

**Digital Infographic: Its Impact on Cognitive
Achievement and Visual Thinking Skills of
Students with Different Cognitive Styles
(Independent/ Dependent)**

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Digital Infographic: Its Impact on Cognitive Achievement and Visual Thinking Skills of Students with Different Cognitive Styles (Independent/ Dependent) ۶.

Digital Infographic: Its Impact on Cognitive Achievement and Visual Thinking Skills of Students with Different Cognitive Styles (Independent/ Dependent)

Dr. Nader Said Shemy¹

Abstract

The current research aimed to identify the impact digital infographic cognitive achievement and visual thinking skills of students with different cognitive styles (dependent/ independent) in scientific courses in basic education stage. The researcher used the quasi-experimental approach, where the research sample consisted of two experimental groups that classification according to the cognitive style (dependent/ independent). The researcher converted the educational content from traditional style to e-content based on the digital infographic strategy, which contains many formations and visual effects. The results indicated that there is a statistically significant effect when applying the educational content based on the digital infographic on the sample (dependent/ independent) in development visual thinking skills, and there is also a statistically significant effect on the cognitive achievement of the sample. The researcher recommended the importance of converting educational curricula into interactive e-content based on the digital infographic strategy, with an emphasis on commitment to educational design standards, as well as standards for technical development. Considering the preparation of professional development programs for teachers about the developing of e-content and for its effective utilize in the context of instruction and learning.

Keywords: Digital Infographic, Cognitive Achievement, Visual Thinking Skills, Dependent Cognitive Style, Independent Cognitive Style.

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1. Introduction

Visual literacy is one of the important transformations whose presence makes a difference in the development of several skills among students. Since the availability of much visual media characterizes our current age, and the current generation of students is characterized by the digital generation, which deals with these media on an intense daily basis, the researcher finds the importance significant in developing visual literacy among students in various educational stages. The infographic is one of the visual media that contributes to the development of students' visual thinking skills (Damyanov & Tsankov, 2018), where there is a great motivation towards achievement among students who suffer from learning difficulties and limited visual thinking skills when learning through infographics.

Infographics can be defined as a strategy in which information is converted into images and graphics that help simplify complex information and make it easier to learn (Fragou & Papadopoulou, 2020). In the search for the best educational strategies, the infographic appeared with its various advantages, the results of the Gebre's study (2018) showed the effectiveness of the infographic in developing visual memory for kindergarten children, and the results of Lee & Lim's study (2019) showed the importance of the infographic in retaining English vocabulary for eighth-grade students, and also showed Fadzil (2018) study of the efficiency of infographics in developing some scientific concepts among university students. The advantages of the infographic have gone beyond to reach students of all categories, even the special needs' students, as the study of (Delgado. et al., 2020) proved the effectiveness of the infographic in raising the level of achievement of students with hearing disabilities. The role of infographics, with its different styles, has emerged in raising the level of achievement of students in various stages, in addition to developing the aspect of visual thinking and its various skills, which depends on understanding the images and graphics and deriving concepts and information from them. (Yilmaz, et al., 2019)

On the other hand, cognitive styles represent one of the important determinants of individual differences in many of the cognitive variables of the personality that involve the individual's distinctive style of processing information. They serve as control mechanisms that determine the characteristics of individuals in organizing and controlling the processes of attention, remembering, thinking, processing information, forming perceptions, dealing with environmental stimuli, retrieving information, speed of synthesis among them, and continuous evaluation of ideas. (Dermawan, et al., 2021) The cognitive style (dependent/ independent) is one of the most famous cognitive styles in this field, as it refers to the individual's way of perceiving the elements of a field or situation, The dependents are aware of the elements of the situation, influenced by what surrounds it from other elements, and in a global way, while neglecting the details. (Alqudah, et al., 2019) On the other hand, the independent are realize the elements of the situation, unaffected by what surrounds it from other elements in the field, and in an analytical way in which the individual is interested in the details of that field. (Gambari, et al., 2018)

