



## Research Article

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# Effects of Motion Infographics on High School Students' Programming Skills

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## Abstract

*This study examines the potential of motion infographics in enhancing high school students' programming skills. It employs a quasi-experimental design, dividing participants into two groups. To collect the data for the study, the achievement test and performance observation sheet for programming skills are prepared. A random sample of high school students is selected, with 30 students assigned to the control group, which follows traditional learning methods, and 31 students assigned to the experimental group, which utilizes motion infographics for learning. The results indicate statistically significant differences in mean scores between the control group and the experimental group, favoring the posttest and performance observation of the experimental group. Based on these findings, the study recommends the integration of motion infographics in teaching programming skills to students at various stages.*

**Keywords:** Infographic Design, Instructional Design, Motion infographic, Programming skills

## 1. Introduction

Digital technology has brought significant changes in teaching and learning environments. These changes place a greater responsibility on educators to adopt new methods and techniques for innovative teaching. In the field of information technology, images and other linguistic and non-linguistic elements are utilized to display information in a way that is both visually engaging and easy to understand (Knorr, 2019). It is argued that images clarify and simplify information presentation more effectively than words alone, and digital technologies heavily rely on the use of images, particularly infographics (Bayoumi, 2022; Gebre, 2018; Leggette, 2020). Infographics are designed to present information to students more easily and attractively (Al-Shammari, 2022). In parallel to infographics, the concept of 'digital illiteracy' has gained significant attention in recent years. Digital literacy does not only mean the ability to attend to digital technology and interact with it effectively, but it also means individuals' abilities to tackle problems innovatively by designing modern software that uses programming languages such as C++, Python K, and PHP JAVA. Based on this, learning programming has become fundamental for students (Aleksic & Ivanovic, 2016; Topalli & Cagiltay, 2018). However, programming languages can be confusing for students who are unfamiliar with programming (Syropoulos, 2023). On the other hand, providing students with motion infographics has the potential to be a promising teaching tool.

### 1.1 Motion Infographics

There is a growing body of literature that recognizes the importance of motion infographics. Motion infographics are not only considered a tool for collaborating knowledge in a clear form to facilitate learning, but rather a tool for building knowledge and understanding complex information through the use of static and moving images, which helps in further consolidating the knowledge in the student's mind so that they can learn more interestingly and effectively (Gebre, 2018). Abdelrahman and Qhouf (2019) indicated that motion infographics enhance learning, which in turn, affects achievement positively. Furthermore, motion infographics assist individuals in translating knowledge into a visual form, making information easier to read and absorb (Tsai et al., 2020). Moreover, Mohieddin (2018) confirmed the effectiveness of motion infographics, demonstrating how this technology enabled students to interpret and analyze complex concepts in a shorter time. Additionally, Bayoumi (2022) highlighted that using images and graphics in animation in its two- and three-dimensional forms contributes to increasing comprehension. This in turn, leads to increase students' knowledge achievement—thanks to motion infographics that enable the collection of scattered information based on common characteristics and present them in a short and attractive form.

AlShaya (2018) evaluated the effect of static and motion infographics on the academic achievement of high school students in the computer course. She found that both static and motion infographics had a favorable impact on the academic achievement of students. Furthermore, Hassan (2021) conducts a comparative analysis between text-only, static infographics, and motion infographics as tools for the learning process. He observed a more positive effect of motion infographics on information perception and retention. In addition, a recent study by Sabry et al. (2021) examined the impact of the interaction between the learning styles and the infographic patterns (static and motion) in an adaptive learning environment on the programming skills of high school students. The findings highlight a positive effect that was achieved through the use of the interaction between the learning styles and the infographic patterns in an adaptive learning environment on developing programming skills among high school students.

There are many definitions of motion infographics in the literature. Some scholars subsume motion infographics as under an infographic, which is generally defined as a visual representation of data, information, or knowledge that uses charts, graphs, icons, images, and text to collectively convey a message or tell a story (Al-Darwish & Abdelaleem, 2020; Al-Shammari & Alanazi, 2021). For Gebre (2018), motion infographics mean moving images that can be easily shared and understood by a broad audience. In Knorr' (2019) words, "infographics are multimodal texts that combine words, visuals, and data to convey complex data" (p. 97). According to Bayoumi (2022), motion infographics are videos or GIFs that capture viewers' attention use transitions, transformations, rotations, scaling, and fading techniques to create dynamic and engaging visuals. Khalifa (2020) uses the term 'motion infographic' to refer to an infographic that uses motion to enhance message delivery. For the purpose of this study, the term "motion infographic" refers to a series of varying components that combine pictures, animations, shapes, and video clips in an attractive manner to enhance programming skills in the Digital Technology course taught to first-year high school students in Saudi Arabia.

