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The effectiveness of using graphic design programs in enhancing visual thinking skills among educational technology students in Jordan

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Abstract

Graphic design programs enhance students' skills and enable them to gain new perspectives on complex data and facts by visually interpreting information through shapes and images. This study analyzes the impact of graphic design education on enhancing visual thinking skills among Educational Technology students in Jordan. A quantitative quasi-experimental approach with a single-group pre-and post-test design was employed. The study was conducted with 30 students from Middle East University during the second semester of the 2023-2024 academic year. A visual thinking skills test was developed as the primary tool. The results demonstrated that graphic design programs, which train students to think visually, significantly improve their ability to understand, distinguish, and differentiate between various images and shapes. The study concludes that integrating graphic design programs into educational curricula can play a vital role in fostering visual thinking skills, which are essential for critical analysis and problem-solving in Educational Technology. The study recommends that graphic design programs focus on practical training emphasizing visual skills, critical thinking, and problem-solving abilities.

Keywords: Educational technology, Effectiveness, Graphic design, Visual thinking skills.

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1. Introduction

Due to the rapid technological development in the fields of information and communication, the world is witnessing major changes in general and in the field of education in particular [1]. Humanity is currently experiencing a technological revolution that is transforming every aspect of life [2, 3], with the true wealth of nations rooted in the intellectual contributions of thinkers advancing knowledge [4]. This revolution highlights the importance of visual processing, as research reveals that the brain processes up to 36,000 images per minute, and 80-90% of the information it receives is visual, underscoring the brain's preference for visual data [5]. Visual processing plays a crucial role in engaging cognitive functions through sensory stimuli, which is essential for learning and problem-solving [6]. Graphic design programs, such as Adobe Illustrator, contribute significantly to enhancing analytical and interpretative skills by integrating visual communication elements, including typography, layout, and image processing [7, 8].

Graphic design tools, such as Adobe Illustrator, are effective in education because they help students interact with visual elements, organize compositions, and enhance spatial thinking skills [9]. Studies confirm the effectiveness of visual learning tools in enhancing higher-order thinking. For example, Raiyn [10] found that interactive visual aids significantly improve critical thinking skills, while Barnes, et al. [11] demonstrated that graphic media help with longer retention of information. Further, research by Huda, et al. [12] revealed that an interactive CD for teaching graphic design led to measurable improvements in students' abilities by tracking their progress. Similarly, Al Shamry and Sand [13] highlighted the significant impact of interactive infographics on visual thinking, and Elboksomaty [14] emphasized the importance of creative thinking strategies to overcome design challenges.

Graphic design, a practice as old as humanity itself, originated in ancient art, such as the Lascaux cave paintings, which were used for protection and ritualistic purposes [15]. Over the past two centuries, graphic design has evolved from traditional media to include interactive and user-centered design, with education in this field becoming widely available [16]. Graphic design is fundamentally about organizing text and images to convey messages visually, making it a powerful tool for communication [17].

By organizing information visually, graphic design engages learners and enhances visual thinking skills, which is essential for effective problem-solving and creativity [5]. Educational frameworks that focus on visual thinking can significantly enhance students' project development and information visualization skills [18]. Visual thinking, which includes the use of imagery, charts, and mind maps, supports the comprehension and retention of information. Individuals possessing strong visual skills often grasp concepts more quickly [19]. Visual thinking skills are crucial for problem-solving, creativity, and design comprehension. These skills involve distinguishing details (e.g., size, color, shape), visualizing concepts, organizing data spatially, recalling images, and analyzing relationships [20]. Design thinking combines creative and analytical methods, enhancing problem-solving capabilities in visual communication design [21].

