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LEARNING STYLES OF A STORY ABOUT SUSTAINABILITY: THEIR EFFECT ON THE LEVEL OF QUESTIONING OF STUDENTS IN PRIMARY EDUCATION

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Abstract. *The use of stories in science education can make science more interesting and engaging, illustrate concepts, and provide opportunities for contextual and meaningful learning. Also, integrating a scientific story in which the sustainability goals are incorporated can lead to increasing students' motivation to learn as well as improve and facilitate the learning process. Having children ask questions allows the educator to learn about the child's insights, views, level of interest, motivation for learning, and knowledge. Therefore, this study focuses on the relationship between science storytelling, questioning, and sustainability among elementary school students. It compares the levels of questioning among primary students who learned a sustainability story in segments versus those who learned the story in its entirety. A quantitative study was conducted involving 120 second graders from the Arab sector in Israel. The results revealed a significant difference in the two groups' level of questions: the students in the experimental group, who learned the story in segments, asked higher-level questions than those in the control group. The study concluded that learning a scientific story in segments proved effective in enhancing primary students' questioning ability, and that there was a notable preference for this segmented storytelling approach over traditional whole unit learning methods.*
Keywords: *asking questions, science story, storytelling, sustainability education, text learning*

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Introduction

Education for Sustainability

Sustainability education is both a value and cultural education that deals with clarifying the values that guide people in their daily lives, on both a personal and social level. Sustainability education also applies basic principles in value education; these principles include narrowing the gap between a person's beliefs and verbal statements as well as his lifestyle and daily behavior, e.g., setting a personal example, making decisions based on hard facts, as well as considering values (Van Poeck et al., 2016). Sustainability is generally not defined as a separate field of study, but rather, as a transversal field whose content is often integrated into other fields of study (Mintz and Tal, 2014). Sustainability education also encounters difficulties and challenges regarding implementing transformative pedagogies associated with sustainability. These difficulties and challenges are reflected in several important cognitive processes, such as research, criticism, and reflection, which develop value judgment or critical thinking (Sarid & Goldman, 2021).

Generally, the field of sustainability is currently integrated into curricula in various subjects and fields of study, such as agriculture, geography, science, and technology, as well as language, in the frameworks of elementary education, middle school, and upper school (Mintz and Tal, 2014).

Storytelling: Characteristics, Components, and Purposes

In general, stories have the power to immerse audiences in new or unusual situations; thus, they provide audiences with new experiences through "messengers", i.e., the characters in the story (Kromka & Goodboy, 2019; Nwoga, 2000; Hinyard & Kreuter, 2007; Tobias, 2011; Heimes, 2016; Woodside, 2010). Storytelling may use an educational or content-oriented

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approach to stimulate learning processes and conceptual changes (Downs, 2014). When storytelling is used to persuade audiences by incorporating a particular message, it can take on a persuasive character and influence the audience through stylistic and rhetorical means. In contrast, storytelling aimed at promoting deliberation tends to have a more balanced and dialogue-oriented tonality (Arnett et al., 2008), for example, by raising questions or presenting opposing viewpoints (Lengauer et al., 2012).

The advantage of using stories to assess knowledge lies in the fact that the learner is required to take the information conveyed to him and formulate it in his own words (Csikar & Stefaniak, 2018). In this context, Kromka and Goodboy (2019) emphasized that "good" storytelling performed correctly makes effective use of the narrative by directing students to the relevance of the narrative. It creates a clear beginning, body, and end, emphasizing students' evaluation of the content. In addition, it builds connections and finds the missing links; it uses a positive emotional tone and ensures that the students understand the context correctly.

People can learn new facts from stories with some degree of success without prior exposure by using traditional teaching methods (Dahlstrom, 2014; Marsh, 2003). Importantly, a digital story helps students improve their communication skills, increases their motivation, creates contacts and social connections through a shared experience, and serves as a means of increasing their involvement in the learning process (Campbell, 2012; Hwang et al., 2016; Kilic, 2014; Morais, 2015).

