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A RESEARCH OF THE VISUAL REPRESENTATION IN SCIENCE QUESTIONS OF HIGH SCHOOL ENTRANCE EXAMS IN TÜRKIYE BETWEEN 1999 AND 2022

UMA PESQUISA SOBRE A REPRESENTAÇÃO VISUAL EM QUESTÕES DE CIÊNCIAS NOS EXAMES DE ENTRADA DO ENSINO MÉDIO NA TURQUIA ENTRE 1999 E 2022

UNA INVESTIGACIÓN SOBRE LA REPRESENTACIÓN VISUAL EN LAS PREGUNTAS CIENTÍFICAS DE LOS EXÁMENES DE INGRESO A LA EDUCACIÓN SECUNDARIA EN TURQUÍA ENTRE 1999 Y 2022

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ABSTRACT: The study analyzes 610 science questions from Türkiye's high school entrance exams (1999–2022) to evaluate their visual representations. Using an embedded case study design and descriptive analysis, it examines visuals by subject area, year, placement, and role in problem-solving (ineffective, partial, effective). Findings show that visuals appear mainly in the subject areas "Living Things and Life" and "Physical Phenomena." Although visual types vary over time, schematic drawings remain the most frequent. Most visuals contribute only partially to solving the questions. Overall, the exams do not present a balanced distribution of visual content across subject areas.

KEYWORDS: High School entrance exams. Visual representation. Science questions.

RESUMO: *O estudo analisa 610 questões de ciências dos exames de admissão ao ensino médio da Turquia (1999–2022) para avaliar suas representações visuais. Utilizando um estudo de caso incorporado e análise descritiva, examina os recursos visuais por área temática, ano, nível de conhecimento e papel na resolução de problemas (ineficaz, parcial, eficaz). Os resultados mostram que os recursos visuais aparecem principalmente nas áreas temáticas de "Seres Vivos e Vida" e "Fenômenos Físicos". Embora os tipos de recursos visuais variem ao longo do tempo, os desenhos esquemáticos permanecem os mais frequentes. A maioria dos recursos visuais contribui apenas parcialmente para a resolução das questões. No geral, os exames não apresentam uma distribuição equilibrada de conteúdo visual entre as áreas temáticas.*

PALAVRAS-CHAVE: *Exames de ingresso ao Ensino Médio. Representação visual. Questões de ciências.*

RESUMEN: *El estudio analiza 610 preguntas de ciencias de los exámenes de ingreso a la escuela secundaria de Türkiye (1999–2022) para evaluar sus representaciones visuales. Utilizando un diseño de estudio de caso incrustado y un análisis descriptivo, examina los recursos visuales por área temática, año, ubicación y función en la resolución de problemas (ineficaz, parcial, eficaz). Los resultados muestran que los recursos visuales aparecen principalmente en las áreas "Seres vivos y vida" y "Fenómenos físicos". Aunque los tipos de recursos visuales varían con el tiempo, los esquemas siguen siendo los más frecuentes. La mayoría de los recursos visuales contribuyen solo de manera parcial a la resolución de las preguntas. En general, los exámenes no presentan una distribución equilibrada de contenido visual entre las áreas temáticas.*

PALABRAS CLAVE: *Exámenes de ingreso a la escuela secundaria. Representación visual. Preguntas de ciencias.*

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INTRODUCTION

Science education should be conducted through appropriate methods and techniques that take into account the child's interests and needs, developmental level, desires, and environmental opportunities, making it a simple and concrete form of education (Hançer et al., 2003; Böyük, 2017). Schools should be organized as social institutions that teach scientific process skills and ways of accessing knowledge in line with the needs of the era and society (Çetin, 2004; Karazeybek, 2020).

Once the content is determined and the learning environment is arranged, teaching begins in science education. Teaching consists of three stages: input, process, and output (Açıkgöz, 2003; Böyük, 2017). In the input stage, teaching materials, the teacher, the student, and the student's readiness level are included. In the process stage, the environment, the time allocated for education, and the way instruction is delivered are involved. In the output stage, the changes and learning outcomes that occur in the student are observed.