### 1.2 Programming Skills

Much attention has been given to the importance of programming skills. Topalli and Cagiltay (2018) indicated that learning programming greatly influences thinking skills and problem-solving abilities. The same authors also indicated that programming brings a deep knowledge of programming concepts and contributes to progress in the skillful performance of programming skills, resulting in promoting motivations and positive attitudes towards programming. Additionally, learning programming enhances students' computer thinking abilities, which supports their creativity in problem-solving, and encourages them to reevaluate problem-solving approaches from different

perspectives (Koleva & Duman, 2017). Furthermore, Gomes et al. (2018) asserted that programming was found to be interesting for students in their study, which subsequently increased their motivation to learn programming.

Programming skills refer to a set of detailed commands performed by a programmer using a particular computer language to solve a specific problem (Mohamed, 2019). These skills involve writing commands and instructions in programming languages and translating them into machine language for the computer to understand and execute (Al-Qahtani, 2021). For this study, the definition of programming skills is adopted from Alholo (2016) who defined programming skills as a set of practical steps through which a computer can be given a set of precise and detailed commands through a particular language that it understands to solve a specific problem.

Generally speaking, programming languages are categorized into two types: low-level and high-level languages (Al-Maliki & Allam, 2019). The former type, which include early programming languages, refer to either assembly language or machine language. Machine language consists of binary code (zero and one), which is the only language that a computer can understand. Assembly language, on the other hand, is similar to machine language but it is much easier to work with than machine language. Assembly language has some symbols in English, in which each symbol represents a purpose in the program. For example, the symbol (ADD) is used for the addition operation. The latter type is easier to use for programming than the former type because it is closer to human language. The programs written in high-level languages are converted into machine language by a computer translator (compiler) before being executed. There are many examples of high-level programming languages, such as Scratch, Java and Python (Al-Qahtani, 2021; Muhammad, 2019; Topalli & Cagiltay, 2018). For this study, the Python language will be used to program Micro: bit.

### 1.3 Problem Statement

The advancements in information and communication technology in recent years have led to a growing necessity for programming skills. However, the difficulty associated with learning programming is a big challenge for students. In the Saudi context, recent studies have highlighted the low level of programming skills among students. For instance, Al-Omari (2019) reported severe difficulty in programming skills in general and pointed out a low level of coding skills due to the difficulty of teaching programming concepts and skills. Likewise, Al-Maliki and Allam (2019) emphasized the difficulties faced by the majority of first-year high school students in writing code commands. In addition, a finding echoed by Al-Farani and Al-Qarni (2020), who revealed similar challenges in understanding programming elements and abstract concepts at the high school level in Saudi Arabia.

High school students encounter problems in both the cognitive and performance aspects of programming skills. Al-Hafizhi (2021) attributes this to weaknesses in cognitive and performance aspects related to electronic support. Moreover, Al-Shammari and Alanazi (2021) highlighted a general weakness in the programming skills of first-year High school students, leading to decreased achievement and performance. This weakness can be explained by various factors, including heavy reliance on traditional teaching methods and a shortage of technological innovations in teaching computer subjects. Al-Shehri (2021) stated a similar assertion that weakness in the cognitive achievement and skill performance of programming skills among high school students results from traditional classroom teaching and presenting skills.

Taking the aforementioned findings into account, the researcher conducted an exploratory analysis by discussing students' low programming performance with computer teachers in the Saudi context. A questionnaire was distributed to 18 computer teachers and supervisors in Al-Kharj Governorate. Relying on the results, 66.6% of the respondents stated that the most challenging unit in the Digital Technology course at the high school level was the programming unit using Micro:bit. The difficulties in this unit stem from challenges in writing programming codes, much overlapping information in the programming unit, and difficulty in performing practical and fundamental skills

associated with programming that likely occurred under deficiency in the teacher-student interaction. The exploratory questionnaire also revealed that 72.2% of the respondents believe that motion infographics are suitable for addressing the difficulties faced by high school students in programming skills within the Digital Technology subject. Therefore, this study aims to address the low level of programming skills among first-year high school students in the Digital Technology course, primarily based on the results of the exploratory questionnaire conducted prior to the experiment. The assumption is that motion infographics will lead to improved programming performance, and there is a need to validate this assumption.