Scientific storytelling can be used as a means of conveying complex scientific information in the classroom (Csikar & Stefaniak, 2018). A scientific story includes three aspects: (1) *the plot's structure*: A typical plot structure has six essential components: (i) setting the scene – the introduction or beginning; (ii) a problematic situation - a problem that arises, usually of a scientific nature, or science is involved; (iii) a crisis - something must be done by the main character due to the same problem; (iv) a critical decision - the main character makes a crucial choice; (v) the climax - the story reaches a turning point, when events change rapidly, for better or worse; and (vi) the conclusion - the problematic situation is resolved in either a positive or negative way. (2) *The outcome of the story* depends on a critical choice, or the choices made by the main character. (3) *Science and the content of the essence of science*. Depending on its purpose, a scientific story will contain scientific content and/or the nature of science. This content should be assimilated from the point of view of the characters and should appear natural and necessary so that the story can properly develop (Klassen & Klassen, 2014).

The use of storytelling that relates to sustainability in the context of education almost inevitably brings up a discussion about normativity, i.e., a discussion about the manner of behavior expected of individuals and groups in a certain society, behavior that is perceived as acceptable and proper according to the society's values (Ehrenfeld, 2008). In the humanistic tradition, education concerns helping learners better relate to the world in which they live, successfully deal with the challenges they face, and empower them to change the world for the benefit of all (Masschelein, 2004). Storytelling in the context of sustainability contributes to positive changes towards sustainability, and it increases the ability of the learners to act with self-determination and persistence. It must foster awareness, challenge basic assumptions, clarify values and ideas regarding what kind of sustainability is desired, and empower individuals and groups to act accordingly (Fischer et al., 2020).

Reading Comprehension

It was found that a text that is well organized and that clarifies to the reader the nature of its structure in terms of the information it contains, improves the reader's understanding, recall, and ability to apply the information presented (Jian, 2019; Liang et al., 2017). A text can be presented either as one complete unit or as short segments. These modes of presentation involve two possible procedures for presenting complex teaching materials: a conventional procedure and an alternative one. In the conventional procedure, in the first step, a complete set of the material is presented, and only then are the elements that comprise it, separately revealed, one by one, with the learner controlling the timing of the transition from element to element. The rationale behind this procedure is that exposing the entire material in the first stage can allow the learner to build a coherent context, which helps learning in the second stage, where the learner focuses on each of the elements separately. However, the disadvantage of this procedure, especially when there is a high level of interactivity between its elements, concerns the overload placed on the learner's working memory. This could diminish the possibility of building a coherent context and could decrease the efficiency of the entire procedure. On the other hand, in the alternative procedure, the order is reversed: the elements are first presented separately, one after the other,

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when the learner has control over the timing of the transition from element to element, and only then is the entire material completely presented (Mayer & Chandler, 2001; Mayer et al., 1999).

Mayer et al. (1999) hypothesized that presenting the elements separately as a first step is more effective for complex learning materials. The students in their study watched an animation depicting the formation of lightning while listening to a suitable narration. The findings indicated better performance in measures of transfer and retrieval in the group of students who watched the animation in small units, compared with the group of students who watched the animation in large units.

Robinson et al. (2003) asked students to study material that included a relatively long text. Some students received the original text as one large unit, and the remaining students received the original text in seven small text units. In a recall test at the macro level, it was found that presenting large units was more effective than presenting small units. The researchers attributed these findings to the design of the conditions of the small units in their study.

In his research, Ayres (2006) examined the effect of a strategy used to separate elements in a solution of an algebraic exercise and consequently on students' learning. The students were requested to focus on solving one component of the exercise, and in the next stage, to focus on the next component, and so on. It was found that in solving the exercise the strategy of separating the elements reduced the level of cognitive load in both groups of students.