However, to monitor the changes in the output stage, measurement and evaluation must be carried out (Sönmez, 2007; Böyük, 2017). If measurement and evaluation are to be conducted only at the classroom or school level, achievement tests are used. But if measurement and evaluation studies are to be conducted at the national level and are expected to guide education policies, then national and international examinations are employed (Demirbaş, 2008; Böyük, 2017). National and international assessment studies determine the level of success in education of countries. According to this level of achievement, countries decide their future position in the global market and adjust or revise their education programs accordingly (Böyük, 2017).

Among these, Trends in International Mathematics and Science Study (TIMSS), Progress in International Reading Literacy Study, and Programme for International Student Assessment (PISA) are the most widely used. These exams make it possible to determine countries' educational rankings, policies, teaching processes, strengths, and weaknesses in education (Çelen et al., 2011; Karazeybek, 2020; Sırgancı, 2023). For example, in the 2015 PISA exam applied across OECD countries, Türkiye scored below the OECD average (Organisation for Economic Co-operation and Development [OECD], 2016). Similarly, in the 2018 PISA exam, Türkiye ranked 30th among 37 countries.

According to the OECD 2022 report, although Türkiye's science achievement score is still below the OECD average, it is also observed that Türkiye is the country that made progress in the last decade (OECD, 2016, 2022).

Studies in this field have focused on high school entrance, university entrance, and international exams such as TIMSS and PISA. However, in the international literature, the structures of exam questions themselves have not received as much attention (Borji & Sánchez,

2019; Rodrigo et al., 2018). Similarly, most of the studies conducted in Türkiye have examined high school entrance exam, TIMSS, and PISA, but the effects of question structures on student achievement are often overlooked (İnaltekin & Göksu, 2020).

In Türkiye, exam questions are mostly evaluated in terms of their alignment with the curriculum. However, in the international literature, there are relatively few studies evaluating the textual and visual structures of questions and their functions (Anagnostopoulou et al., 2012; Yeh & McTigue, 2009; İnaltekin & Göksu, 2020). Despite the recognized importance of national and international exams for a country's education system and society, there are very limited studies assessing the textual and visual structures and functions of science questions in these exams in Türkiye (Altun et al., 2016; İnaltekin & Göksu, 2020).

METHOD

In this study, the visual content of science questions asked in high school entrance exams is examined within certain limitations. Since there is no external intervention in the exam questions, a case study, one of the qualitative research methods, is employed. Case studies are descriptive analyses conducted by examining a particular phenomenon, document, or situation within specific boundaries (Merriam, 2002; Yin, 2009). In other words, it is a qualitative approach in which the researcher collects information about a specific phenomenon over a certain period of time through various materials and documents (Creswell, 2013; İnaltekin & Göksu, 2020).

The study can also be defined as an embedded single case study (Yin, 2009; MacDonald & Tipton, 1996; Bretschneider et al., 2017; İnaltekin & Göksu, 2020). The data source of this study consists of the science questions from the Secondary Education Institutions Entrance Exam (OKS) administered in Türkiye between 1999 and 2022. Yeh and Mc Tigue's (2009) eleven-part classification of visual content is as follows: Formatted Drawing(A1), Labeling (A2), Measurement Diagram(A3), Flowchart (A4), Table (A5), Graphics/Histogram (A6), Cross-section (A7), Hybrid (A8), Photograph (A9), Natural Drawing(A10) and Map (A11). (A) is the classification code for image types.

According to the rubric in which Yeh and McTigue (2009) have defined the role of the visual in solving science questions, a two-level classification is created as a partial and effective role of the visuals in question answering. In addition to this two-level classification, a category has been added in which visuals have no effect on question answering, and the rubric has been increased to three levels.

Visuals that have a partial role in question answering describe the situation in which the student needs both the visual and the question root to answer the question. Visuals that

have an effective role in question answering indicate the situation in which the student uses only visual representation to answer the question. Visuals that do not have a role in question answering describe the situation in which the student only needs the question root to answer the question. Questions involving visual representation are analyzed in these three categories. The calculations are made by using descriptive statistics such as frequency and percentage values of the data obtained from this qualitative study.

