Pedagogical Perspective

2024, Vol 3, No 2, 420-433
ISSN: 2822-4841
https://doi.org/10.29329/pedper.2024.94

Developing an association with daily life test for 5th-grade science education: Propagation of light unit[1]

Ayhan Çinici[1*] Nazife Aktaş[2]

[1]Mathematics and Science Education, Faculty of Education, Ordu University, Ordu, Türkiye.
[2]Ministry of National Education, Ordu, Türkiye.

Article Info

Keywords

Context-based learning
Open-ended questions
Test development.

Article History

Received 20.12.2024
Received in revised form 25.12.2024
Accepted 29.012.2024

Article Type

Research Article

Abstract

Students' difficulties associating science topics and concepts with daily life continue from primary school to university. This study aims to develop an open-ended test to determine the level of 5th-grade students' associating the topics related to the "*Propagation of Light*" unit with daily life events. The study employs a mixed-methods research model incorporating both qualitative and quantitative methods for test development and validation. To examine the validity of the test, pilot application was applied to 20 students in 6th grade. Then, the test was used on 119 students in 5th grade for actual application of the test. As a result of the study, a valid and reliable "*Propagation of Light"* unit daily life association test (PoLDAT) consisting of 10 open-ended questions was developed. According to the findings obtained from applying the developed test, it is noteworthy that misconceptions are intense with partial understanding of the unit on the propagation of light. As a result, the PoLDAT will serve measurement and evaluation purposes and enable students to realize the relationship between science subjects and daily life events by activating their thinking processes.

1 Introduction

Education is one of the primary tools that provides a vision for transforming individuals, societies, and, ultimately, nations (Sbhatu, 2021). Considering the radical changes societies are expected to embrace today, it is evident that there is an urgent and growing need for education systems capable of leading societal progress. Consequently, rapid advancements in science, technology, and social structures compel education and its objectives to evolve (Karslı, 2012). Science education, in particular, plays a pivotal role in adapting to these rapid changes and transformations by aiming to nurture individuals who can understand themselves and their environment (Bennett & Lubben, 2006; Bennett, et. al., 2007; Ormancı, et. al., 2020), who can contribute to technological developments and who can benefit from these developments in every field they need (Hançer, Şensoy & Yıldırım, 2003). For this reason, it is very important in terms of science education that

[1] This study's data was obtained from the second author's master's thesis.

Cite: Çinici, A., & Aktaş, N. (2024). Developing an association with daily life test for 5th-grade science education: Propagation of light unit. *Pedagogical Perspective, 3*(2), 420-434. https://doi.org/10.29329/pedper.2024.94

* ayhancinici@odu.edu.tr

students are encouraged to make connections between scientific knowledge and natural phenomena with daily life and to produce solutions to real-world problems (Aikenhead, 2006; Gilbert, 2006; Overton, 2007). However, many students perceive science topics as abstract and disconnected from everyday experiences, often resulting in various learning difficulties and misconceptions (Gilbert, 2006). Therefore, it is crucial in science teaching to create environments where students can connect scientific knowledge to real life. (Osborne & Collins, 2001). Providing learning experiences that support students in connecting with daily life events while making sense of scientific concepts should be one of the main goals of teaching these concepts (Bennett et al., 2007; Magwilang, 2016).

Making connections to daily life can be defined as relating a subject, concept, or phenomenon to examples from everyday events. This approach enhances students' motivation to learn by demonstrating the practical applications of knowledge in their daily lives and improves knowledge retention (Coştu, et. al., 2007; Ormancı & Çepni, 2018). Developing students' ability to link scientific knowledge to their daily experiences is a crucial step in science education and in fostering scientific literacy and critical thinking skills. Therefore, placing greater emphasis on making connections to daily life in science education can strengthen students' scientific thinking and problem-solving abilities, enabling them to respond more effectively to future challenges (Bodur & Şahin, 2017; Ormancı & Çepni, 2018). In conclusion, integrating real-life connections into science education supports the learning process by making it more meaningful. It allows students to develop their scientific thinking skills and devise and implement effective solutions to real-world problems (Feinstein, et. al., 2013; Ülger, et. al., 2022). Emphasizing the strategies of making connections with daily life experiences in science curricula can help this approach to be adopted more widely (Göçmençelebi & Özkan, 2011; Ormancı & Çepni, 2018).

In current science curricula, students are supported to understand the interaction between science, technology, society, and the environment and to use science and technology to gain new knowledge and solve problems (Ministry of National Education [MoNE], 2024). However, the results of international assessment programs such as TIMSS and PISA, whose primary purpose is to provide data to evaluate and improve the effectiveness of education systems by comparing student achievement at the international level, reveal that many countries, including Türkiye, face common problems in science education (Arık Güngör & Saraçoğlu, 2023). One of the main reasons for these problems is the lack of sufficient opportunities for students to concrete abstract science concepts and connect course content with real-world problems. This situation adversely affects students' interest and motivation in the lesson, ultimately reducing their learning performance (Aikenhead, 2006; Rofii, et. al., 2018). To address this issue, making abstract concepts tangible and linking them to everyday life effectively enhances students' learning motivation and achievement (Chiappetta, et. al., 2002). Gilbert (2006) emphasizes that overcoming such challenges in teaching requires presenting course content within a meaningful context. Numerous studies have echoed the significant impact of context on the individual's ability to structure and make sense of information in their mind (Arık Güngör & Saraçoğlu, 2023; Genç et al., 2023; Kabuklu & Kurnaz, 2019; Pınar & Dönel Akgül, 2023).