Asking Questions

In general, having students ask questions is an essential cognitive strategy, since the act of composing questions focuses students' attention on the content and the main ideas as well as determines whether the content is properly understood (Yu et al., 2015; Su & Chen, 2018). Garcia and colleagues (Garcia et al., 2014) added that asking questions is a cognitive strategy that fosters understanding; as a learning strategy, it is involved in creating meaningful learning. This strategy was found in previous studies to have positive effects on student performance in various aspects, such as understanding, motivation to learn, positive attitudes towards the subject studied, more diverse and flexible thinking, problem-solving skills, and developing a cognitive and metacognitive strategy (Chin & Brown, 2002; Chin & Osborne, 2008; Song et al., 2017; Yu et al., 2015; Yu & Liu, 2008; Yu et al., 2013). According to the classification of Pizzini and Shepardson (1991), students' questions can be divided into three types according to the cognitive level of the questions: input, processing, and output. Input-level questions require students to remember information from sensory data. In contrast, processing-level questions require them to draw connections between the data, and output-level questions require them to go beyond the data to hypothesize, generate, and evaluate information.

The strategy or skill of asking questions in science has many advantages, as reflected in the goals of using this strategy. These goals include developing curiosity and stimulation towards further learning, developing creative thinking, providing all students with an opportunity to express their personal points of view and interests, focused thinking, experiencing a critical or important stage in the scientific research process, developing the ability to link several factors using prior knowledge, developing the ability to identify a problem, legitimizing uncertainty in learning and science, and creating an opening for a research/learning process (Chin & Osborne, 2008). Despite the many contributions and benefits of having students ask questions, as described above, accumulating evidence indicates that most of the questions in the classroom are asked by the teachers, and only a minority are asked by the students (Eshach et al., 2014; Kaya, 2014; Su & Chen, 2018). Furthermore, the questions that students ask are of a relatively low level (Garcia et al., 2014). A variety of reasons and factors can explain the small number of questions asked by students in class and their low level, for example, the didactic teaching style of the teacher, a competitive and unfriendly atmosphere in the classroom (Jung et al., 2016), and limited teaching time (Chin & Osborne, 2008).

Blonder et al. (2008), who examined students' skills of asking questions during a chemistry laboratory class, classified their questions into three levels: Level 1- questions regarding the topic under discussion; Level 2 - questions regarding scientific equipment and scientific methods; and level 3 - questions concerning the phenomenon in real life. They found that the highest and most complex level of the students' questions is level 3 because it requires them to understand the subject being studied, the tools and methods of measurement, and above all, the ability to transfer this knowledge to real-life situations. However, they found that students rarely ask level-3 questions.

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In science classrooms, asking questions is the most crucial aspect of inquiry learning (Tan & Seah, 2011). Learning should be designed to enable students to build their own knowledge (Zion & Sadeh, 2007). In inquiry learning, instead of teacher-guided materials, students' curiosity drives the lessons. In this learning framework, students are free to ask questions, gather information, and analyze it to answer the questions (Jorgenson et al., 2004). Because students are actively involved in these processes, they retain more of their learning for a longer time and therefore are more motivated to learn (Pedrosa-de-Jesus & Watts, 2014).

Asking or creating questions is a metacognitive process because it focuses students' attention on the content and promotes deeper thinking. The nature of students' questions indicates their understanding of the course material (Chin & Osborne, 2008), as well as their misconceptions about the subject (Pedrosa-de-Jesus & Watts, 2014). Asking questions may even help teachers determine the direction of the lesson and see the teaching materials from different perspectives (Chin & Brown, 2002). A certain period (sometimes years) is considered critical in terms of developing the ability to create questions in general, and at higher levels (Kaya & Temiz, 2018).

Considering the importance of students asking questions, the current study will present a possible framework linking it to the important teaching practice of telling stories, which can help elevate the level of students' questions. It will relate to the issue of sustainability, a cultural value issue that is topical and of great importance nowadays. More specifically, the study will describe the positive effect of storytelling in relation to sustainability and how it contributes to primary school students by elevating their level of asking questions on both the theoretical and applied levels. At the theoretical level, the research expands the existing knowledge regarding science students' ability to ask questions. This topic has recently gained increased interest in the scientific-educational literature. At the applied level, and based on the current research, the development and implementation of the scientific topic "the sustainability story in short segments" encourages and promotes the creation of questions among the students and provides them with practical strategies and tools to promote the skill of asking high-level questions.

Problem

The research problem addressed in this study revolves around the skill of asking questions among students in the context of learning a narrative text about sustainability. Specifically, the study examined whether the mode of presenting the narrative text (in short segments versus in its entirety) affects young students' level of questioning. The central goal was to determine how storytelling, when utilized as a teaching practice in sustainability education, can influence the depth and complexity of students' questions.