Through the researcher's work in the educational supervision of many public schools, and with the repercussions of the Covid 19 pandemic, the decision was made to switch from traditional learning to distance learning, this sudden transition called for relying mainly on multimedia in providing students with targeted knowledge and skills, but It was noticed with the analysis of the results of the first exam that the students were exposed to that their level of knowledge did not reach the required level, and the researcher conducted more than one personal interview with the teachers in those schools, and the majority of the teachers indicated that these multimedia lack elements that are attractive and motivating to students that help them understand the educational content, and also these media do not contribute to the analysis, conclusion and deduction of information from the content by the students, as they lack many interactive visual elements that are consistent with the perception of each student. Based on the foregoing, the researcher emphasizes the possibility of utilizing infographics in

providing educational e-content to students, considering the inclusion of the infographics with interactive visual elements that respond to different cognitive styles of students, which ultimately leads to an increase in the achievement level of students, as well as the development of visual thinking skills among these students. Considering this and based on the many studies that have indicated the importance of this strategy in raising learners' motivation and increasing their achievement and develop visual thinking skills, the main research question can be stated as follows: what is the impact of digital infographic on cognitive achievement and visual thinking skills of students with different cognitive styles (dependent/ independent)?

2. Literature Review

2.1. Infographics Strategy

Through the researcher's review of the relevant studies, he found that the infographic is one of the effective tools that transform the complex information presented in a solid template into information that is easy to link and visually perceive the relationships between them. It also develops several aspects and skills, as the dissemination of knowledge in our current age mainly depends on presenting it in an infographic strategy, as it is a concise and attractive tool for all ages (Ismaeel & Al Mulhim, 2021).

An infographic can be defined as a visual representation of all digital data and information, and scientific knowledge, and its presentation in a practical and easy to understand and perceive manner, using an integrated use of all texts, various graphics and images of all types, and the combination of symbols, signs, and all types of mental maps (Hope & Cheta, 2018). As (Kunze, et al., 2021) define it, it is a structured visualization that presents clearly complex information using: tags, pictures, graphics, and diagrams. Based on the foregoing, the researcher adopts an infographic definition in line with the current research paper based on transforming knowledge and information from its traditional complex styles to an attractive visual style that works to excite students and attract their attention using several visual tools.

The researcher points out the importance of infographics, as it makes learning more fun and interesting, works to convey cognitive messages in less time and effort, and contributes to simplifying information, and linking abstract concepts with pictures. It also helps to develop visual skills in interpreting images. The researcher noted that the studies did not neglect to address the subject of the infographic as an independent variable that has a positive relationship with a number of dependent variables, and this is what (Martins, et al., 2020) concluded in their study, where the results were in favor of developing the skills of students with learning difficulties in mathematics in their ability to process images and increasing their achievement motivation when presenting educational content through the infographic strategy compared to the traditional strategy. The researcher adds, based on the importance previously mentioned, the need to switch to the use of digital visual content and expand their capabilities by integrating them with educational videos to achieve greater effectiveness, in presenting information in a binary language (graphs, and visual presentations) contributes to the development of the communication skills of learners and makes them aware of the strengths and their weakness (Maneewong, 2019).

The researcher emphasizes that designs that are subject to clear criteria achieve the outputs in a better way, and their use can go beyond a presentation style to an assessment style, as it has a clear link to the perceptual field, and this is consistent with the basics of Gestalt theory, where this theory adopts the idea of visual learning using an image standardized, and this simulates the presentation through an infographic strategy (Weiner & Lorber, 2021).

2.2. Visual Thinking

The importance of visual thinking is that it plays an important role in preparing students to face future challenges, and the teacher must develop this type of thinking because it works to elicit ideas, analysis, and discussion by means of visual tools, which make the student be an effective role in the educational process (Poirier, et al., 2020). The most important skills of visual thinking are visual reading, visual discrimination, interpretation of information and observations,

information analysis, and belief in meaning (Smolkowski, et al., 2020). The researcher emphasized the need to use visual thinking skills in the educational process, as studies such as Elsayed & Al-Najrani (2021) indicate that students' exposure to a discussion in visual content made them have a clear visual literacy, and they practice thinking more deeply even as their learning abilities have become superior to their peers in the traditional way of learning.