In Türkiye, the Science Curriculum revised in 2024 adopted a teaching approach associated with previous learning, daily life, and other disciplines to support meaningful and permanent learning. This approach also designed an integrated curriculum around values, skills, and competencies (MoNE, 2024). This curriculum emphasizes that individuals should be able to produce knowledge and use it functionally in daily life. In addition, considering the "Turkish Qualifications

Framework" it is aimed at students who use science literacy skills with a holistic perspective in problem-solving and informed decision-making. This competence also emphasizes applying knowledge and skills to problem situations that can be encountered in various contexts, such as home, school, and workplace, based on previous learning and life experiences. Consequently, when the general and specific objectives, field-specific skills, and learning outcomes of the current science teaching program are examined, it is seen that student's ability to relate information to daily life and produce solutions to real-world problems is frequently mentioned (MoNE, 2024).

In studies to determine the level of students' associating science subjects with daily life (Balkan Kıyıcı & Aydoğdu, 2011; Bodur & Şahin, 2017; Coştu et al., 2007; Çelik & Güler, 2013; Dede Er, et. al., 2013; Göçmençelebi & Özkan, 2011; Hürcan & Önder, 2012; Mercan, et. al., 2019; Ormancı et al., 2020; Uğraş, et. al., 2017) demonstrate that most students are unable to make this association at the expected level or in an expected manner. For example, Doğan et al. (2004) found that high school students could not sufficiently associate the information they learned in the biology course with events in daily life and could not adequately interpret the causes and consequences of events. On the other hand, Coştu et al. (2007) tried to determine the effectiveness of the teaching enriched with group discussions that examined the relationships between 10th-grade students' science concepts and events in daily life compared to the traditional approach. As a result of the study, it was seen that the experimental group was statistically significantly more successful than the control group in interpreting events in daily life. Pekdağ et al. (2013) found that the effect of university students' academic achievement levels on the level of associating chemistry knowledge with daily life was not statistically significant. Balkan Kıyıcı and Aydoğdu (2011) found that pre-service science teachers were highly successful in associating physics-related scientific knowledge with their daily lives. In contrast, their ability to connect chemistry- and biology-related knowledge to daily life was comparatively lower. Similarly, Ülger et al. (2022) analyzed pre-service science teachers' lesson plans on cells regarding their connection to daily life and identified a generally weak association. Aydın Gürler (2022) reported that middle school students demonstrated a low ability to relate their knowledge of "pure substances and mixtures" to daily life. Likewise, a study by Göçmençelebi and Özkan (2011) involving 6th-grade students revealed that those who engage with printed or visual publications containing scientific content and utilize technology were better able to associate science topics with their daily lives. Korkmaz and Buyruk (2016) aimed to determine the 7th-grade students' use of the concepts of "work, physical change, chemical change, expansion and contraction" in daily life through metaphors. When the metaphors were analyzed, it was seen that the students were inadequate in associating the related concepts with daily life and had misconceptions.

On the other hand; Bortnik, et. al., (2021); Demircioğlu, et. al., (2018); Elmas and Geban, (2016); Gül, et. al., (2017); Karslı Baydere and Kurtoğlu (2020); Karslı and Saka, (2017); Keleş and Dede (2020); Keskin and Çam (2019); Magwilang (2016); Majid and Rohaeti, (2018); Quainoo, et. al., (2021); Putri, et. al., (2019); Sak and Kaltakçı Gürel (2019); Sheshtawy, et. al. (2023); Şensoy and Gökçe (2017); Yıldırım and Gültekin, (2017) examined students' levels of associating subjects with daily life with multiple-choice tests; Aydın Gürler (2022), Ayvacı, et. al., (2016), Campbell and Lubben (2000), Canpolat and Ayyıldız (2019); Demircioğlu and Özdemir (2019), Derman and Senemoğlu (2020); Karslı Baydere and Aydın (2019); Kirman Bilgin and Yiğit (2017); Ormancı, et. al. (2020), Park (2004); Puspita (2016), Ramsden (1997) used open-ended questions in this regard.

According to the abovementioned literature, students' difficulties relating science topics and concepts to daily life continue from primary school to university. In addition, when the studies are examined, it is noteworthy that multiple-choice tests are mainly used to determine students' levels of relating science topics to daily life. The studies using daily life association tests consisting of open-ended questions are limited. In addition, no test was found in the literature review to determine the ability of middle school students to associate the topics of light propagation with daily life.

This study aims to develop an open-ended test to determine the level of 5th-grade students associating the topics related to the "Propagation of Light" unit with daily life events. This study is also thought to contribute to developing learning-teaching activities that will serve critical purposes in science teaching, such as developing students' creative and critical thinking skills, reducing misconceptions, and relating scientific knowledge to daily life. Therefore, the PoLDAT to be developed in this study is expected to make an original contribution to literature.

2 Method

2.1 Research design

Within the scope of the research, a measurement tool consisting of open-ended questions was developed to determine the 5th-grade students' associations of the topics related to the "Propagation of Light" unit with daily life events (The PoLDAT). A mixed-methods research model incorporating qualitative and quantitative methods is employed for test development, validation, and revision. This approach conceptualizes test development, validation, and revision as an integrated and cyclical set of procedures. Additionally, the study provides a systematic guide to the open-ended test development process by detailing the key 'stages,' 'levels,' and practical 'tasks' involved in these procedures. (Luyt, 2012).

2.2 Participants

Due to the development of a test consisting of open-ended questions in the study, detailed data was collected from a small number of students (20 sixth-grade students). Sixth-grade students were chosen for the test development process because they had already studied the "Propagation of Light" unit.