RESULTS

The rate of visual representation of the Science questions in the high school entrance exams according to the subject headings

When the data is examined, there are a total of 610 Science questions between 1999-2022. It is observed that 494 of these questions include visual representation. In addition, In addition, the subject with the most visual representation is “Physical Phenomena” with 205 questions, the subject with “Living Things and Life” with 153 questions, and the subject with “Matter and Nature” with 122 questions, while the subject with the least visual representation is “World and Universe” with 14 questions.

The rate of science questions in high school entrance exams according to the visual representation types over the years

When the distribution of visuals used in science questions in high school entrance exams by type and year is examined; it is seen that the drawing is the most preferred with 115 and the labeling with 97 pieces. It is seen that measurement diagram 49, flow chart 43, table 56, graphic-histogram 44 and hybrid 67 are frequently used visual representation categories.

In addition to these, a small number of science questions are used with 7 cross-sections, 8 photographs, 6 natural drawings and 2 maps. In addition, during the examination, it is determined that the highest use of visual representation was used in 2008 OKS with 25 and the least visual representation was used in 2021 LGS with 11. It is determined that all Science questions in these exams contained visual representation with 25 questions containing visual representation in the 2008 OKS and 20 questions in the 2016 TEOG 2. It is seen that these exams proportionally are the science exams with the most visual representation.

The distribution of visual representations in science questions in high school entrance exams by years in science subject areas

When the percentage distribution of visual content in science questions in high school entrance exams is examined according to the fields and the total number of questions: of the

total number of questions, 3.77% are "Earth and Universe," 34.26% are "Living Things and Life," 39.67% are "Physical Phenomena" and 22.29% are "Substance and Its Nature." When we look at these data, the majority of the science questions asked in high school entrance exams are "Substance and Its Nature" and "Living Things and Life."

The number of questions asked about the subject of "Earth and Universe", which is the least frequently asked topic, has been increasing in recent years. This shows that the subject of "Earth and Universe" is important. Considering the years, 80.98 percent of the science questions consist of questions with visual representation content. When we look at the subject headings, the subject with the least amount of visual representation content is the subject of "Earth and Universe" (56%). It is determined that the subject of science with the highest rate of visual representation is "Substance and Its Nature" (89.70%).

The distribution of visual representations in science questions in high school entrance exams according to subject areas

When the visual content of the Science questions in the high school entrance exam is examined in terms of subject areas and percentage distributions by year: it is seen that A8 (22%) visual content type on "Earth and Universe" is more than other types. In addition, it is seen that A3 and A7 visual contents are not included at all. It is observed that the questions of the "Earth and Universe" subject area are included at different rates compared to other types of visual content, albeit slightly. A2 (27%) visual content type is preferred more than the others in the "Living Things and Life." It is determined that the A11 visual content type is not preferred at all in the subject area of "Living Things and Life."

It is observed that other types of visual content are used at different rates. In the subject area of "Physical Events," it is seen that A1 (35%) visual representation is preferred more than other types of visual content. It is observed that the type of visual content that is not preferred at all in this subject area is A11. Other types of visual representation are used in different proportions. In the topic of "Substance and Its Nature," where the visual representation content rate is the highest, it is determined that the most preferred visual representation type is A5 (25%), and the visual content types that are not preferred at all are A9, A10 and A11.

Looking at all topics, A3 and A7 in the subject area of 'Earth and Universe'; A11 on "Living Things and Life"; Visual content types A11 for "Physical Phenomena" and A9, A10 and A11 for "Matter and Its Nature" are not used at all. When all four subject areas are examined, it is determined that the A11 visual content type is the least used visual content type. When we look at the years examined and the four subject areas, it is seen that the A11 visual content type is used only in 2 questions in the subject area of "Earth and Universe." It has been

determined that the most balanced distribution of visual content type among the subject headings is in the subject area of "Earth and Universe."

The effect of visual representations in science questions in high school entrance exams on answering questions

When the percentage distributions are examined, it is determined that in the subject area of "Earth and Universe," the questions were asked in the 2001 OKS, 2006 OKS, 2010 SBS 8, 2011 SBS 8, 2012 SBS 8, 2013 SBS 8, 2018 LGS, 2019 LGS and 2020 LGS exams, and there were no questions containing visual representation related to the subject area in the other exams. Visual representation plays a partial role in question answering in all of the questions containing visual representation in the 2001 OKS, 2006 OKS, 2013 SBS 8, 2019 LGS and 2020 LGS exams. We see that the image has no effect on the question answering in all of the questions in the 2011 SBS 8 and 2012 SBS 8 exams.