The results of many studies showed the role of infographics in developing visual thinking, including the study of Fernández et al. (2020), which confirmed the positive impact of infographics on visual thinking among basic education students and raising their level of achievement. Also, Lee's study (2021) confirmed that infographics contributed to the development of visual thinking for students of the College of Education, and the results of the study of Markovits and others (2022) showed the impact of the infographic on the development of visual literacy and visual thinking among university students, and the results of the study of Wetcho & Na-Songkhla (2021) showed the importance of the infographic in developing visual thinking among secondary school students in learning social concepts.

Based on the foregoing, the researcher concludes that there is a relationship between infographics and visual thinking, and it can use infographics for assessment in the educational process, by relying on visual skills by realizing the relationships between graphs, it also provided solutions in addressing some of the challenges facing teachers in teaching different categories of students.

2.3. Cognitive Styles

Through the researcher's review of many studies related to all the previous variables, he noticed that the cognitive aspect is the common relationship that links visual contents and visual thinking, and to complete the picture of the cognitive field, the researcher must address the cognitive style, as there is a relationship with a clear impact between cognitive styles, infographics, achievement, and visual thinking skills.

Cognitive styles are the differences between individuals in how cognitive processes are practiced, such as perception, thinking, problem solving, learning, and realizing the relationships between the elements or variables that the individual is exposed to during the behavioral situation. (Porzak, et al., 2021) Cognitive styles refer to the tendency to prefer the use of specific mental processes and mental abilities over others during the perception of motivations and during response to them. (Akinyemi, et al., 2022)

Dependent/ Independent style refers to the individual differences that exist between people in the processes of their perception of different situations in terms of their commitment to the overall context in which the situation occurs or dealing with it independently. Accredited individuals look at the total area in which the situation occurs, including the details it contains, and they cannot deal with the situation as being an independent part of the field in which it occurs. Whereas individuals who are independent in their perception of the domain are more capable of analysis and can separate the situation from the domain in which it occurs. (Мосіна, 2020)

Dependent individuals often face difficulty in perceiving situations as separate parts from each other, as the results of studies showed that they cannot differentiate between the object and the background on the scale of the shapes compared to the independent individuals. (Bicen & Beheshti, 2022) As for the characteristics of a individuals who is characterized by dependence, studies have indicated that he has a constant need for the support of others, a tendency to gather, an interest in eye contact, and an interest in feelings and emotions during interaction with others. One of the characteristics of an independent individuals is the ability to analyze the situation, distinguish oneself from others, and not need a frame of reference to face any problem or new situation. (Joshi & Gupta, 2021)

Through the above, the researcher sees that cognitive methods have a clear relationship with everything related to the cognitive domain and that there is a clear relationship between the previous variables and the main driver of the learning process, which is cognitive achievement.

3. Research Hypotheses

Based on the literature reviewed, along with my personal experience with instructional technology, e-Content, and the design and production of multimedia, the following hypotheses are proposed:

1. There will be a statistically significant difference at the significance level of 0.05 between the mean scores of the students of the first experimental group (Independent cognitive style) and the second experimental (Dependent cognitive style) in the post-administration of the cognitive achievement test in favour of the students of the first experimental group (Independent cognitive style).
2. There will be a statistically significant difference at the significance level of 0.05 between the mean scores of the students of the first experimental group (Independent cognitive style) and the second experimental (Dependent cognitive style) in the post-administration of the visual thinking skills scale in favour of the students of the first experimental group (Independent cognitive style).

4. Research Methodology and Procedures

4.1 Research Design

The quasi-experimental approach was chosen for the purposes of this study. It was deemed appropriate for testing and measuring the effect of the Infographics as an independent variable on the two dependent variables (cognitive achievement and visual thinking skills) for students with different cognitive styles (dependent/ independent) regarding teaching scientific courses to basic education stage. Furthermore, this approach provides higher external validity than most true experiments, and higher internal validity than other non-experimental approaches because they allow better control for confounding variables than other types.