#### 1.4 Research Objective

The objective of the current study is to determine the effectiveness of using motion infographics in improving both the cognitive achievement and performance skills of high school students in programming.

#### 1.5 Research Questions

The study aimed to answer the central research question: What is the effectiveness of motion infographics in enhancing the programming skills of high school students? This question can be further divided into the following sub-questions:

1. How effective are motion infographics in developing programming achievement skills in the Digital Technology course?
2. How effective are motion infographics in improving programming performance in the Digital Technology course?

#### 1.6 Hypotheses

Two hypotheses were formulated based on the two research questions.

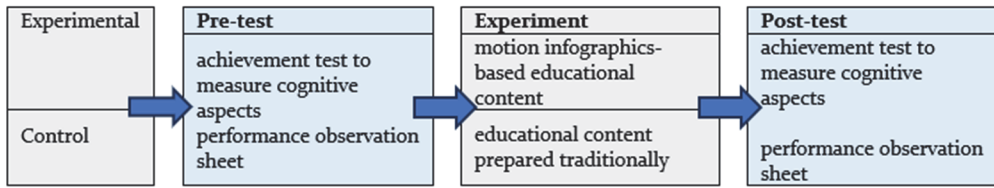
H1: There are no statistically significant differences, at the significance level ( $\alpha \leq 0.05$ ), between the mean scores of the experimental group students and the control group in the post-achievement test.

H2: There are no statistically significant differences, at the significance level ( $\alpha \leq 0.05$ ), between the mean scores of the experimental group students and the control group in the post-observation sheet for programming skills.

## 2. Methodology

### 2.1 Research Design

The study was conducted within the framework of a Digital Technology course that includes a unit on programming using Micro:bit, taught to first-year high school students in Saudi Arabia. The research took place during the third semester of the academic year 2023 and focused on high schools in the Al-Kharj Governorate, under the Department of Education. The study employed a quantitative research design to test the hypotheses formulated in the introduction. The study involved two variables: the independent variable, motion infographics, and the dependent variable, programming skills. Considering these variables, an experimental design was utilized to assess the effectiveness of motion infographics in developing programming skills among high school students (refer to Figure 1).



**Figure 1.** The Experiment design (Developed by the researcher)

### 2.2 Sampling

A random sample was drawn from first-year high school students, representing 34 schools within the Al-Kharj Education Administration (1163 students), during the third semester of 2023. Certain considerations were taken into account during the sample selection process. Students who did not complete any pre- or post-measurements were excluded, as well as those who were absent for 25% or more of the total hours of the experimental treatment. Table 1 presents the distribution of the sample across the experimental and control groups. The sample was divided into an experimental group (n=31) and a control group (n=30).

**Table 1.** Distribution of the Sample

Group	Students in the class	Students of the experiment
Control	31	30
Experimental	33	31
Total	64	61

According to the table, the initial sample consisted of 64 students. However, there were some changes in the sample size during the pre- and post-measurements due to student absences. Therefore, the actual sample size considered for the study is 61 students: 30 students in the control group and 31 students in the experimental group.

### 2.3 Experiment

#### 2.3.1 Motion Infographic Design and Implementation

The researcher utilized the ADDIE model to design the motion infographic for several reasons. Firstly, the ADDIE model is widely recognized and popular in the field. Secondly, the model's sequence of steps is clear and well-defined. Thirdly, the model's procedures are straightforward and easy to follow. Finally, the model is applicable and suitable for the current study, aligning with the study's data and objectives. The general ADDIE model consists of five main steps: analysis, design, development, implementation, and evaluation. The analysis stage involves examining all aspects of the educational process, including problem analysis, needs assessment, educational task analysis, analysis of student characteristics, and analysis of resources and constraints in the learning environment.

In the design step, the researcher defined goals and began designing strategies related to training and organizing content. Previous studies and relevant training courses (Al-Shammari, 2022; Jouda, 2021; Leggette, 2020; Ali, 2019) were reviewed to provide guidance during the design phase. The design process included the following steps:

1. Selecting multiple learning resources.

2. Creating a list of behavioral goals.
3. Designing a strategy for organizing and sequencing content presentation.
4. Defining teaching and learning methods and strategies.
5. Designing scenarios for educational interaction strategies.
6. Designing learning styles and methods.
7. Designing a general learning strategy.