During the implementation phase of the developed test, 119 fifth-grade students participated in the study. The school where the research was conducted was selected using purposive sampling, a non-random sampling method. Among the various purposive sampling techniques, easily accessible case sampling was preferred. This method allows researchers to conduct in-depth studies by selecting information-rich cases relevant to the purpose of the research (Büyüköztürk et al., 2010). Convenience sampling, as a subtype of purposive sampling, involves selecting a sample that is easily accessible to the researcher, thereby facilitating speed and practicality in the research process (Yıldırım & Şimşek, 2018).

2.3 Steps of test development

In the test development process, the following steps should be followed in order: clearly defining what is to be measured, specifying the theoretical structure of the variables in detail, creating a question pool, deciding on the format of the measurement tool, having the items reviewed by experts, ensuring item validity, applying the scale, evaluating the items, and finalizing the test (Şahin & Boztunç Öztürk, 2018). A similar approach was adopted in this study.

The following steps were employed in the development and implementation process of PoLDAT:

1. Determination of the subject to be measured
2. Conducting a literature review
3. Creating a question pool for the PoLDAT
4. Conducting validity and reliability studies for the PoLDAT
5. Obtaining the necessary permissions for the pilot and primary implementation of the PoLDAT
6. Pilot and main implementations of the PoLDAT
7. Analyzing quantitative data and reporting the results

Literature reviews and expert opinions are frequently utilized in scale development studies (Şahin & Boztunç Öztürk, 2018). In this study, while developing test questions, a literature review was initially conducted based on the topics and learning outcomes of the 5th-grade "Propagation of Light" unit. Activities and exercises related to the "Propagation of Light" unit in current science textbooks were analyzed as part of this process. Furthermore, questions, study fascicles, worksheets published on the official website of the General Directorate of Measurement, Evaluation, and Examination Services under the Ministry of National Education, and sample questions from PISA were reviewed. Based on these examinations, a question pool comprising 36 items was developed.

At the end of this process, 12 questions that were thought to represent the learning outcomes were selected from the pool of 36 questions by an assessment and evaluation expert and two science teachers with at least 15 years of experience. According to the opinions of the assessment and evaluation expert and science teachers, some changes were made to the questions, such as correcting the text and adding visuals. Some of the changes made in determining the test questions are as follows:

> "A favorite guest will come to the Aslı family's house for dinner in the evening. Her mother asked Aslı to help her set the dinner table. Aslı will put forks and spoons on the table. Her mother asks Aslı to put new forks and spoons instead of the forks and spoons they use every day. While placing the spoons, Aslı notices her image on the spoon. She is surprised that she has not noticed this before. Then she goes to the kitchen and looks at the spoons they have used daily for years. However, she cannot see herself on these spoons. She wonders why and asks her science teacher at school the next day. What explanation do you think the science teacher gave to Aslı?"

In line with the comments received from the evaluators, this question was simplified as follows to increase clarity:

> "Aslı prepares the table for the guests coming for dinner and puts the new forks and spoons instead of the old forks and spoons they always use. While placing the spoons, Aslı notices her reflection on the new spoon. Looking at the old spoons, she cannot see her reflection. What could be the reason for this?"

In another question that required students to draw, the three-dimensional image was changed to a two-dimensional one to make it easier for students to draw, and an area for drawing was added to the question. The image in the question before and after the editing is presented in Figure 1.

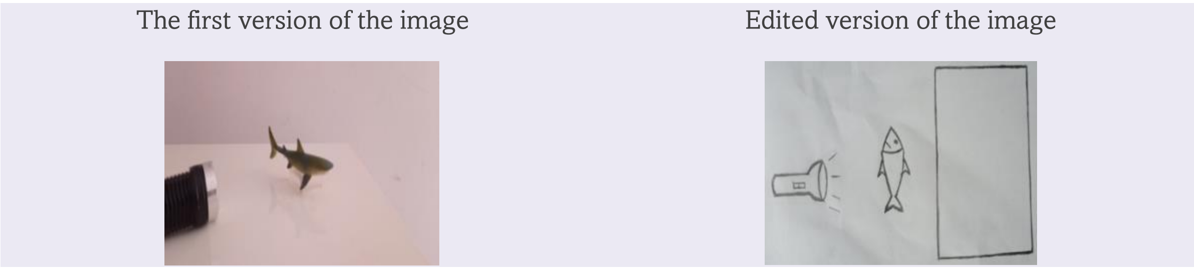


Figure 1 First and final version of the image used in the question

At the end of this process, a draft test consisting of 12 questions was administered to a pilot group of 20 sixth-grade students. Sixth-grade students were chosen because they had studied the unit on the propagation of light in the fifth grade. During the pilot application, it was observed that completing the test with 12 questions exceeded the planned time. Consequently, it was decided to reduce the number of questions in the test.

The students' response speeds were considered to determine which questions to remove. Reducing the number of questions from 12 to 10 was deemed appropriate. The responses were then analyzed to identify which questions should be removed. Answers were coded based on the criteria specified in Table 3, and the corresponding score values were assigned to each code. The questions' frequency, percentage, and mean scores were analyzed using these values.

The analysis revealed that *Question 3* had a very low mean score (Mean = 0.30), indicating that students struggled to interpret it correctly. Therefore, it was decided to remove Question 3 from the test. The removed Question 3 is presented in Figure 2.

"***Question 3***. Seeing that the car he has not used for a long time is covered in dust, Melih notices that the car's color appears quite dull. However, when he wipes away some of the dust with his finger, he realizes that the car has a shiny color. Why does the car appear dull when covered in dust? Explain."

Figure 2 Removed question from the test

Additionally, Question 12 in the test has been removed from the form. The learning outcome intended to be assessed by this question is now aimed at being measured through a revised version of Question 10. (see Figure 3).