The partial and non-effective role of visual representation in question answering are used together in the questions asked in the 2010 SBS 8 and 2018 LGS exams. The partial role of visual representation in question answering is used in the majority of the questions asked in the subject area of "Living Things and Life." It is determined that visual representation is used in three roles in question answering in the "Living Things and Life" subject area questions asked in the 2004 OKS and 2019 LGS exams. The partial and active roles of visual representations in question answering are seen together in the 2000 OKS, 2001 OKS, 2003 OKS, 2007 OKS, 2013 TEOG 1 and 2015 TEOG 2 exams.

It is determined that the partial role of visual representation in question answering is mostly used in the subject area of "Physical Phenomena." The effective, partial and ineffective role of visual representation in question answering is used together at different rates in the 1999 OKS, 2000 OKS and 2019 LGS exams. The effective and partial role of visual representation in question answering is used in the 2001 OKS, 2002 OKS, 2003 OKS, 2008 OKS, 2013 TEOG 1, 2015 TEOG 1 and 2015 TEOG 2 exams.

When the subject area of "Substance and Its Nature" is examined, it is determined that the partial role of visual representation is mostly used. In addition, it is observed that the partial, effective and ineffective role of visual representation in question answering is used together in the 2019 LGS exam. The effective and partial role of visual representation in question answering is used in the 2001 OKS, 2002 OKS, 2003 OKS, 2005 OKS, 2007 OKS, 2010 SBS 8, 2015 TEOG 2 exams. In the 2020 LGS exam, the role of ineffective visual representation is 67%. This ratio shows that the vast majority of visual representations in the questions asked in the subject area of "Substance and Its Nature" in the 2020 LGS exam are used unnecessarily.

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CONCLUSION AND DISCUSSION

The rate of visual representation of the Science questions in the high school entrance exams according to the subject headings

It is seen that the visual content focuses on “Physical Phenomena”, “Living Things and Life” compared to the subjects of “Earth and Universe”, “Substance and Its Nature” in the questions examined. Many concepts in the field of physics are often difficult for students to understand through oral or written texts. For this reason, these concepts in the field of physics should be supported by visuals that students can understand correctly (Martin et al., 2012; İnaltekin & Göksu, 2020).

The situation that arises here can be explained by the fact that experts who prepare questions in the field of physics understand the importance of supporting the content of the topics not only with texts but also with visuals (İnaltekin & Göksu, 2020; Yeh & McTigue, 2009). In addition, it is a surprising result that the visual content is not concentrated on the topic of “Earth and Universe” in the field of physics, but on the topic of “Physical Phenomena” in the same field.

Another surprising result is that the visual content on “Living Things and Life” in the field of biology is more than the topic of “Substance and Its Nature” in the subject area of chemistry. This situation can be explained by the fact that the experts who prepare the questions on the topics of “Earth and Universe” and “Matter and Nature” in the science questions create question content only on texts instead of visually supported question contents, because it is easier to prepare this question structure than the latter.

Choosing and preparing an image suitable for the content of a problem is often seen as a laborious task in science (İnaltekin & Göksu, 2020). The images in the questions do not show a balanced distribution according to the subject headings. This shows that the experts who prepare the questions are either not given field-specific visual content training or they are weak in the subject (İnaltekin & Göksu, 2020).

The ratio of science questions in high school entrance exams to including visual representation

During the examination, it is determined that the highest use of visual content was used in the 2008 OKS with 25 and the least visual content was used in the 2021 LGS with 11 pieces. With 25 questions containing visual representation in the 2008 OKS and 20 questions in the 2016 TEOG 2, it is determined that all science questions in these exams contain visual representation.

These exams are proportionally the Science exams with the most visual representation. It is observed in the studies of İnaltekin and Göksu (2020) that the rate of visual representation in the questions asked in physics and chemistry courses has decreased in recent

years, while the rate of visual representation in the questions asked within the scope of the biology course has increased. Visual representation rates increase and decrease over the years, but we cannot say that there has been an increase or decrease in recent years on the basis of subject areas.