Aim and the Research Question

This study compared two modes of learning a story: one where the narrative is presented in short segments and another where it is presented in its entirety. The main interest lies in researching how these two modes affect the level of young students' questioning in the context of sustainability education. The research question is: Is there a difference between the level of questions asked by students who studied a story about sustainability in short segments and those who studied it in its entirety?

Hypothesis

The hypothesis is that there is a difference in the level of questions asked by students who studied a story about sustainability in short segments and those who studied it in its entirety: the level of questions of students who studied the story in short segments would be higher than the level of questions of those students who studied it in its entirety.

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Research Methodology

General Background

The research hypothesis was tested using the quantitative approach due to its suitability for the present study: an objective examination (as much as possible) of the correlations between variables without the researcher's personal interpretation or conclusion. In addition, the quantitative approach (a quasi-experimental design, which makes it possible to carry out experiments under field conditions) allows a high level of research generalization and maintains the principle of repeatability, and its reliability is relatively high (compared with the reliability of qualitative research) (Creswell, 2014).

Each of the students in the control group received a complete story on sustainability from the teacher; they studied it, and finally answered the questions that appeared at the end of the story for two consecutive lessons (90 minutes). In contrast, each student in the experimental group received the same story from the teacher; however, the story was divided into short sections. After the students read a certain passage, they answered the questions that appeared at the end in two consecutive lessons (90 minutes). The students in both groups wrote their answers regarding the text. Next, the students were asked to write questions that came to them after they had read the story.

The procedure of the research was carried out during science lessons for second grade students in the 2022/2023 academic year; the students were taught by two science teachers in each of the schools that participated in the study. Note that the teachers did not intervene during the study, apart from minimal interventions of clarifications and explanations to the students, if necessary. The full texts were collected by the teachers at the end of the lesson.

Sample

The study involved a sample of 120 students from four second-grade classes in two primary schools located in the Arab sector in northern Israel. Each school had two second-grade classes, and the participants were randomly divided into two groups: an experimental group (*N*=30) and a control group (*N*=30); each group comprised students from one grade.

Several factors were considered:

1. **Representation**: Given the localized nature of the study within the Arab sector in northern Israel, having 120 students from four different second-grade classes from two primary schools helps in obtaining a fair representation of the population in this specific geographic and cultural setting.
2. **Randomized Group Allocation**: The division of participants into experimental and control groups, each with 30 students, allows making a balanced comparison between the groups. This balanced design enhances the statistical power of any comparisons made, providing a clearer understanding of any effects observed.
3. **Homogeneity**: The relative homogeneity of the sample with respect to key variables such as gender, learning disabilities, academic achievements, and socioeconomic status, helps to control potential confounding variables. This control increases the likelihood that any observed differences are due to manipulation in the study rather than to extraneous variables.
4. **Convenience Sampling**: Although convenience sampling was used due to the accessibility of the students to the researcher, it was thought that the size of 120 students might help in overcoming some of the biases associated with this non-random sampling method by providing a larger pool of participants from which to draw conclusions.
5. **Statistical Power and the Effect Size**: The sample size of 120 can offer a good balance between achieving sufficient statistical power to detect effects (if they exist) while remaining manageable in terms of resources and logistics.
6. **Practicality**: The sample size is also justified on practical grounds, since it aligns with the resources, access, and time available to the researcher.

In sum, the sample size of 120 students seems to be a well-considered choice given the localized setting, the study design, and the practical constraints faced by the researcher.

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In computational terms, the formula for calculating the required sample size for a proportion in a large population, when the population's proportion is known or assumed, is given by:

$n=(Z/E)^2 \cdot p(1-p)$

where:

- Z is the z-score (which corresponds to the desired confidence level, 1.96 for 95% confidence).
- E is the margin of error= .05
- p is the estimated proportion= .91

$n= (1.96/.05)^2*0.085(1-0.085) =120$

The sample of students was relatively homogeneous with respect to variables such as gender, the number of children with learning disabilities, academic achievements, and socioeconomic status. For the sake of good order and orderly ethics and before the texts (of both types) were transferred to all classes, the study was presented and all participants were asked to give their consent to participate, it was made clear that the worksheets would be anonymous, and the data would be used for research purposes only. Also, and for the sake of professional ethics, after the end of the research, the control group that studied the text in its entirety, the teacher was asked to choose an environmental science story and teach the text in a fragmented manner.