Graphic design tools foster these skills by allowing users to interact with visual elements, organize compositions, and experiment creatively. The graphic design thinking model combines knowledge and cognitive dimensions, significantly enhancing creative thinking within design projects [12]. Encourage empathy and iterative processes, allowing designers to enhance their ideas through feedback and modeling [22]. Furthermore, the feedback provided by these tools helps users refine their designs, enhancing their visual analysis and critical thinking abilities [23]. Furthermore, the evolution of graphic thinking, including creative thinking and project thinking, is critical for adapting to new design process techniques and methodologies [24]. Studies confirm that the use of graphic design software in educational settings significantly enhances visual thinking and creativity in problem-solving [23, 25]. Visual thinking skills, such as processing data through charts, images, and designs, are crucial in today's technological environment. However, many students face difficulties in recognizing and creating visual connections between shapes and information [16]. Research has shown that graphic design software can significantly enhance these skills by promoting spatial organization, visual analysis, and creative problem-solving [10, 23]. Despite this, there remains a gap in understanding how these tools specifically support the development of visual thinking skills among educational technology students in Jordan. This study seeks to address this gap by investigating the effectiveness of graphic design programs in improving visual thinking skills and enhancing the ability to interpret visual information.

To achieve this goal, the researcher aims to answer the following question:

Is there a statistically significant difference at the significance level ($\alpha = 0.05$) between the pre-test and post-test results in visual thinking skills among educational technology students in Jordan after using graphic design programs?

2. Literature Review

Raiyn [10] study aimed to investigate how visual strategies for learning might improve students' ability to engage in higher-order thinking (HOT). [10]. The aim of the study was to improve these abilities by using interactive diagrams, charts, and other visual learning aids. The study evaluated the development of higher-order thinking abilities by contrasting visual learning strategies with conventional methods. It aimed to evaluate student performance and compare the effectiveness of visual learning against conventional teaching methods. The findings showed that students' capacity for higher-order thinking is significantly increased when they use visual aids in their learning.

Barnes, et al. [11] aimed to explore the effectiveness of graphic media, including infographics, in enhancing information retention compared to traditional texts [11]. The experimental study involved 400 students divided into two groups: one received content via visual media, and the other through conventional texts. Assessments through tests and questionnaires revealed that students exposed to graphic media retained information more effectively and for longer periods than those using standard texts.

Huda, et al. [12] developed and tested an interactive CD for teaching graphic design [12]. The experimental study involved 30 SMK school students, divided into groups. Interactive exams within the CD were used to track students' progress and engagement. Data analysis using descriptive statistics revealed that the interactive CD significantly improved students' educational attainment and graphic design skills.

Al Shamry and Sand [13] study highlights how interactive infographic design improves students' visual thinking skills and enhances their conceptual understanding by accelerating data processing and interpretation [13]. By involving college students from various ICT domains and adopting a mixed-methods approach, the statistically significant results in favor of the experimental group underscore the potential of this teaching strategy.

Elboksomaty [14] study aims to comprehend how inventive solutions to design challenges can be enhanced through the effective application of creative thinking strategies [14]. The researchers employed the analytical method to analyze and evaluate methods of creative thinking in graphic design. This approach included a review of current design practices, an examination of earlier studies, and the presentation of case studies illustrating the use of these techniques. The findings provided several helpful methods for using creative thinking to address design-related issues. Developing critical and creative thinking, growing mental flexibility, and applying experimental and methodical thinking are some of these techniques. According to the study, designers should keep up with the latest developments in graphic design technologies and trends to broaden their skill set and learn how to apply other modes of thinking to solve design problems.

3. Methodology

3.1. Research Design

A quasi-experimental design was employed in this study, utilizing pre- and post-tests within a single group of students. The pre-test was administered initially to assess the students' baseline visual thinking skills. Following this, the students underwent training using Adobe Illustrator, a graphic design program designed to enhance their visual thinking abilities. Figure 1 shows the four steps of visual thinking: In the first step, the students ask themselves, "What am I looking at?" After that, they ask themselves, "Have I seen this before?" Then, they will try to fill in the gaps and finally reflect on the visual information in their minds.