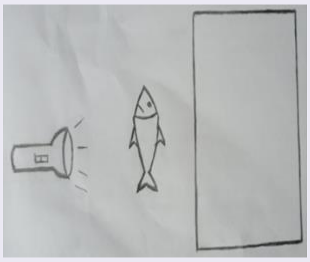
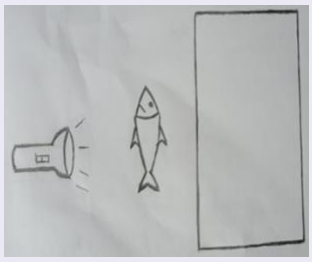
The first version of question 10	The final edited version of question 10
On an evening when the electricity is out, Ensar is playing with shadow puppets with his sibling. He places different objects in front of the flashlight and observes the shadows formed on the wall. When Ensar places a fish-shaped toy in front of the flashlight and turns it on, what kind of shadow will appear on the wall? Illustrate by drawing. 	On an evening when the electricity is out, Ensar is playing with shadow puppets with his sibling. He places different objects in front of the flashlight and observes the shadows formed on the wall. When Ensar places a fish-shaped toy in front of the flashlight and turns it on, what kind of shadow will appear on the wall? Illustrate by drawing. What should Ensar do to increase the length of the shadow? 

Figure 3 Initial and final version of the 10th question

Following the pilot implementation, interviews were conducted with students who scored the lowest and the highest on the test to gather their opinions about the questions—the pilot testing aimed to identify parts of the test that were unclear or overlooked by the students. Based on students' feedback, some questions were revised. An example of the revised questions, updated in line with student feedback, is provided in Table 1.

Table 1 Sample question revised according to student opinions

The initial version of the question	Revised version after pilot testing	Student opinion as a reason for the revision
"Farmers use glass or plastic materials to cover the outside of greenhouses. What could be the reason for choosing these materials? What would happen if they used tulle curtains and dark-colored fabrics instead?"	"Farmers use glass or plastic materials to cover the outside of greenhouses: i) What could be the reason for choosing these materials? ii) What would happen if they used a tulle curtain instead of glass or plastic? iii) What would happen if they covered it with dark-colored fabric instead of glass or plastic?"	"Evaluating the tulle curtain and the dark-colored fabric together was confusing because they were mentioned in the same sentence."

As a result of the steps outlined above, the final PoLDAT form consisting of 10 open-ended questions was created. The specification table for the PoLDAT is shared in Table 2.

Table 2 Specification table for the PoLDAT

Topic	Learning outcome	Question number	Cognitive Level
Propagation of Light	F.5.5.1.1. Observes and illustrates that light from a source travels in all directions and a straight path.	1 2	Comprehension Application
Reflection of Light	F.5.5.5.2.1. Observe and illustrate the reflection of light on smooth and rough surfaces.	3 4	Application Application
	F.5.5.2.2. Explains the relationship between the incident ray, reflected ray, and the normal on a surface.	5	Synthesis
Interaction of Light with Matter	F.5.5.3.1. Classify materials based on their transparency to light.	6 7	Analysis Evaluation
Full Shadow	F.5.5.4.1. Observes and demonstrates how a complete shadow is formed through simple ray diagrams.	8 9	Comprehension Application
	F.5.5.4.2. Discovers the variables affecting the formation of a complete shadow through experiments.	10	Application

2.4 Reliability

Since PoLDAT consists of open-ended questions, scorer reliability was used to determine reliability. After determining the scoring criteria (based on the scoring rubric of Abraham, Williamson Westbrook, 1994) for the questions in the test, the researchers prepared an answer key, and scoring was performed based on this answer key. The researcher and a science teacher scored the data with 17 years of expertise in the field.

The level of reliability between the two scorers was determined using Cohen's Kappa coefficient. To calculate scorer reliability, the pre-test and post-test responses of 20 randomly selected students from the sample were evaluated independently by two scorers, following the methodology described in the studies of Canpolat and Ayyıldız (2019). Cohen's Kappa coefficient (K value) was computed individually for the overall test and each question. To ensure unbiased evaluations, the scorers did not mark their assessments directly on the scale but recorded them in charts prepared by the researchers.

Cohen's Kappa coefficient assesses agreement when the variable under analysis is categorical or ordinal and when scorers evaluate independently without mutual influence. A Kappa value below 0.20 indicates insufficient agreement, between 0.21 and 0.40 indicates low agreement, between 0.41 and 0.60 indicates moderate agreement, between 0.61 and 0.80 indicates good agreement, and between 0.81 and 1.00 indicates excellent agreement (Can, 2013). The Kappa coefficient results for the scale are tabular in the findings section.

2.5 Data analysis

Descriptive analysis was conducted on the research data, considering the mean, percentage, and standard deviation values. For scoring open-ended questions in the PoLDAT, the scoring rubric used by Abraham et al. (1994) was applied. The researchers created A response key according to the criteria in the scoring rubric (see Table 3), and student responses were scored according to the response key. Table 3 shows the degree of understanding considered in the scoring, the corresponding scores for the degree of understanding, and the scoring criteria.

Table 3 Scoring rubric (based on the scoring rubric of Abraham et al., 1994)

Numerical Score	Understanding Level	Scoring Criteria
0	No understanding (NU)	Repeating the question, empty, irrelevant answers, lack of explanation
1	Misconception (MC)	Scientifically incorrect answers
2	Partial understanding of misconception (PUMC)	Answers containing partial understanding and misconceptions
3	Partial understanding (PU)	Answers containing some of the scientifically accepted answers
4	Complete understanding (FU)	Answers containing the full scientifically accepted answer

The PoLDAT consists of 10 open-ended questions, and students who answer all the questions at a complete understanding level according to the scoring key receive 40 points. After the students' responses are evaluated according to the scoring key, the total points they receive are converted into the hundred-point grading system used in schools.