The development stage involved creating electronic educational content in the form of a motion infographic, based on the previous analysis and design stages. This included defining and analyzing goals and content and utilizing the Vyond Website to produce the educational lessons' motion infographics. A total of 12 educational lessons in motion infographic format were created. These lessons are as follows:

1. Introduction to Micro: bit.
2. Introduction to Python.
3. Python Variables.
4. Working with Strings and Numbers.
5. Python Arithmetic Operators.
6. Python Functions.
7. Python XY Coordinates.
8. Python For Loops.
9. Python While Loops.
10. Python If Statement.
11. Python If-else Statement.
12. Python If-elif Statement.

The created lessons were then experimentally tested on a sample of students from the study population (outside the selected sample) to ensure the validity of the digital content for experimentation, verify the integrity and clarity of the educational content, and gather feedback for final modifications during the experimental application. The evaluation stage was conducted after completing the application phase, pilot testing, and making necessary adjustments. The product was now ready to be used in its final form for the research experiment.

## 2.4 Measurement Tools

### 2.4.1 Observation sheet

An observation sheet was developed to assess students' performance of programming skills in the Digital Technology course. Firstly, the purpose of the observation sheet was defined, which aimed to evaluate the effectiveness of motion infographics on the programming skills of first-year high school students in the Digital Technology course. The researcher referred to a list of programming skills specified in the Digital Technology course, consisting of 12 skills. The observation sheet required the identification of specific aspects to be observed, expressed in concise, clear, and precise phrases. A quantitative assessment scale was established, consisting of four options to describe the level of skill demonstrated: high, medium, low, and weak. These four options were precisely defined to clarify the expected performance levels (refer to Table 2). These measurements were developed based on feedback received from experts in the field of measurement and evaluation.

**Table 2.** Rubric of Performance Observation

Level	Standard	Points
High	Student performs the skill perfectly from the first time without the guidance of the teacher	4
Medium	student performs the skill perfectly after several attempts and under the guidance of the teacher for one time only	3

Level	Standard	Points
Low	The student's improper performance of the skill	2
Weak	The student's non-performance of the skill at all	1

After preparing the initial version of the observation sheet and the instruction page, it was presented to 11 experts specializing in curricula, teaching methods, educational technology, psychology, and computer teachers to ensure its validity for the study. Furthermore, it was piloted on an exploratory sample of 28 participants, who were randomly selected and had similar characteristics to the students in the experimental and control groups. The researcher utilized the Cooper equation to calculate the level of agreement between the observers. This involved calculating the number of items of agreement and difference between the two observation sheets for both the researcher and the teacher. The percentage of agreement reached was determined to be 94.64%, which is considered high given the subjective nature of personal observation. This indicates that the observation sheet has an appropriate level of reliability and validity for measuring its intended purpose. The final version of the observation sheet was approved based on the preceding steps of preparation, validation, and piloting.

#### 2.4.2 Achievement Test

To assess the effectiveness of motion infographics, an achievement test was developed to measure students' cognitive abilities in programming skills. The test consisted of 30 multiple-choice questions, as this type of question is considered one of the most effective objective test formats. The objective of the test was to evaluate the extent to which educational objectives were achieved in the programming unit using Micro: bit in the first-year Digital Technology course for high school students. When constructing the test, the number of items was determined based on the importance of the topics and cognitive objectives. Each question comprised two parts: the stem, which specified the required performance and presented the problem to be solved, and the distractors, which included possible answer options, with only one correct answer.

The researcher established test design specifications through the following steps: (a) determining the course topics to be assessed and calculating their relative weight, and (b) determining the relative weight of the objectives. This process aimed to achieve a balance between the cognitive content topics and the cognitive processes represented by the six levels of Bloom's taxonomy: remembering, understanding, applying, analyzing, synthesizing, and evaluating. The test also included instructions for students, providing guidance on how to answer the test questions, along with an illustrative example. In addition to the test design specifications and instructions, the researcher created an answer sheet where students could mark the correct answers. Each correctly answered item was awarded one point, while incorrect answers received zero points.