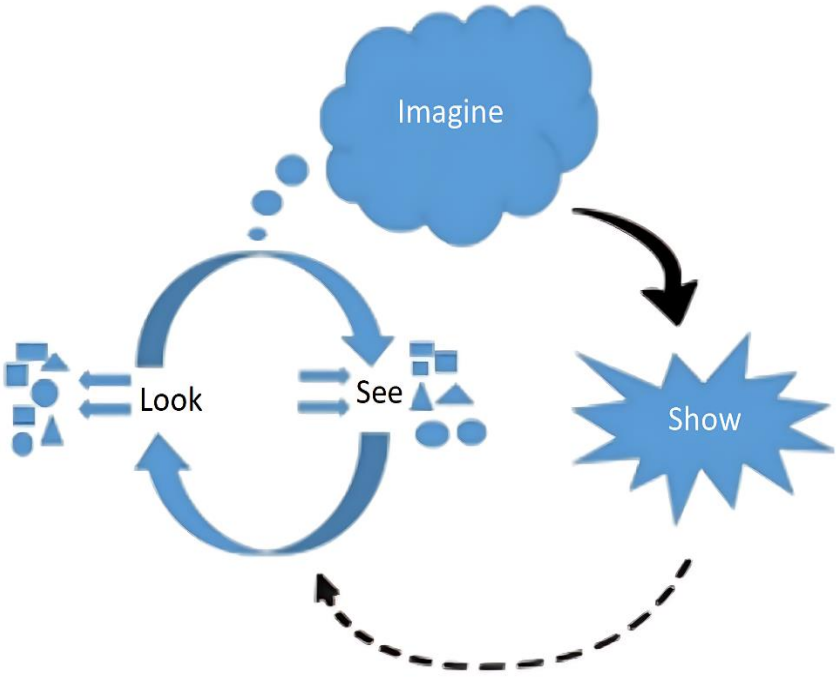

Figure 1.
Steps of visual thinking.

Previous illustrations were designed to enhance students' visual thinking skills during the training phase. These activities included multiple exercises such as identifying the embedded figure, choosing the correct image reflection, and completing a series of logical shapes (Sequential Pattern). Samples of activities are shown in the following Figure 2:

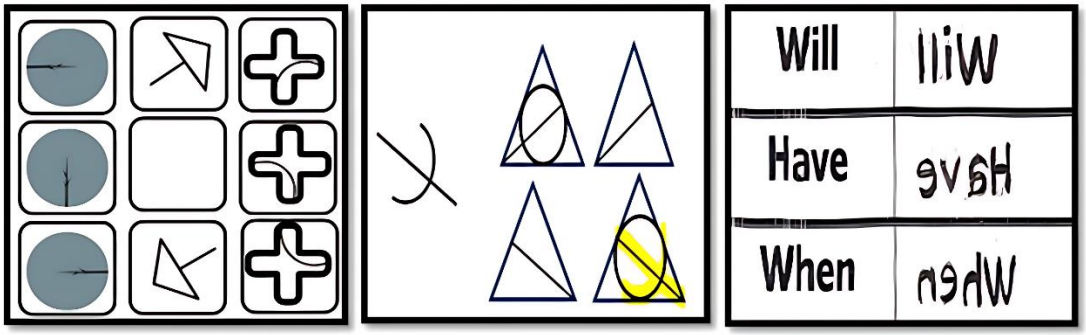

Figure 2.
Samples of visual thinking activities.

3.2. Participants

The study included 30 undergraduate students majoring in Educational Technology at the Middle East University in Jordan, specifically enrolled in a graphic design course. Purposeful sampling was used to select participants who were actively engaged in courses relevant to the study's focus. Students were required to have basic computer skills to interact effectively with the graphic design software (Adobe Illustrator) used in the study. Exclusion criteria included students not enrolled in the graphic design course, those without basic computer literacy, individuals with visual impairments that could affect their ability to engage with the study, and students who did not voluntarily consent to participate. This selection ensured the participants' alignment with the study's objectives and facilitated meaningful engagement with the study tools and methodology.

