosters positive attitudes toward science. The results also indicate that authentic learning affects both science achievement and the durability of these attitudes. At the end of the study, the recommendations included investigating the effectiveness of questions at different cognitive levels in promoting learning gains. The influence of various skills, such as problem-solving, metacognitive awareness, and reflective thinking, could also be explored. Additionally, instructional materials could be developed and provided to science teachers to support them in implementing authentic learning practices. Teachers' awareness of this approach could be enhanced through professional development focused on designing authentic activities and technology-supported learning environments.

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Appendix

Monday **18-22/25-29 April 2022**

LESSON PLAN	
Lesson	**LIFE SCIENCE**
Grade	**3rd**
Week	**29-30**
Unit Title	**Journey to the World of Living Things**
Topic	**Let's Protect Our Environment**
Suggested Duration	**4 Class Hours**
Student Learning Outcomes	**F.3.6.2.5. Realizes the importance of the natural environment for living things.** **F.3.6.2.6. Suggests solutions by researching how to protect the natural environment**
Teaching-Learning Methods and Techniques	**Lecture, discussion, Q&A, observation, individual activities, storytelling, hands-on practice, discovery learning, research, analysis, demonstration, brainstorming, collaborative work, rule-following, learning by doing and living, visual reading, inference.**
Educational Technologies – Tools, Materials and References Used *Teacher / Student*	**Computer, projector, colored papers, drawing tools, various models, usable household waste, cardboard, glue, scissors, etc.**

Teaching-Learning Activities:
• **Attention Getter:** A video [https://www.youtube.com/watch?v=Dn_KJ1sb0LM] is shown to highlight environmental issues mentioned by "Çevki". • **Motivation**: "We see similar problems in our environment too, don't we? We will learn how to protect our natural environment and how to avoid such problems. This way, we can leave a clean world for future generations." • **Review**: "By the end of this lesson, you will learn what environmental problems are, which organizations are working on them, and what we can do individually and as a society." • **Transition to Lesson**: Questions are asked like "Children, have you seen the colorful bins in our school corridors? Do you know what they are for? How are they different from regular trash bins?" Then the rest of the video is shown, followed by questions such as "Where would all this waste go if there were no recycling? What effect would it have on places it is dumped in?" to guide students to the idea that the natural environment is being harmed. • **Individual Learning Activities**: Prepare interview questions to ask school administration about recycling bins at school—their purpose, usage, and what is done with collected waste. The results will be published in a class newspaper. • **Group Learning Activities**: Plan a seminar with an expert from the Amasya Provincial Directorate of Environment and Urbanization about the deterioration of the natural environment and the problems it causes. Invitations for the seminar will be designed and voted on, and the winning invitation will be printed and distributed. • Each group selects a type of environmental pollution and designs a material to prevent it. Planning takes place at school; research and production occur after school in teams. Each group prepares a presentation and presents their project in a classroom exhibition. • **Summary:** The importance of the natural environment for living beings, actions to protect it, types of pollution, and suggested solutions will be covered.

Assessment and Evaluation:	
• Individual learning • Group learning • Assessment and evaluation activities for students with learning disabilities and students with advanced learning speeds	Week 5 will be planning and distributing invitations, while week 6 will be organizing seminars and exhibitions. Observation forms for the process Diaries Peer assessment Achievement tests Application of science attitude scales
Explanations Related to the Plan	This unit aims for students to distinguish between living and non-living things, recognize and protect their environment, understand natural vs artificial surroundings, and develop responsibility, frugality, and healthy living habits. **Topics Include:** National parks and natural monuments. **Key Concepts:** School and living environment, cleanliness, nature, forest, park, garden, buildings, national parks, natural monuments, etc.