The initial version of the achievement test was reviewed by 11 experts mentioned previously to validate its content. The test's reliability was assessed using the split-half method. The test items were divided into two similar halves, and the correlation coefficient between the two parts was calculated. The Spearman-Brown equation was then applied to determine the reliability coefficient. The reliability coefficient for the entire test was calculated using the following equation:  $\text{Test coefficient} = (2 \times \text{half-test correlation coefficient}) \div (1 + \text{half-test correlation coefficient})$ . Since the correlation coefficient between half of the test is (0.785), the reliability coefficient for the entire test  $= 2 \times 0.785 \div (1 + 0.785) = 0.879$ . This score indicates that the reliability of the achievement test is achieved at a high degree so that it can be considered reliable to be used in this study. The test was also piloted on a random sample of 28 students from outside the selected sample, who shared similar characteristics. The final version of the test, comprising 30 questions worth a total of 30 points, was adopted for the study.

2.5 Procedures

Based on the necessary preliminary preparations for the experiment in terms of sampling and measurement tools, initial procedures were carried out to measure the participants' programming skills. This involved conducting a pre-test and observing their performance in both the control and experimental groups. The T-test was used to identify the differences between the control and experimental groups, and the results are shown in Table 3. The data in the table indicates that no statistically significant differences were found at a significance level of 0.05 between the experimental and control groups in terms of the pre-test and performance observation. Therefore, it can be concluded that the proficiency level of the two groups was identical.

**Table 3.** Results of the Pre-test and Performance Observation Prior to the Experiment

Measurement Tool	Group	Mean	St. D.	F	t	Sig.
Observation sheet	Control	20.35	6.301	59	1.241	0.221
	Experimental	22.64	6.640			
Achievement test	Control	13.72	3.861	59	0.892	0.381
	Experimental	14.53	3.345			

3. Results

This study utilized both descriptive and inferential statistics, and the results are presented in Tables 4–7. The descriptive analysis involved calculating the mean scores and standard deviations, while the inferential statistics included the t-test for independent samples and the eta-square test to determine the effect size between independent samples. The results of the study are presented in this section according to the order of the research questions.

3.1 Research Question #1:

The research question aimed to measure the effectiveness of the motion infographic on programming skills and students' performance in the Digital Technology course. Two hypotheses were formulated to address this question.

**H1:** There are no statistically significant differences, at the significance level ( $\alpha \geq 0.05$ ), between the mean scores of the experimental group students and the control group in the post-achievement test.

To examine this hypothesis, the mean scores and standard deviations of the performance scores for both the experimental group and the control group students were calculated in the post-test. The significance of the mean differences was evaluated using the t-test for independent samples, and the results are presented in Table 4. The table shows that the mean score for the experimental group is 25.31, while the mean score for the control group is 17.24. This indicates statistically significant differences at the level ( $0.05 \geq \alpha$ ) between the mean scores of the research groups in the post-test, favoring the experimental group. Consequently, the null hypothesis is rejected, and the alternative hypothesis is accepted. Thus, there are statistically significant differences, at the significance level ( $\alpha \geq 0.05$ ), between the mean scores of the experimental group and the control group students in the post-test.

**Table 4.** T-test of Independent Samples of Control and Experimental Groups in Post-test

Measurement Tool	Control Group		Experimental Group		F	t	Sig.	Dec.
	Mean	St.D.	Mean	St.D				
Achievement Test	17.24	3.32	25.31	3.25	59	4.41	0.000	Sig at (0.05)



The effect size was determined using the Eta-square equation ( $\eta^2$ ) for independent samples to quantify the magnitude of performance differences between the control and experimental groups. As presented in Table 5, the calculated eta-square value ( $\eta^2$ ) is 0.249, indicating a moderate effect size.

**Table 5.** Effect Size of Significance of Differences in Post-test for Control and Experimental Groups

Measurement Tool	$\eta^2$ ( Eta Square)	Effect size
Achievement Test	0.249	moderate

These results indicate that students in the experimental group, who were exposed to motion infographics, achieved higher performance compared to their counterparts in the control group. This could be attributed to the fact that the motion infographics present the educational content in an animated way that contains two and three-dimensional graphics, which makes the educational content full of stimuli that attract students' attention even more and provide feedback with appropriate reinforcement, compared to the traditional method. This aligns with the works of Tsai et al (2020), who emphasize that motion infographics promote more effective and enduring learning, facilitating long-term information retention and simplify the presentation of educational content, making it more accessible to students.

### 3.2 Research Question #2:

The second research question corresponds to the second hypothesis.