3.3. Data Collection

After the training, a post-test was conducted to pre-measure the students' visual thinking skills and compare the pre-test and post-test results to assess any improvements. To measure visual thinking skills, a 20-question test was developed based on a thorough review of relevant literature and previous studies by Montilla and Guirado [26] and Elboksomaty [14]. A team of experts in educational technology, psychology, measurement, and evaluation ensured the test's validity. Additionally, responses from a group outside the study sample were analyzed to determine the difficulty and discrimination indices of the test items. Table 1 presents these indices for each item, arranged in ascending order based on the discrimination index.

The reliability of the test was confirmed by calculating Cronbach's alpha coefficient, which yielded a value of 0.83, indicating a high level of internal consistency. This value is considered acceptable for this study and supports the robustness and validity of the findings. Table 1 shows that the difficulty indices of the test items ranged from 0.25 to 0.65, and the discrimination indices ranged from 0.40 to 0.80. Based on these ranges, all items are considered acceptable.

Table 1.
Difficulty and discrimination indices for the visual thinking skills test.

Item number	Difficulty index	Discrimination index
9	0.25	0.50
2	0.4	0.60
13	0.35	0.4
1	0.35	0.50
18	0.35	0.60
30	0.45	0.40
7	0.35	0.40
3	0.25	0.60
12	0.30	0.70
11	0.40	0.80
6	0.40	0.50
8	0.40	0.40
4	0.55	0.40
16	0.50	0.60
14	0.65	0.50
10	0.50	0.60
15	0.45	0.50
19	0.65	0.50
5	0.45	0.50
17	0.45	0.50
20	0.65	0.50

3.4. Data Analysis

The normality of the data was tested using the Kolmogorov–Smirnov and Shapiro–Wilk goodness-of-fit tests. To summarize the study sample's responses, means and standard deviations were calculated. A paired-samples t-test was then conducted to identify significant differences between the pre-test and post-test results. Additionally, Cohen's d effect size was calculated to measure the magnitude of the effect.

3.5. Findings

3.5.1. Normality of the Distribution

The Kolmogorov–Smirnov and Shapiro–Wilk tests were used to check the normality of the distribution. Table 2 presents the results of the Kolmogorov–Smirnov and Shapiro–Wilk tests for the pre-test and post-test of the student group.

Table 2.
Kolmogorov–Smirnov and Shapiro–Wilk test results on the pre- and post-tests of the student group.

	Kolmogorov-Smirnov[a]			Shapiro-wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Pre_ test	0.119	30	0.200	0.559	30	0.292
Post-test	0.146	30	0.100	.955	30	0.235

Note: a. Lilliefors Significance Correction.

Table 2 presents the results of the Kolmogorov-Smirnov and Shapiro-Wilk tests to assess the normality of the distribution for both the pre-test and post-test. The p-values for both tests (greater than 0.05) indicate that the data follow a normal distribution for both the pre-test and post-test. This suggests that parametric tests can be used for further analysis, as there is no significant deviation from normality in the data.

3.5.2. Difference Between Pre and Post-Test Scores of Visual Thinking Skills

Based on the alternative hypothesis (H_1), we assumed that there is a significant difference between the pre-test and post-test scores of visual thinking skills among educational technology students in Jordan. To test this, a paired samples t-test was conducted to identify any differences between the mean scores of the study group on the pre-test and post-test for visual thinking skills. The results are presented in Table 3.

Table 3.
Means, standard deviations, and t-tests for the difference between pre-test and post-test scores of visual skills among educational technology students in Jordan.

Test	Number	Mean	Std. dev.	t-value	DF	Sig
Pre-test	30	10.67	2.12	-3.66	29	0.001
Post-test	30	12.33	1.68			

Table 3 presents the results of the paired samples t-test comparing the pre-test and post-test scores for visual thinking skills among educational technology students in Jordan. The pre-test mean was 10.67, with a standard deviation of 2.12, while the post-test mean increased to 12.33, with a standard deviation of 1.68. The t-value was -3.66 with 29 degrees of freedom, and the p-value (Sig) was 0.001. Since the p-value is less than 0.05, the difference between the pre-test and post-test scores is statistically significant, indicating that the training program effectively improved the students' visual thinking skills.