Instrument and Procedures

The first story, "Rose in the Dark", is a symbolic story that demonstrates to the student the importance of taking care of the Earth in which we live, and not polluting the air so that adequate light reaches us. The second story, "The Polluted Lake", is about a group of animals that live near a lake. A real disaster occurs because of sewage water pollution. The animals decide to deal with the problem of environmental pollution to preserve their natural environment.

The two stories were compiled by Hugerat (2007). The stories are intended to increase students' awareness of sustainability. Importantly, they even strengthen three additional aspects for the students: the scientific-environmental aspect, the social aspect, and the educational aspect. The stories are accompanied by questions that were also composed by Hugerat (2007). The stories are in Arabic, the native language of the research sample. The two stories, including the questions about their content, in order to evaluate the students' understanding, were presented in two ways: as a complete story, and as a story composed of short segments that have a gradual connection between them. The students in the two classes were randomly divided into two groups: one group served as a control group (that learned the subject of sustainability through a complete story), and the second group was an experimental group (that learned the subject of sustainability through a story that appeared in short segments). Each group studied for three lessons; each lesson lasted 45 minutes. The described study procedure was carried out by two science teachers; as mentioned, the teachers did not intervene during the study, except for minimal interventions of clarifications and explanations to the students, if necessary. The full texts were collected by the teachers at the end of the lesson.

The research was carried out in the following stages:

1. Each story was presented in two ways: as a complete story and as a story consisting of short segments that maintain a gradual connection between them. The questions in the complete story appeared at the end, whereas the questions in the story in segments appeared after each segment, according to its content. The two ways in which the stories were presented in the study (described in the previous segment) were examined by two experts who have a PhD in science teaching and who have a deep knowledge of the subject. They were asked to refer to the following: the clarity of the stories and questions, how well the stories and questions were adapted to the level of the research sample, how well the short segments were adapted to the purposes of the research, as well as the length of the questions. Following their comments, the questions were changed accordingly. Then, two Arabic language researchers with PhDs were asked to comment on the interpretation of the sentence's meaning, wording, and clarity. The comparison at the end of the process showed that there was "almost" full agreement of the assessments of the two lecturers. The comments made to the research editor focused on grammatical and clarity issues.

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2. The students in the two classes were randomly divided into two groups: one group served as a control group (they learned about sustainability through a complete story), and the other group was an experimental group (they learned about sustainability through a story that appeared in short segments). In the pre-intervention phase, the basic question levels of the students in the control group and the experimental group were tested. In this test, the students read a science story presented in its entirety. Similarly, the students' level of understanding of the story they had read was also tested. The students answered questions about the content of the story. In the intervention phase, each student in the control group read a complete story about sustainability, studied it, and then answered the questions that appeared at the end of the story. In contrast, each student in the experimental group read the same story, which was divided into short segments. After the students read a certain passage, they answered in writing the questions that appeared at the end. Next, the students were asked to write down any questions that they had after they had read the story.
3. In another stage after the intervention, the level of the questions and the level of understanding of the two groups of students were determined again, after the intervention.
4. The data were analyzed regarding the level of the questions that the students raised about the content of the story they had read. In addition, the data obtained from the students' answers to the questions were analyzed regarding their understanding of the content in the stories.

Data Analysis

To examine the research hypothesis, the data collected on the level of the students' questions (the types of questions) in both groups were evaluated and coded according to Bloom's taxonomy (Bloom, 1956). Bloom described six levels of questions (1-knowledge, 2-understanding, 3-application, 4-analysis, 5-synthesis (fusion), and 6-evaluation), according to the level of thinking that they activate in the questionnaire (from the lowest to the highest level).

In the next step, to examine the research hypothesis, a *t*-test for independent samples was conducted to determine whether there was a significant difference in the level of questions asked by students in the experimental group (learning the story in short segments) and students in the control group (learning the story in its entirety).