In the experimental design of the intervention, the post-test equally matched groups design was used, because the measurement process for the dependent variables (cognitive achievement and visual thinking skills) depends on the style of presentation of the instructional

content delivered through the independent variable (digital infographics).

Table 1: Experimental design of the study

Group	Pre-testing	Experimental Treatment	Post-testing
1 st Experimental Group	None	Digital Infographics with Independent cognitive style's individuals	•Cognitive achievement test
2 nd Experimental Group		Digital Infographics with dependent cognitive style's individuals	•Visual thinking skills test

4.2 Research Sample

The target population included tenth-grade students in Oman, whose ages ranged from 14 to 15 years. Generally, the characteristics of this group include speedy mental development, and the growth of their imagination from illusion to realism, which tends towards innovation and creativity. In addition, at this age, students show early signs of critical thinking towards the end of that stage. The research sample consisted of 30 tenth-grade students from a private school, who were divided into two experimental groups, each of which included 15 students. This number was suitable to be used as a sample for the current study. In addition, these students were classified according to the cognitive style (dependent/ independent), so that each experimental group represented a type of this cognitive style.

4.3 Research tools

For the specific purposes of the current study, two main research tools were used: a cognitive achievement test, and a visual thinking skills scale. These are explained further in the sections that follow.

4.3.1. Cognitive Achievement Test (prepared by the researcher):

This test aims to measure the cognitive achievement of the sample individuals after they have learned the educational content through the infographic. The test questions are formulated in a MCQ form, and it has been considered that an appropriate number of levels of knowledge

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are covered, such as: understanding, remembering, application, and evaluation. The marks were determined for each item, so that the student was clearly evaluated, and the student was aware of the marks of each question.

The researcher presented the test to a group of experts in instructional technology and measurement & evaluation, and a modification was requested in the wording of some sections. The researcher responded and implemented these modifications. The test was applied to the exploratory sample to measure the reliability, and then the data and results were collected from the responses, and then the reliability coefficient was calculated, and its result was (0.86), which is an acceptable stability coefficient, and thus the test is ready for the actual application.

4.3.2. Visual Thinking Skills Scale (prepared by the researcher):

This scale aims to measure the possession of visual thinking skills by the sample individuals, and the impact of providing infographic-based content on these skills. After reviewing the literature and studies, the researcher identified the following skills: visual reading, visual information analysis and interpretation, visual meanings deduction, and visual discrimination skill. Then the researcher prepared the items of the scale to measure the previous skills of visual thinking skills.

The scale was presented to a group of experts in educational technology and measurement & evaluation, and the experts agreed on the validity of the scale. Then the reliability coefficient was calculated, and it was (0.70), which is a good reliability coefficient and indicates the stability of the test and its readiness for application.

4.3.3. Group Embedded Figures Test:

The researcher used the (Group Embedded Figures Test) which has been prepared in its original version by (Witkin, 1979), and it was translated into Arabic by (Al-Sharqawi and Alsheikh, 1988), and it aims to classify students according to the cognitive style (dependent/independent).

4.4 Experimental treatment of Groups

The researcher relied on the general model for instructional design ADDIE, and followed the following phases:

The Analysis Phase:

- Analyzing the characteristics of the learners, where the “group embedded figures test” was used to classify the research sample into two groups according to the cognitive style (dependent/independent).
- Analysis of the educational environment, where the Google Classroom application was selected, and the efficiency of the networks for all sample individuals was also verified, and access was ensured at the time of the application of the experiment.
- Analysis of educational tasks: analysis of the target educational content, to determine the concepts, terms, and objectives essential for preparing the achievement test, visual thinking skills scale, and for designing the infographic content.