Table 4.
Effect size of using graphic design programs on developing visual thinking skills among educational technology students.

Test	t-Value	Effect size(d)	Effect size sig
Visual T. S	3. 66	0.66	High

3.5.3. Effect Size of Graphic Design Training on Visual Thinking Skills

Table 4 presents the effect size for the impact of using graphic design programs on developing visual thinking skills among educational technology students. The t-value of 3.66 indicates a statistically significant difference between the pre-test and post-test scores. The calculated effect size (d) is 0.66, which is considered a medium to large effect, suggesting that the graphic design program had a considerable impact on improving students' visual thinking skills. The "Effect Size Sig" column confirms that the effect size is significant, indicating that the observed improvement is not due to random chance but a result of the training program.

4. Discussion

The results of this study provide valuable insights into the impact of using graphic design programs, specifically Adobe Illustrator, on the development of visual thinking skills among educational technology students in Jordan. Based on the alternative hypothesis (H_1), it was hypothesized that there would be a significant difference between the pre-test and post-test scores, reflecting an improvement in visual thinking skills after the training.

The paired samples t-test results, as presented in Table 3, revealed a statistically significant difference between the pre-test and post-test scores ($p = 0.001$), indicating that the graphic design program effectively improved the students' visual

thinking skills. The pre-test mean score of 10.67, with a standard deviation of 2.12, was significantly lower than the post-test mean score of 12.33, with a standard deviation of 1.68. This increase in the mean score demonstrates the positive effect of the program in enhancing visual thinking abilities, particularly in areas such as spatial awareness, problem-solving, and creativity, which are fundamental to graphic design and visual representation.

Furthermore, the effect size analysis, shown in Table 4, indicated a medium to large effect (d = 0.66), supporting the conclusion that the training program had a meaningful impact on the students' visual thinking skills. According to Cohen's guidelines, an effect size of 0.66 is considered substantial, which suggests that the graphic design program contributed significantly to the improvement of students' abilities in visual thinking tasks.

The findings of this study demonstrate that the use of graphic design programs, particularly Adobe Illustrator, plays a significant role in enhancing students' visual thinking skills. This conclusion is consistent with the growing body of research that highlights the importance of visual thinking in educational contexts. For instance, Elboksomaty [14] and Dilek [7] emphasize the pivotal role of visual thinking in fostering students' ability to comprehend and interpret visual information, which is essential for developing both cognitive and design skills [7, 14].

Adobe Illustrator, with its extensive array of tools for manipulating and creating designs, facilitates the development of visual thinking abilities. Huda, et al. [12] support this by confirming that graphic design programs, such as Adobe Illustrator, enable students to arrange visual elements and produce professional-quality designs [12]. This process not only aids in the creation of visually compelling works but also deepens students' understanding of fundamental design principles, including balance, contrast, and harmony.

Furthermore, the technical skills students acquire through hands-on experience with graphic design programs contribute significantly to their ability to understand and apply color theory within cohesive designs. Raiyn [10] highlights that as students engage with design tools, they develop the capacity to differentiate between various design elements [10]. This ability enhances their potential to create visually engaging and effective designs by utilizing elements such as color, form, and structure in meaningful ways [27].

The development and refinement of visual thinking skills are critical for students, and the use of graphic design programs plays a substantial role in this process. As students interact with various visual components—manipulating shapes, colors, and patterns—they gain the ability to organize and communicate their ideas visually. This capability is particularly emphasized in Abelrahman [9], who notes that the skill to arrange visual components effectively is vital for conveying ideas in an organized and clear manner.