In addition, the students' answers to the questions that appeared at the end of the story (the control group), or after reading each passage (the experimental group) were analyzed. The data collected on the answers of the students in both groups were evaluated and coded according to seven criteria as follows: (1) the sentence structure – the creation of a sentence that makes sense and has internal coherence, (2) causality – the use of inference and reasoning while using an explicit expression that affects relationships, (3) direct reference of the answer to the question - understanding the question and organization in writing the answer; (4) coherency: the fluency of words - the total number of words used by the writer; (5) the fluency of ideas - the total number of ideas expressed by the writer in each answer; (6) knowledge - the level of knowledge shown by the student on the topic being studied; and (7) originality - reference to answers that indicate unconventional thinking, where the rating for each criterion ranges from 1 to 6, 1- the lowest rating, up to 6 - the highest rating (Calpon & Eshel, 1999).

In the next step, to evaluate the students' answers, an additional *t*-test for independent samples was conducted to determine whether there was a significant difference in the students' level of understanding and their knowledge of the subject being studied (the content of the story) between students in the experimental group) and in the control group.

Research Results

Descriptive Results

Before testing the research hypothesis, the descriptive indices (e.g., minimum, and maximum values, mean and standard deviation) of the research variable were examined in the two groups, in both measurements (pre-test and post-test). The results are shown in Table 1.

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Table 1
Descriptive Indices of the Research Variable - The Level of the Students' Questions

Variable	Min	Max	*M*	*SD*
Control Group-				
First measurement	1	2	1.03	0.57
Second measurement	1	2	1.15	0.95
Experimental Group-				
First measurement	1	3	1.4	0.8
Second measurement	1	4	3.10	1.20

As shown in Table 1, the averages in the first measurement of the general question level in the experimental group and the control group were lower than in the center of the scale. In the second measurement, the averages of the general question level in the experimental group were in the center of the scale (3), and in the control group, they were lower than the center of the scale. Thus, the questions asked by the students in the control group and the experimental group (respectively) were at a low level in the first measurement, and at a low-to-medium level in the second measurement.

Inferential Results

As mentioned, the research hypothesis was that the level of questions from students who studied the story in short segments (the experimental group) would be higher than the level of questions from students who studied the story in its entirety (the control group). To test the research hypothesis, a two-way mixed design ANOVA was used. The between-subjects independent variable was the study group, and the within-subjects independent variable was the measurement time. The dependent variable was the measured values. Two such analyses were performed: one for the variable of the level of questions asked by the students, and one for the variable of the students' level of understanding. First, the variable level of students' questions was tested. The results are presented in Tables 2-4.

Table 2
Means and Standard Deviations of the Level of the Student's Questions, Divided by the Measurement Time

Levels of Student's Questions	Experimental Group		Control Group	
	M	*SD*	*M*	*SD*
First measurement	1.40	0.80	1.03	0.57
Second measurement	3.10	1.20	1.15	0.95

Table 3
Results of the Analysis of Variance for the Level of the Students' Questions - Variables within Subjects

The Source of Variation	*SS*	*df*	*MS*	*F*	*p*
The Measurement Time	3.41	1	3.41	224.30	< .001
Interaction - Measurement Time X Study Group	3.32	1	3.32	212.52	< .001
The Error Factor (Time of Measurement)	0.53	116	0.08		

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Table 4
Results of the Analysis of Variance for the Level of the Students' Question Variables between Subjects

The Source of Variation	*SS*	*df*	*MS*	*F*	*p*
The Research Group	5.73	1	5.73	36.39	< .001
The Factor of Error (Study Group)	7.06	116	0.28		

As shown in Table 3, in accordance with the research hypothesis, a significant interaction was found between the study group and the measurement time (F (1,116) = 212.52, p < .001). In addition, significant main effects were found for the measurement time (F (1,116) = 224.30, p < .001) and the study group (F (1,116) = 36.39, p < .001).