The Design Phase:

After analyzing the targeted educational content, the researcher derives the behavioral educational objectives, then the infographic templates were prepared and designed, the formative and final assessment tools were prepared and designed, and then the infographic images and shapes were designed, and finally, the interactive activities and exercises were prepared and designed.

The Development Phase:

At this stage, the researcher designed and produced the infographic using the PowToon application, and the instructional and technological design standards were considered in the production process to ensure the quality and validity of the final outcomes.

The Evaluation Phase:

At this stage, the researcher presented the design to experts in instructional technology and educational supervisors in the field of specialization, and the researcher implemented the required modifications according to the observations and comments made by

experts and supervisors, and in the end the infographic and other instructional items were published and made available to all individuals of the research sample.

4.5 Data Collection

In the beginning, a meeting was held with the individuals of the research sample to aware and explain the mechanism that the researcher will follow in implementing the research experiment and informing them that all their responses will be used only for the purpose of research, to control cheating or any external variables. The mechanism of infographic design and its importance in the visual field were also explained, how information is extracted from the infographic and how to interact with the activities included in it.

The timing of the application was determined on the Google Classroom platform, and to ensure the attendance of all members of the research sample, and to ensure the strength of the network during the entire application. Then the educational content was made available through the infographic designed for all members of the research sample, and the individuals were followed up throughout the application period, and support was provided, whether educational or technical. The researcher was keen to encourage the experimental groups to actively discuss and compete when applying the included activities. Teaching the educational content took two hours, during which all the targeted learning outcomes were achieved.

Research tools (Cognitive Achievement Test and Visual Thinking Skills Scale) were applied to all sample members for the purpose of post-measurement after they were exposed to the infographic-designed educational content, and all data were collected in preparation for statistical processing.

5. Research Results

5.1 Testing the 1st hypothesis

To test or verify the validity of this hypothesis, an independent-sample T-test was used. This revealed the significance of the differences between the students of the first experimental group and

those of the second experimental group on the cognitive achievement post-test, as shown in Table 2 below:

Table 2: T-test value of the significance of the differences between the mean scores of students’ achievement in both the 1st and 2nd experimental groups in the cognitive achievement post-test

Cognitive achievement post-test	Group	No	SMA	STD Deviation	Freedom	T value	Significance Level
	1st Experimental	15	17.55	1.07			
2nd Experimental	15	13.20	3.77	38	7.30	0.001	

It is clear that the value of T reached 7.30 at the probability value of 0.001, which is smaller than the significance level adopted in this research study (0.05). Furthermore, there is a clear difference between the mean scores of the post-test for both groups in favor of the first group, where the SMA of the post-test for the first group was 17.55, while that of second was 13.20. This confirms the 1st hypothesis and indicates its validity. This is consistent with the results of the study of: (Ozdamli & Ozdal, 2018); (Pazilah & Hashim, 2018); (Prandi, et al., 2021); (Waddell & Clariza, 2018)

5.2 Testing the 2nd hypothesis

To test or verify the validity of this hypothesis, an independent-sample T-test was used. This revealed the significance of the differences between the students of the first experimental group and those of the second experimental group on the visual thinking skills post-test, as shown in Table 3 below:

Table 3: T-test value of the significance of the differences between the mean scores of students’ achievement in both the 1st and 2nd experimental groups in the visual thinking skills post-test

Visual thinking skills post-test	Group	No	SMA	STD Deviation	Freedom	T value	Significance Level
	1st Experimental	15	27.70	3.26			
2nd Experimental	15	15.35	1.83	38	8.78	0.0001	

It is clear that the value of T reached 8.78 at the probability value of 0.0001, which is smaller than the significance level adopted in this research study (0.05). Furthermore, there is a clear difference between the mean scores of the post-test for both groups in favor of the first group, where the SMA of the post-test for the first group was 27.70, while that of second was 15.35. This confirms the 1st hypothesis and indicates its validity. This is consistent with the results of the study of: (Yakovleva, et al., 2021); (Cueva & Inga, 2022); (Gaol & Prasolova, 2022); (Homsombat, et al., 2021).