The findings also highlight the importance of incorporating graphic design tools in educational programs, especially those focused on educational technology, as they provide practical opportunities for students to develop essential skills that are increasingly important in today's visually driven world [28]. By using tools like Adobe Illustrator, students gain technical skills and enhance their ability to think critically and creatively about visual problems, which are key competencies in both educational and professional settings[21]. Studies highlight that the application of design thinking in the design of visual communication enhances students' visual thinking skills, enabling them to analyze, create, and solve complex design problems effectively, and promotes the creativity and critical thinking necessary for designing graphics. Mental knowledge, which consists of facts, concepts, laws, and theories, is one of the most crucial components of problem-solving. Problem-solving also involves using appropriate strategies, which are the steps and procedures a person uses to apply their mental knowledge to solve a problem [29].

Drawing contributes to the promotion of problem-solving and knowledge generation in education. The development of graphic skills is crucial in the curriculum [30]. Visual thinking in collaborative activities facilitates learning and increases motivation. Using visual language in scientific subjects helps create a positive learning environment [31]. Visual tools can enhance retrieval, comprehension, and critical thinking skills. Mind maps, concept maps, and thinking tools are effective resources for various purposes [32].

In summary, the study provides strong evidence that using graphic design programs can significantly enhance visual thinking skills. The results suggest that integrating such programs into the curriculum for educational technology students can play a crucial role in developing the cognitive and creative abilities needed for success in the digital age. Future research could explore the long-term effects of such training and the impact of different types of graphic design programs on various cognitive skills. While focusing on graphic design and visual thinking is vital, some believe that traditional methods may still hold value in some contexts, potentially limiting the exploration of innovative practices in design education [18].

5. Conclusion

This study demonstrates that the use of graphic design programs, particularly Adobe Illustrator, significantly enhances the visual thinking skills of educational technology students. The findings confirm that training students to use these programs not only improves their ability to arrange and manipulate visual elements but also deepens their understanding of key design principles such as balance, contrast, and harmony.

The results highlight the importance of visual thinking in education, aligning with previous research that emphasizes its role in developing critical cognitive skills such as interpretation, visualization, and creative problem-solving. By interacting with various design tools and elements, students are able to refine their technical abilities, which further enhances their capacity to distinguish between design components and create visually engaging, effective designs.

In addition to improving visual thinking skills, the study also underscores the broader educational value of graphic design programs. As students apply their knowledge in real-world design contexts, they develop stronger critical thinking and analytical skills. This study contributes to the growing body of literature supporting the integration of graphic design programs in educational settings to promote visual literacy and cognitive development.

Overall, the findings suggest that incorporating graphic design programs into curricula can play a crucial role in developing students' visual thinking abilities, which are essential for both academic success and professional competence in the field of educational technology and design. Further research is recommended to explore the long-term impact of graphic design training on visual thinking skills and its application across various disciplines.

5.1. Study Limitations

Sample: The sample was selected from students of a single university, which may affect the generalizability of the results to all students across different universities or educational institutions. The study sample was limited to a specific group with particular cultural and social backgrounds, which may impact the diversity of opinions and skills.

Time Duration: The study was conducted within a short time frame, which may not reflect long-term changes in students' visual thinking skills after using graphic design programs. Therefore, the results may not be representative of long-term future effects.

Techniques and Programs Used: Specific graphic design programs were used in the study, which may be limited compared to many other available programs. The use of these programs may not reflect the impact of other techniques that may be more advanced or better suited to the varying needs of the students.

5.2. Recommendations

Educational institutions need to incorporate graphic design tools, such as Adobe Illustrator, into their curricula to enhance students' visual thinking skills. This integration can be achieved by focusing on developing students' visual literacy through activities that encourage analyzing, interpreting, and creating visual designs. To effectively guide students in this process, teachers, particularly in educational technology, should receive training on using graphic design programs. Additionally, future studies should explore the long-term impact of graphic design training on students' problem-solving and creativity. Customized programs should be developed for students in various fields to ensure the practical application of visual thinking skills while promoting interdisciplinary collaboration to foster a broader understanding of visual thinking applications. Furthermore, research should assess the effectiveness of other graphic design tools to determine which are most beneficial for enhancing visual thinking.