3 Findings

In this section, the descriptive data obtained from the pilot testing will first be presented, followed by the results of the actual application of the PoLDAT. The lowest, highest, and average scores, along with the standard deviation values from the pilot testing data, are summarized in Table 5. An examination of the data in Table 5 reveals that the average score for Question 3 is notably low (mean = 0.30). A review of the responses indicates that most participants either misunderstood the question or requested that it be repeated. Since it became clear that the students did not fully comprehend the question, it was decided to remove it from the test.

Following these steps, the final version of the test, consisting of 10 questions, was developed. The finalized PoLDAT was administered to 119 fifth-grade students. After the test, the inter-rater agreement for the average evaluation scores was calculated as 0.85, indicating a very high level of consistency between the two raters. The Kappa coefficient values for each question in the test are presented in Table 4.

Table 4 Kappa coefficient results for each question of PoLDAT

Questions	1	2	3	4	5	6	7	8	9	10
K score	0.903	0.867	0.806	0.862	0.870	0.862	0.832	0.840	0.795	0.871

According to the Kappa coefficient values presented in Table 4, there was good agreement for the ninth question and excellent agreement for the other questions between the two raters for each question.

Table 5 Descriptive analysis results of pilot testing

Question number	Lowest score	Highest score	Average score	SD
1	0	4	3.05	1.316
2	1	4	3.40	0.940
3	0	2	0.30	0.571
4	0	3	1.20	1.281
5	0	4	2.35	1.899
6	0	4	2.50	1.051
7	0	4	2.10	1.071
8	0	3	1.00	0.858
9	0	4	2.80	1.056
10	0	4	2.60	1.535
11	0	4	1.60	1.429
12	0	4	2.90	1.55

Finally, for the actual implementation of the PoLDAT, the frequency and percentage distributions of the answers according to the categories in the scoring rubric are given in Table 6.

Table 6 Frequency and percentage distributions of responses

Questions	N.U		M.C.		P.UM.C.		P.U.		F.U.	
	f	%	f	%	f	%	f	%	f	%
1	13	10.9	2	1.7	27	22.7	36	30.3	41	34.5
2	1	0.8	18	15.1	22	18.5	15	12.6	63	52.9
3	26	21.8	11	9.2	13	10.9	16	13.4	53	44.5
4	38	31.9	11	9.2	23	19.3	13	10.9	34	28.6
5	12	10.1	13	10.9	25	21.0	18	15.1	51	42.9
6	3	2.5	17	14.3	31	26.1	30	25.2	38	31.9
7	44	37.0	0	0	11	9.2	11	9.2	53	44.5
8	10	8.4	2	1.7	22	18.5	23	19.3	62	52.1
9	1	0.8	12	10.1	42	35.3	33	27.7	31	26.1
10	13	10.9	33	27.7	37	31.1	10	8.4	26	21.8

No understanding (NU); Misconception (MC); Partial understanding with misconception (PUMC); Partial understanding (PU); Full understanding (FU)

As shown in Table 6, there is a notable prevalence of misconceptions and partial understanding regarding the unit on light propagation. Students demonstrate particularly low comprehension levels in questions related to the reflection of light (questions 3 and 4) and question 7, which focuses on the interaction of light with matter. Conversely, the findings reveal that more than half of the students achieved complete understanding (FU) in questions 2 and 8. Question 10 had the highest number of misconceptions (MC and PUMC).

4 Results and discussion

In this study, the PoLDAT test, consisting of 10 open-ended questions supported by images, was developed to assess the extent to which 5th-grade students can relate the topics of the "Propagation of Light" unit to real-life events. Open-ended questions were preferred in the test because they allow students to provide original answers based on their thoughts. Furthermore, students can elaborate on their reasoning while writing their answers, support their ideas with data, or express their responses through diagrams (Park, 2004; Puspita, 2016; Ramsden, 1997).

The process of developing the questions for the test began by examining examples and exercises from the current textbook, skill-based sample questions, and study booklets published by the Ministry of National Education (MoNE). Additionally, questions from previous years' LGS (the centralized placement exam for high school admission in Türkiye) and PISA science sample questions relevant to the topic were analyzed. This analysis was conducted within the 5th-grade unit on "Propagation of Light," focusing on the curriculum's specified topics and learning outcomes.

Following this preliminary review, a draft comprising 36 questions was prepared. A specification table (see Table 2) was created to ensure the content validity of the draft questions. This table outlines the associated learning outcomes and cognitive levels based on Bloom's Taxonomy for each question. The authors reviewed the draft questions and the specification table. As a result of this review process, 12 questions were selected that effectively assessed students' ability to connect the subject's learning outcomes to real-life situations. These 12 questions were evaluated by an assessment expert and two science teachers, each with over 15 years of experience. Some revisions were made to question texts in line with their feedback, and visual elements were added where necessary.

A pilot application was then conducted with 20 sixth-grade students who had previously studied the "Propagation of Light" unit. Feedback from this pilot application led to further refinements, including simplifying some question items and removing two questions from the test based on item statistics. These steps helped enhance the validity of the test.

On the other hand, since the test included open-ended questions, inter-rater reliability was assessed, and Kappa coefficients were calculated. To achieve this, two raters independently scored data from the pilot study, and the agreement between them was evaluated using Cohen's Kappa coefficient. As a result of these studies and analyses, the test's validity and reliability were established. Consequently, a test (The PoLDAT) comprising 10 open-ended items was developed to evaluate the real-life connections in the 'Propagation of Light' unit. The final version of the PoLDAT is included in the appendix of Nazife Aktaş's (2023) master's thesis.