The distribution of visual representations in Science questions in high school entrance exams according to subject areas and years

When the distribution of the use of visual representation in science questions in high school entrance exams by years and subject areas is examined, the rate of questions with visual representation is higher than the questions without visual representation. In fact, it is seen that the rate of use of visual representation on the basis of the subject is high in the topic of "Substance and Its Nature."

In the 2015 TEOG 1 exam in the subject area of "Living Things and Life" and in the 1999 OKS exam in the subject area of "Matter and Nature," the number of questions without visual representation is higher than the number of questions with visual representation. In the 2021 LGS in the subject area of "Earth and Universe," there is no visual representation in any of the questions asked. In the subject area of "Physical Phenomena," the number of questions containing visual representation is high in all years.

When it is considered whether it contains visual representation on the basis of subject areas, the vast majority of the questions asked in all four subject areas (80.98%) contain visual representation. According to Martin et al. (2012); İnaltekin and Göksu (2020), supporting the subject areas with visuals is a good method to eliminate the misconceptions in the minds of the students. However, the use of written texts in the exams makes it difficult for students to understand the questions.

The distribution of visual representations in Science questions in high school entrance exams according to subject areas

When the visual content type distributions of the questions on the basis of subject areas are evaluated, it is determined that the percentage of hybrid in the subject area of "Earth and Universe," labeling in the subject area of "Living Things and Life," table in the subject area of "Substance and Its Nature," and drawing in the subject area of "Physical Events" are high. However, when all subject areas are examined, 115 of the 494 questions have a drawing. In other words, when all subject areas are combined, drawing has become the most preferred type of visual representation.

The least preferred type of visual representation in all areas is the map. In fact, it has never been preferred in subject areas other than the subject area "Earth and Universe."

According to Stern et al. (2003), drawing is mostly preferred in the exam questions examined and drawings are one of the most effective visual representations that can be preferred for students to improve their understanding of concepts in science. According to Yeh and McTigue (2009), the reason why drawing stands out in science questions is that information is most easily transformed into questions by drawing method.

According to İnaltekin and Göksu, this may be due to the easy preparation of this type. The result that drawing is mostly used in high school entrance exams is also seen in the studies of İnaltekin and Göksu (2020), in which they have examined the visual content of science questions in university entrance exams in Türkiye. In other words, the results of these two studies conducted in Türkiye are in parallel with each other.

However, in the studies of Yeh and McTigue (2009), it is stated that contrary to this research, the commonly used visuals are picture dictionaries, graphics and hybrid. Photographs and maps are included in many subjects in science textbooks (İnaltekin & Göksu, 2020). However, as a result of our examination, it is seen that the map is the least used visual representation content in the high school entrance exams in Türkiye. Our results are in line with the study conducted by İnaltekin and Göksu (2020).

The effect of visual representations in science questions in high school entrance exams on answering questions

When the roles of visual representations in solving questions are evaluated, it is seen that we could obtain few data in the subject area of 'Earth and Universe,' and in the data we have obtained, visuals have a partial or ineffective role in answering questions. None of the visual representations present in this subject area have an effective role in answering questions. The vast majority of visual representations in the topics of "Living Things and Life," "Physical Phenomena," "Substance and Its Nature" have a partial role in answering questions.

It is understood that the explanations, numbers, and symbols in the texts are exactly the visuals added to the question and appear to be repeated in the examined questions (İnaltekin & Göksu, 2020). So, the role of visuals is complete in such a question, and the text is understood as superfluous. In addition, the prominence of the partial role of visuals in question answering in science questions shows that some questions are difficult to structure only visually (Anagnostopoulou et al. 2012; İnaltekin & Göksu, 2020). This is because visuals alone are weak in presenting many topics in science. For this reason, some supporting information is needed in addition to visuals when preparing questions on such topics (İnaltekin & Göksu, 2020; Yeh & McTigue, 2009).

This research reflects the visual representation analysis results of the high school entrance exams administered between 1999-2022. New information can be obtained by

conducting similar studies in different exams. These evaluations, which are made with the science questions in the high school entrance exams, can be supported by in-class observations, student notebooks, textbooks, student interviews, and teacher interviews, and a richer definition opportunity can be obtained. The study is not limited to science courses and can be done on the basis of all courses.

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