6. Discussion

6.1 Dissections related to the first hypothesis

In the beginning, the researcher emphasized the effectiveness of the infographic according to the results in raising the level of cognitive achievement of all individuals in the research sample in both groups. The learners of the (independent) cognitive style have more than the learners of the (dependent) cognitive style in raising their achievement level, and the researcher explains this result that the independent learners could perceive separate from any other details that may surround the main information it contains the infographics, unlike dependent learners tend to be holistic or comprehensive, without going into details, which may be vague to them.

The researcher points out that learners learn better when information and concepts are presented to them in the form of a visual layout, and the effectiveness of storing information in the brain increases when it is sent and received in an orderly manner. Also, the infographic contributes to helping the learner achieve a cognitive structure characterized by stability, clarity, and organization.

Independent learners tend mainly to interact in a perceptual field that depends on shapes, symbols, images, and relationships among them without there being any overlap or conflict with the backgrounds or any other factors that exist in the same perceptual field for them. So the strategy of providing educational content in the infographic is the appropriate field from which the target can be clearly understood it is

clear and comprehensive by the independent learners, and this is consistent with what Lee's study (2021) indicated that the visuals that include shapes, symbols, images and relationships among them will be an appropriate environment to increase the cognitive achievement of learners with the independent cognitive style, while (Maneewong, 2019) indicated that the dependent learners will face difficulties and challenges in order to realize targeted knowledge through visuals that collect information and data that cause them conflict and overlap in the target knowledge, as these learners tend to have a holistic view without targeting specific learning objects, and this will negatively affect their cognitive perception, and thus negatively affect their knowledge outcome.

If the concepts of Gestalt theory are used in this context, we find that it supports the idea of learning based on understanding and focus with the forms and relationships among them and dealing with those forms and relationships in an integrative manner away from any distractions that may negatively affect this learning.

6.2 Dissections related to the second hypothesis

The results of the research indicate that the independent learners were the most developed in the skills of visual thinking through the infographic strategy, perhaps this result in its general form confirms the main role that infographics play in developing these skills, and by reference to the nature of visual thinking skills, we find that a system of operations for an individual's ability to read a visual form, convert the visual language it carries into a verbal language (written or spoken), extract information from it, perceives and interpret ambiguity, and derive meanings.

The researcher emphasized that teaching with infographics enhances students' understanding of scientific concepts and communication ability by improving visual thinking abilities, which has a positive impact on academic achievement and attitudes toward science, this agrees with the results of a study Noh & Son (2015). In this context, it is necessary to rely on specialized programs to ensure a good output of the infographic, and there is no objection to the participation of learners in the design and production processes, this

will contribute to the interaction of learners with the content of the infographic. (Drushlyak, et al., 2020)

The researcher emphasized that the infographics could encourage the following characteristics in independent learners: curiosity, passion, inspiration, discernment, self-motivation, self-examination, accountability, critical thinking, and persistence. It should develop the ability of the pupil to know when they need support. These characteristics are the main catalyst for developing the visual thinking skills of these learners, and this is what Yunita and others (2019) refers to in their study, as he mentions that the availability of distinct characteristics among independent learners will effectively help them in developing their visual thinking skills. While dependent learners have fewer opportunities than their independent counterparts to develop these skills due to their different characteristics among them. Dependent learners lack the passion, activity, and interaction necessary to make the most of the infographic strategy.

7. Conclusion and Recommendations

The infographic strategy is one of the most effective strategies that contribute to raising the level of knowledge and developing the learners' visual thinking skills, regardless of their cognitive style, but it has more impact on independent learners. Considering this, the researcher emphasizes the great importance of organizing professional development programs for teachers on how to design and produce infographics, as well as how to utilize them in the context of teaching and learning. The researcher also emphasizes the importance of involving students in the design and production processes to become active participants and not just to receive information from the infographic. The researcher recommends that educational content be converted into digital content based on infographics and that this be done in a systematic and institutional manner to ensure the wide spread of this strategy within educational institutions at various stages.

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