The literature indicates that assessing students' ability to relate concepts to real-life situations can enhance their science achievement, interest in science, and motivation (Arık Gungor & Saracoglu, 2023; Bortnik et al., 2021; Taasoobshirazi & Carr, 2008; Ülger et al., 2018). In this context, it can be argued that such tests, which help students connect school subjects to real-life events, not only function as measurement and assessment tools but also foster students' interest, improve their thinking skills, and ultimately facilitate meaningful learning.

The students questioning, "Why are we learning these topics?", "Where will we use this knowledge?" and "How is this knowledge connected to daily life?" during lessons highlight the importance of relating lesson content to real life for meaningful learning (Pekdağ et al., 2013). If students cannot connect science topics and concepts to their daily lives, they may perceive these concepts as abstract and difficult, seeing them as merely subjects to learn for school purposes (Yıldırım & Maşeroğlu, 2016). Reducing the perception that science topics are difficult depends on helping students realize that the concepts and principles learned in science can be applied to solving real-life problems (Göçmençelebi & Özkan, 2011).

Literature on this topic (Ormancı & Çepni, 2018; Kabuklu & Kurnaz, 2019) indicates that students' inability to relate science topics to daily life hinders knowledge transfer and affects the development of their scientific thinking skills. Therefore, practices that provide students with opportunities to connect science lessons to daily life can enhance their understanding of the subject and scientific thinking skills.

At this point, teachers are expected to intentionally integrate real-life connections into science lessons, providing opportunities for students to apply their scientific knowledge in everyday contexts. Moreover, future curriculum updates should emphasize the link between science topics and real-life applications. In this context, the updated 2024 Science Curriculum, developed within the framework of the 'Türkiye Maarif Model' (Türkiye's Education Model), highlights the importance of strengthening the connection between science topics and real-life experiences in both teaching-learning processes and assessment practices (MoNE, 2024).

4.1 Conclusion

In this study, the daily life association test developed for the "Propagation of Light" unit aims to assess students' ability to relate science topics to real-life situations. The findings revealed that students struggled to apply the content learned in science lessons to understand and explain real-world events they encounter daily, and they exhibited misconceptions. In this context, teachers need to consciously employ methods that link science lessons to everyday life and for curricula to incorporate this approach. Such integration makes science topics more meaningful and strengthens the learning process. Feedback from the students during validity and reliability studies of the developed test further underscores the importance of these applications in education.

The PoLDAT, developed in the study, serves as a valuable tool for assessing students' understanding and identifying misconceptions about the propagation of light and for diversifying science teaching approaches. These approaches can foster students' problem-solving, creativity, and reflective thinking skills, enabling them to recognize the connections between scientific phenomena and real-world events.

5 Statements of researchers

5.1 Conflict statement

The authors declare no potential conflicts of interest.

References

Abraham, M. R., Williamson, V. M., & Westbrook, S. L. (1994). A cross-age study of the understanding of five chemistry concepts. *Journal of Research in Science Teaching, 31*(2), 147–165.

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice.* Teachers College Press.

Aktaş, N. (2023). The effect of context-based REACT teaching model on students' level of associating science with daily life and their motivation toward science (Master's thesis, Ordu Üniversitesi, Fen Bilimleri Enstitüsü).

Arık Gungor, B., & Saracoglu, S. (2023). Content analysis of theses on context-based learning approach in science education. *Anadolu Journal of Educational Sciences International, 13*(2), 564–598. https://doi.org/10.18039/ajesi.1118396

Aydın Gürler, S. (2022). Association level of the knowledge on "Pure Substances and Mixtures" of secondary school students with daily life. *Ahi Evran University Journal of Kırşehir Education Faculty, 23*(1), 822–862. https://doi.org/10.29299/kefad.918847

Ayvacı, H. Ş., Er Nas, S., & Dilber, Y. (2016). Effectiveness of the context-based guide materials on students' conceptual understanding: "Conducting and insulating materials" sample. *Van Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 13*(1), 51–78.

Balkan Kıyıcı, F., & Aydoğdu, M. (2011). Determination of pre-service science teachers' levels of relating the scientific knowledge to their daily lives. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 5*(1), 43–61.

Bennett, J., & Lubben, F. (2006). Context-based chemistry: The Salters approach. *International Journal of Science Education, 28*(9), 999–1015.

Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Science Education, 91*(3), 347–370.

Bodur, Ş., & Şahin, Ç. (2017). The relation between the secondary school 7th grade students' learning styles and associating skills the science subjects to daily life. *Ahi Evran University Journal of Kırşehir Education Faculty, 18*, 65–79.

Bortnik, B., Stozhko, N., & Pervukhina, I. (2021). Context-based testing as assessment tool in chemistry learning on university level. *Education Sciences, 11*(8), 450.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, S., & Demirel, F. (2010). *Scientific research methods (6th edition)*. Pegem Akademi.

Campbell, B., & Lubben, F. (2000). Learning science through contexts: Helping pupils make sense of everyday situations. *International Journal of Science Education, 22*(3), 239–252.

Can, A. (2013). *SPSS ile nicel veri analizi*. Pegem Akademi.

Canpolat, E., & Ayyıldız, K. (2019). Level of 8th grade students' ability to relating science course with daily life. *Anadolu University Journal of Education Faculty, 3*(1), 21–39.

Chiappetta, E. L., Koballa, T. R., & Collette, A. T. (2002). *Science instruction in the middle and secondary schools*. Merrill.