To locate the source of the interaction, a Bonferroni post-hoc test was used. In accordance with the research hypothesis, it was found that in the experimental group, the level of questions asked by the students in the second measurement (M = 3.10, SD = 1.20) was significantly higher (p < .001) than in the first measurement (M = 1.40, SD = 0.80). It was also found that in the control group, the level of questions asked by the students in the second measurement (M = 1.15, SD = 0.95) did not significantly differ (p = .735) from the first measurement (M = 1.03, SD = 0.57). Therefore, the research hypothesis was confirmed.

In addition, the variable level of students' understanding was tested. The results are presented in Tables 5-7.

Table 5
Means and Standard Deviations of the Students' Level of Understanding, Divided by the Measurement Time

Students' Level of Understanding	Experimental Group		Control Group	
	SD	*M*	*SD*	*M*
First Measurement	0.66	1.37	0.81	1.05
Second Measurement	1.40	4.20	1.84	1.55

Table 6
Results of the Analysis of Variance for the Students' Level of Understanding - Variables within Subjects

The source of variation	*SS*	*df*	*MS*	*F*	*p*
The Measurement Time	1.76	1	1.76	158.30	< .001
Interaction - Measurement Time X Study Group	1.63	1	1.63	189.46	< .001
The Error Factor (Time of Measurement)	0.38	116	0.09		

Table 7
Results of the Analysis of Variance for the Students' Level of Understanding - Variables Between Subjects

The source of variation	*SS*	*df*	*MS*	*F*	*p*
The Research Group	8.65	1	8.29	27.09	< .001
The Factor of Error (Study Group)	12.07	116	0.63		

As shown in Table 6, in accordance with the research hypothesis, a significant interaction was found between the study group and the measurement time (F (1,116) = 189.46, p < .001). In addition, significant main effects were found for the measurement time (F (1,116) = 158.30, p < .001) and the study group (F(1,116) = 27.09, p < .001).

To locate the source of the interaction, a Bonferroni post-hoc test was used. In accordance with the re-

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search hypothesis, it was found that in the experimental group, the students' level of understanding in the second measurement (M = 4.20, SD = 1.40) was significantly higher (p < .001) than in the first measurement (M = 1.37, SD = 0.66). It was also found that in the control group, the level of the students' understanding in the second measurement (M = 1.55, SD = 1.84) did not significantly differ (p = .441) from the first measurement (M = 1.05, SD = 0.81). From these findings, apparently, students who learned about sustainability in short segments of a story improved their level of understanding in comparison with those who learned it in its entirety.

Discussion

Considering the importance of the skill of asking and answering questions by science students, especially among students at the beginning of their schooling, and since this skill is hardly reflected in science classes, this study tried to examine a teaching method that may elevate the level of students' questions. Specifically, it examined how the learning mode of a science story on sustainability, presented in short segments, affected the level of questions asked by students.

As hypothesized, it was found that students who studied the story presented in short segments asked questions at a higher level than students who studied the story presented in its entirety: the average level of questions of students who studied the story on sustainability continuously in short segments (M = 3.10) was higher than the average level of questions of students who studied it as one unit (M = 1.15) (Table 2).

The research results, which generally indicated the usefulness of a science story presented in short segments, compared to a whole unit, are consistent with previous empirical findings that showed that learning a text in small units yields better results than learning it in one large unit (Mayer & Chandler, 2001; Mayer et al., 1999; Minaee et al., 2021; Yang et al., 2020).

A possible explanation that supports the research findings is based on the theory of cognitive load in learning. Cognitive overload occurs when the demands placed on the learner by the task exceed the capacity of the learner's attentional resources (Sweller, 1994; 2011). In this situation, both learning and the learner's performance are adversely affected, as found in Ayres' research (Ayres, 2006). Cognitive load theory assumes that there are three types of cognitive load: internal load, external load, and relevant load (Moos & Pitton, 2014; Tricot et al., 2020; Zhou & Lamberton, 2021). Internal load refers to the degree of complexity of the subject being studied; it is defined according to the number of elements that the learner's working memory must process at once, i.e., the interactivity of the elements. The complexity of the task also depends on the expertise of the learner. An assignment that is considered simple and with few elements for an expert learner is a complex assignment with many elements for a beginning learner. External load is created in a teaching environment that requires the learner to engage in activities that are not directly related to reaching a consensus or developing automaticity. Since working memory is limited, engaging in these activities places a load that is not conducive to learning. When the internal and external loads exceed the limits of the learner's working memory, learning is impaired. A relevant load can be defined as the mental effort required to learn content. This load is created by cognitive processes relevant to learning (processing, construction, and automation of schemes), and it is effective for learning.