References

[1] M. Altawalbeh and A. M. Al-Mughrabi, "Using the TPB model to determine factors affecting e-learning adoption in Jordanian higher education," *International Journal of Innovative Research and Scientific Studies*, vol. 7, no. 2, pp. 627-637, 2024. https://doi.org/10.53894/ijirss.v7i2.2746

[2] W. J. AlKasasbeh and A. Tawfiq Amawi, "The effectiveness of using mobile learning application on undergraduates' intrinsic motivation and their general nutrition knowledge," *International Journal of Interactive Mobile Technologies*, vol. 17, no. 17, p. 19, 2023.

[3] W. J. AlKasasbeh and A. T. Amawi, "Elevating physical education teacher through technology integration," *International Journal of Interactive Mobile Technologies*, vol. 18, no. 2, p. 16, 2024. https://doi.org/10.3991/ijim.v18i02.43669

[4] K. Al-Said, I. Krapotkina, F. Gazizova, and N. Maslennikova, "Distance learning: Studying the efficiency of implementing flipped classroom technology in the educational system," *Education and Information Technologies*, vol. 28, no. 10, pp. 13689-13712, 2023. https://doi.org/10.1007/s10639-023-11711-x

[5] T. A. R. Amer and E. I. Al-Masry, *Visual thinking its concept-skills-strategies*. Cairo: The Arab Group for Training and Publishing, 2016.

[6] H. M. A. A. and I. A. Shaafe, "The effect of using infographics in developing visual thinking skills among preparatory school students," *Journal of Research in the Fields of Specific Education*, vol. 14, no. 1, pp. 70–115, . 2018.

[7] G. Dilek, "Visual thinking in teaching history: Reading the visual thinking skills of 12 year-old pupils in Istanbul," *Education 3–13*, vol. 38, no. 3, pp. 257-274, 2010. https://doi.org/10.1080/03004279.2010.497276

[8] K. Huh, "Visual thinking strategies and creativity in English education," *Indian Journal of Science and Technology*, vol. 9, no. 1, pp. 1-6, 2016. https://doi.org/10.17485/ijst/2016/v9is1/109885

[9] N. Abelrahman, "Using the environmental graphic design to create a distinctive visual identity for Egyptian cities," *Journal of Architecture, Arts and Humanities*, vol. 8, no. 9, pp. 983-1002, 2023.

[10] J. Raiyn, "The role of visual learning in improving students' high-order thinking skills," *Journal of Education and Practice*, vol. 7, no. 24, pp. 115-121, 2016.

[11] S. Barnes, J. Campbell, and L. M. Ndebele, "The effectiveness of infographics and graphical media in communication," *International Journal of Communication and Marketing*, vol. 1, no. 1, pp. 1-10, 2024.

[12] A. Huda, K. Rukun, and Y. Hendriyani, "Construction of graphic design interactive cd for learning achievement using frequency distribution of respondents," *GEOMATE Journal*, vol. 13, no. 37, pp. 93-97, 2017.

[13] A. A. F. S. Al Shamry and A. F. Sand, "The impact of interactive infographic design on developing visual thinking skills and concepts in accelerating data and information," *Arab Journal of Informatics and Information Security*, vol. 4, no. 10, pp. 45–76, 2023.

[14] M. M. K. M. Elboksomaty, *Strategies of creative thinking for solving design problems in the field of graphic design. In Cities' Identity Through Architecture and Arts*. London: Routledge, 2018, pp. 349–356.

[15] R. Al-Arabi, *Graphic design*. Amman: Dar Al-Youssef for Printing Publishing, and Distribution, 2008.

[16] R. Pettersson, *Graphic design*. Tullinge: International Institute for Information Design, 2015.

[17] A.-S. J. K and A.-L. A. Fleih, *Graphic design in education*, 1st ed. Amman: Zamzam Publishers and Distributors, 2011.