Coştu, B., Ünal, S., & Ayas, A. (2007). The use of daily-life events in science teaching. *Ahi Evran University Journal of Kırşehir Education Faculty, 8*(1), 197–207.

Çelik, D., & Güler, M. (2013). Examination of realistic problem-solving skills of sixth grade students. *Journal of Dicle University Ziya Gökalp Faculty of Education, 20*, 180–195.

Dede Er, T., Sen, O. F., Sari, U., & Celik, H. (2013). The level of association for primary school students between science and technology course and daily life. *Journal of Research in Education and Teaching, 2*(2), 209–216.

Demircioğlu, H., Bektaş, F., & Demircioğlu, G. (2018). The effect of teaching of topic of properties of liquids with context-based approach on students' achievement. *Journal of Dicle University Ziya Gökalp Faculty of Education, 33*, 13–25.

Demircioğlu, H., & Özdemir, R. (2019). The effect of context-based learning approach on prospective teachers' understanding of nanotechnology. *Journal of Computer and Education Research, 7*(14), 314–336. https://doi.org/10.18009/jcer.576978

Derman, İ., & Senemoğlu, N. (2020). Seventh-grade students' levels of associating science courses with real life. *Education and Science, 46*(206), 107–129. https://doi.org/10.15390/EB.2020.9178

Doğan, S., Kırvak, E., & Baran, Ş. (2004). The levels of secondary school students making connection between daily life and the knowledge gained during biology lectures. *Erzincan University Journal of Education Faculty, 6*(1), 57–63.

Elmas, R., & Geban, Ö. (2016). The effect of context-based chemistry instruction on 9th-grade students' understanding of cleaning agents topic and their attitude toward the environment. *Education and Science, 41*(185). https://doi.org/10.15390/eb.2016.5502

Feinstein, N. W., Allen, S., & Jenkins, E. (2013). Outside the pipeline: Reimagining science education for nonscientists. *Science, 340*(6130), 314–317.

Genç, M., Söğüt, S., Gün Şahin, E., & Zeynoğlu, E. (2023). A systematic review on context-based learning in science education. *Erzincan University Journal of Education Faculty, 25*(3), 538–550. https://doi.org/10.17556/erziefd.938861

Gilbert, J. K. (2006). On the nature of "context" in chemical education. *International Journal of Science Education, 28*(9), 957–976.

Göçmençelebi, Ş. İ., & Özkan, M. (2011). Does the use of technology and reading scientific publications affect the ability to relate science lesson knowledge to daily life: A comparative study of Turkish primary school students. *Journal of Uludag University Faculty of Education, 24*(1), 287–296.

Gül, Ş., Yalmancı, S. G., & Yalmancı, E. (2017). The effect of REACT strategy in teaching of "Excretory System" subject. *Kastamonu Education Journal, 25*(1), 79–96. https://doi.org/10.24106/kefdergi.308057

Hançer, A. H., Şensoy, Ö., & Yıldırım, H. İ. (2003). An evaluation about the importance of contemporary science education at elementary schools and how this kind of science teaching must be. *Pamukkale University Journal of Education, 13*(13), 80–88.

Hürcan, N., & Önder, İ. (2012, September). Determination of the relationships between the science concepts that the 7th grade primary school students learn in science and technology lessons and daily life. *National Congress of Science and Mathematics Education, Niğde*, September (pp. 27–30).

Kabuklu, Ü. N., & Kurnaz, M. A. (2019). Thematic review of context-based instruction studies made in Turkey in science education. *Asian Journal of Instruction, 7*(1), 32–53.

Karslı, M. D. (Ed.). (2012). *Introduction to educational science (4th edition).* Pegem Akademi.

Karslı, F., & Saka, Ü. (2017). The effect of the context-based approach on 5th grade students' conceptual understanding about "Getting to Know Foods." *Elementary Education Online, 16*(3), 900–916. https://doi.org/10.17051/ilkonline.2017.330230

Karslı Baydere, F., & Aydın, E. (2019). Teaching "The Eye" topic through the explanation-assisted REACT strategy of the context-based approach. *Gazi University Gazi Faculty of Education Journal, 39*(2), 755–791. https://doi.org/10.17152/gefad.345897

Karslı Baydere, F., & Kurtoğlu, S. (2020). The effect of REACT strategy on 5th grade students' conceptual understanding of biological diversity. *Yüzüncü Yıl University Journal of Education, 17*(1), 1015–1041. https://doi.org/10.33711/yyuefd.800921

Keleş, İ. H., & Dede, H. (2020). Teaching "pure substances, mixtures and separation of mixtures" topics with REACT strategy. *Bolu Abant İzzet Baysal University Journal of Faculty of Education, 20*(4), 1657–1675. https://doi.org/10.17240/aibuefd.2020.20.58249-618735

Keskin, F., & Çam, A. (2019). The effectiveness of context-based REACT strategy on sixth grade students' academic achievement and scientific literacy. *Mehmet Akif Ersoy University Journal of Education Faculty, (49)*, 38–59.

Kirman Bilgin, A., & Yiğit, N. (2017). Investigation of effectiveness of teaching materials based on REACT strategy on revelation of the relationship between "Density" concept and contexts. *Journal of Uludag University Faculty of Education, 30*(2), 495–519.

Korkmaz, Ö., & Buyruk, B. (2016). Students' correlation status of concepts of science and technology course in their daily lives. *Ondokuz Mayıs University Journal of Education Faculty, 35*(1), 159–172.

Magwilang, E. B. (2016). Teaching chemistry in context: Its effects on students' motivation, attitudes, and achievement in chemistry. *International Journal of Learning, Teaching and Educational Research, 15*(4), 60–68.