Therefore, it can be assumed that the students in the control group, who learned the story as a whole unit, experienced cognitive overload when reading the story in its entirety, answering all the questions at the end, and especially when they were asked to ask questions themselves. This overload consisted of three types: (1) an internal load that resulted from the complex subject of sustainability that was learned through the story, (2) an external load resulting from the task of creating questions on their own about the content of the story, and (3) a relevant load that probably resulted from the great mental effort they had to make in processing information on a new topic (sustainability), which was presented to them as one long narrative text. In contrast, the students in the experimental group, who studied the text in short segments, experienced a lower level of cognitive load, because the text was presented to them in short segments. Consequently, they were able to ask questions at a higher level.

Support for the above explanation, based on the theory of cognitive load in learning, was obtained through the research findings that indicated that students who studied a story continuously through short segments had a better understanding of it than did students who studied the story as a whole unit (Tables 5-7). Therefore, it can be concluded that the students in the experimental group learned more than their counterparts in the control group due to the lower level of cognitive load in the experimental group and that this led to a higher level of questions that they asked compared with their peers in the control group.

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This finding perhaps indicates a connection between understanding educational content and the level of questions that can be asked about it. This assumption is supported by the claim in the literature that asking questions by students reflects their level of understanding the subject being studied (Bergey et al., 2022; Chin & Brown, 2002; Chin & Osborne, 2008; Maplethorpe et al., 2022; Song et al.., 2017; Su & Chen, 2018; Touissi et al., 2021; Yu et al., 2013, 2015; Yu & Liu, 2008).

Finally, the research results can be explained through the cognitive benefits and contributions attributed to the presentation of an educational text in short segments. Dividing the text into short segments, accompanied by questions to which the reader is asked to answer, helps the reader to focus on the task assigned to him and directs his attention to the pieces of information in the text that can help complete it. Therefore, it can be assumed that a short segment with questions about its content at the end promotes cognitive processes that ultimately make it possible for students to ask questions at a higher level. An important limitation is that in the statistical analysis, the research did not examine how the students' understanding of the story segments they had read affected the level of the questions they asked. It is reasonable to assume that students who understood better and more accurately the content they read could ask questions at a higher level than students who did not sufficiently understand what they had read.

Conclusions and Implications

The research results yield three significant conclusions: First, they demonstrate that the level of questions posed by young learners concerning sustainability shows a tendency towards being low to moderate, indicating a predominantly superficial cognitive processing approach. Second, the study provides supporting evidence for the efficacy of adopting a segmented approach in learning scientific narratives. It was shown that this approach effectively elevates the level of questioning among primary school students. Third, the results indicate a clear preference among primary school students for the segmented mode of learning when studying science subjects, as opposed to traditional whole-unit learning.

The study reveals that regardless of the learning method employed (i.e., short segments versus complete narrative), the overall level of questions regarding sustainability posed by primary level students in the Arab sector remains within the low to moderate range. However, students who learned the story in segmented form exhibited higher-level questioning compared with their counterparts who learned the story as a unified unit.

Consequently, the study advocates integrating scientific narratives tailored for segmented learning in primary school science curricula. Thus, it is imperative for primary science educators to incorporate these research insights into their professional development strategies. By employing practical approaches and utilizing resources according to the study's findings, educators can effectively break up scientific narratives into smaller, digestible segments, fostering curiosity among students and can stimulate the students to ask thought-provoking questions.

Finally, the research findings can be explained through the cognitive benefits and contributions attributed to presenting an educational text in short segments. Dividing the text into short sections, accompanied by questions to which the reader is asked to answer, helps the reader to focus on the task assigned to him and directs his attention to the pieces of information in the text that can help complete the task. Thus, it can be assumed that a short section with questions about its content at the end promotes cognitive processes that ultimately make it possible to ask questions at a higher level.

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Declaration of interest

The authors declare no conflict of interest.

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