[18] J. Bueno, "Is it possible to improve our visual thinking? A didactic experience in Graphic Design undergraduate degree," *InfoDesign-Revista Brasileira de Design da Informação*, vol. 17, no. 3, pp. 22–42, 2020. https://doi.org/10.51358/id.v17i3.842

[19] E. S. De Alencar, "Upside-down brilliance: the visual-spatial learner," *Gifted and Talented International*, vol. 18, no. 1, pp. 53-54, 2003. https://doi.org/10.1080/15332276.2003.11673009

[20] C. I. Johnson and R. E. Mayer, "A testing effect with multimedia learning," *Journal of Educational Psychology*, vol. 101, no. 3, p. 621, 2009. https://doi.org/10.1037/a0015183

[21] R. R. Anwar, B. S. Bachri, and A. Kristanto, "Design thinking in visual communication design subjects as an effort to improve problem solving and creative abilities," *EduInovasi: Journal of Basic Educational Studies*, vol. 4, no. 1, pp. 476-487, 2024. https://doi.org/10.47467/edui.v4i1.5458

[22] L. Mukhametzyanova, E. Akhmetshina, M. Yao, J. Emanova, Z. Miskichenkova, and A. Siluyanichev, "Visual means of design and plastic modeling," *Bulletin of the National Academy of Culture and Arts Management*, vol. 1, pp. 15-25, 2018.

[23] E. Lupton and J. C. Phillips, *Graphic design: The new basics*, Revised and expanded ed. Chronicle Books, 2015.

[24] R. Barban Franceschi, "The archetype of graphic thinking. Visual graphic tool that analyses the graphic, creative and project thinking of the product designer," *Perspectives on Design II: Research, Education and Practice*, pp. 91-104, 2022. https://doi.org/10.1007/978-3-030-79879-6_7

[25] W.-M. Roth, "Reading graphs: Contributions to an integrative concept of literacy," *Journal of Curriculum Studies*, vol. 34, no. 1, pp. 1-24, 2002. https://doi.org/10.1080/00220270110068885

[26] Á. B. Montilla and J. L. C. Guirado, "Use of autogenous dentin as a biomaterial for the preservation of the residual ridge. A clinical case report," *VII Jornadas*, vol. 32, no. 2, pp. 29-34, 2021.

[27] W. J. Alkasasbeh, T. Alawamleh, H. Aloran, T. Farash, and B. E. Orhan, "The impact of mobile-assisted swimming applications on intrinsic motivation and fear reduction in aquatic environments among students in the swimming course," *Frontiers in Sports and Active Living*, vol. 6, p. 1496733, 2024. https://doi.org/10.3389/fspor.2024.1496733

[28] J. Al-Nawaiseh, A. A. S. Tabieh, W. F. Maqableh, M. Altawalbeh, and F. B. Ahmad, "The effectiveness of using educational robots in enhancing engineering mathematics skills among students in basic school," *International Journal of Education*, vol. 12, no. 3, pp. 906-921, 2024. https://doi.org/10.18488/61.v12i3.3768

[29] M. Alsmadi, A. A. Tabieh, R. M. Alsaifi, and S. J. Al-Nawaiseh, "The effect of the collaborative discussion strategy think-pair-share on developing students' skills in solving engineering mathematical problems," *European Journal of Educational Research*, vol. 12, no. 2, pp. 1123-1135, 2023. https://doi.org/10.12973/eu-jer.12.2.1123

[30] E. Cicalò and E. Cicalò, "Educating graphic intelligence," *Graphic Intelligence: Drawing and Cognition*, pp. 59-72, 2020. https://doi.org/10.1007/978-3-030-45244-5_8

[31] C. L. Osete and R. C. Álvarez, "Visual thinking as a link between science and art. In IN-RED 2019," presented at the 5th Congress on Educational Innovation and Teaching Online Editorial Universitat Politècnica de València. pp. 850-857, 2019.

[32] H. C. Santiago, "Visual mapping to enhance learning and critical thinking skills," *Optometric Education*, vol. 36, no. 3, pp. 1-15, 2011.