Majid, A. N., & Rohaeti, E. (2018). The effect of context-based chemistry learning on student achievement and attitude. *American Journal of Educational Research, 6*(6), 836–839.

Mercan, G., Gürlen, E., & Köseoğlu, P. (2019). Investigation of biology teacher candidates' ability to associate status of scientific information. *Journal of Qualitative Research in Education, 7*(1), 320–343.

MoNE [MEB]. (2024). *Science curriculum (Primary and secondary school grades 3, 4, 5, 6, 7 and 8).* Ankara: Presidency of the Board of Education and Discipline. https://tymm.meb.gov.tr/ogretim-programlari/fen-bilimleri-dersi

Luyt, R. (2012). A framework for mixing methods in quantitative measurement development, validation, and revision: A case study. *Journal of Mixed Methods Research, 6*(4), 294–316. https://doi.org/10.1177/1558689811427912

Ormancı, Ü., & Çepni, S. (2018). The thematic review of relating with daily life studies in science education. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 12*(2), 350–381.

Ormancı, Ü., Çepni, S., & Ülger, B. B. (2020). Determining secondary school students' understanding and relationship with daily life on cell subject. *Journal of Science Mathematics Entrepreneurship and Technology Education, 3*(2), 125–143.

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: A focus-group study. *International Journal of Science Education, 23*(5), 441–467.

Overton, T. (2007). Context and problem-based learning. *New Directions in the Teaching of Natural Sciences, (3)*, 7–12.

Park, J. W. (2004). Analyzing cognitive or non-cognitive factors involved in the process of physics problem solving in an everyday context: An effort for successful problem solving in an everyday context. *Journal of The Korean Association for Science Education, 24*(4), 774–784.

Pekdağ, B., Azizoğlu, N., Topal, F., Ağalar, A., & Oran, E. (2013). The effect of academic achievement on associating chemistry knowledge with everyday situations. *Kastamonu Education Journal, 21*(4), 1275–1286.

Pınar, M. A., & Dönel Akgül, G. (2023). Content analysis of graduate thesis studies on REACT strategy in science education in Turkey. *Atlas Journal, 9*(51), 1–13. https://doi.org/10.5281/zenodo.8356523

Puspita, D. (2016). The effectiveness of contextual approach in terms of conceptual understanding and learning motivation of junior high school students. *Jurnal Pedagogi Matematika, 5*(8). https://doi.org/10.21831/jpm.v5i8.4606

Putri, M. E., Mardiyana, & Saputro, D. R. S. (2019). The effect of application of REACT learning strategies on mathematics learning achievements: Empirical analysis on learning styles of junior high school students. *International Journal of Educational Research Review, 4*(2), 231–237.

Quainoo, B. A., Otami, C. D., & Owusu, K. A. (2021). Effect of the REACT strategy on senior high school students' achievement in molecular genetics. *LUMAT: International Journal on Math, Science and Technology Education, 9*(1), 696–716.

Ramsden, J. M. (1997). How does a context-based approach influence understanding of key chemical ideas at 16+? *International Journal of Science Education, 19*(6), 697–710.

Sak, M., & Kaltakçı Gürel, D. (2019). Comparing elementary school students' answers to the context-based and traditional questions in the topic of light with developed achievement tests. *Gazi University Gazi Faculty of Education Journal, 39*(2), 655–679.

Sbhatu, D. B. (2021). Challenges of 20th century Ethiopian science education. *Heliyon, 7*(6). https://doi.org/10.1016/j.heliyon.2021.e07157

Sheshtawy, O. M. M., Suudi, S. B., Hadi, M. A., Ramadan, S. B., & Ali, H. (2023). The effectiveness of the context-based learning approach in acquiring scientific concepts in science for primary school students. *Educational Research and Innovation Journal, 3*(10), 171–201.

Şahin, M. G., & Boztunç Öztürk, N. (2018). Scale development process in educational field: A content analysis research. *Kastamonu Education Journal, 26*(1), 191–199. https://doi.org/10.24106/kefdergi.375863

Şensoy, Ö., & Gökçe, B. (2017). The effect of the context-based learning approach on the achievement and motivations of students. *Journal of Academic Social Science Studies, 56*, 37–52. https://doi.org/10.9761/JASSS6997

Taasoobshirazi, G., & Carr, M. (2008). A review and critique of context-based physics instruction and assessment. *Educational Research Review, 3*(2), 155–167.

Uğraş, M., Aydemir, S., & Asiltürk, E. (2017). Analysis of pre-service science teachers' level of associating their chemistry knowledge with daily life and the relationship between these levels and their attitudes towards teaching science. *Journal of Human Sciences, 14*(4), 4539–4545.

Ülger, B. B., Ormancı, Ü., & Çepni, S. (2022). Associating the lesson plans developed by pre-service science teachers with daily life: A cell example. *Journal of Uludag University Faculty of Education, 35*(1), 91–106. https://doi.org/10.19171/uefad.815461

Yıldırım, A., & Şimşek, H. (2018). *Qualitative research methods in social sciences (11th edition).* Seçkin Yayıncılık.

Yıldırım, G., & Gültekin, M. (2017). Applications of context-based learning in primary 4th class science and technology course. *Ahi Evran University Journal of Kırşehir Education Faculty, 18*, 81–101.

Yıldırım, N., & Maşeroğlu, P. (2016). Predict-observe-explain-based activities in the association of chemistry with the daily life and student views. *Turkish Online Journal of Qualitative Inquiry, 7*(1), 117–145. https://doi.org/10.17569/tojqi.47585