**H2:** There are no statistically significant differences, at the significance level ( $\alpha \geq 0.05$ ), between the mean scores of the experimental group and the control group students in the post-observation sheet for programming skills.

In order to verify the second hypothesis, the mean scores and standard deviations of the performance scores of the experimental group and the control group students were calculated in the post-test of performance observation. The significance of the differences between the means was calculated using the T-test for independent samples, and the results are presented in Table 6. The table demonstrates that the mean of the experimental group is 40.42 and the mean of the control group is 28.18, indicating statistically significant differences at the level ( $0.05 \geq \alpha$ ) between the mean scores of the research groups in the post-performance observation in favor of the experimental group. As a result, the null hypothesis is rejected, and the alternative hypothesis is accepted. Thus, there are statistically significant differences at the significance level ( $0.05 \geq \alpha$ ) between the mean scores of the experimental group and the control group students in the post-performance observation.

**Table 6.** T-test of Independent Samples of Control and Experimental Groups in Post Performance observation

Measurement Tool	Control Group		Experimental Group		F	t	Sig.	Deci.
	Mean	St.D.	Mean	St.D				
Observation sheet	28.18	4.61	40.42	4.74	59	7.58	0.000	Sig at (0.05)

The effect size was calculated using the Eta-square equation ( $\eta^2$ ) for independent samples to quantify the magnitude of performance differences between the two groups (control and experimental). The eta-square value ( $\eta^2$ ) is 0.493, which is a large effect size (Table 7).

**Table 7.** Effect Size of Significance of Differences in Post-observation for Control and Experimental Groups

Measurement Tool	$\eta^2$ ( Eta Square)	effect size
Observation sheet	0.493	large

These results indicate that students in the experimental group, who were exposed to motion infographics, outperformed their counterparts in the control group. This could be attributed to the effective design of the motion infographics in which concepts are presented and organized in an order and logical manner, thereby enhancing the motivation of the experimental group towards learning. Consequently, educational goals were achieved, and there was an improvement in programming skills performance. Furthermore, motion infographics-based educational content facilitated a more accessible delivery of the message. It directed students' focus towards specific practical skill elements, eliminating any unnecessary components and allowing them to fully concentrate on the processes and comprehend the relationship between the core skill and its constituent sub-skills.

#### **4. Discussion**

The results obtained for the first research question (Tables 4, 5) align with the first hypothesis. The findings suggest that motion infographics simplify the delivery of educational content, leading to more effective and long-lasting learning, thereby aiding in the retention of information in students' minds for extended periods. This finding is consistent with Brunner's theory, which posits that simplified presentation of content to students facilitates learning by helping them form connections between different parts of a subject (Knorr, 2019).

Moreover, motion infographics hold a compelling role in the educational process, particularly when dealing with a substantial amount of content or when students are unfamiliar with programming. Visual presentation of concepts through motion infographics enhances memory retention which is an advantage to motion infographics, as they effectively convey and retrieve information. Presenting large amounts of content through motion infographics significantly contributes to improved memory recall and information processing, surpassing traditional methods. These findings align with the works of Mohieddin (2018), who highlighted the significant impact of three-dimensional motion infographics on students' understanding of internet concepts, as well as Abdulrahman and Qhouf's (2019) study, which demonstrated the superior performance of students who studied through infographics. Additionally, Bayoumi (2022) demonstrated the effectiveness of infographics in enhancing students' cognitive achievement, further supporting the results of the current study. In a related vein, Delil (2017) observed that motion infographics serve as an effective teaching technology, particularly when dealing with content that involves a large amount of data or information. This is due to the visual stimuli employed in motion infographics, such as animated graphics, and video clips, which significantly enhance students' cognitive processes.

The results obtained for the second research question align with the second hypothesis (Tables 6-7), demonstrating the superiority of the experimental group that utilized motion infographics. This can be attributed to the well-designed motion infographics. The effective design significantly impacted the experimental group by presenting concepts in an organized and logical manner, thereby increasing students' motivation towards learning. Consequently, educational objectives were achieved, and there was an improvement in programming skills performance. Furthermore, presenting educational content through motion infographics facilitated efficient message delivery by directing students' focus towards specific elements of practical skills and eliminating redundant elements. The sequential and progressive presentation of programming skills through motion infographics also aided in clearly presenting each skill in a specific order, enabling students to arrange the skills appropriately and comprehend the relationship between different programming skills. This finding is consistent with the study of Al-Harthy (2019), who highlighted the impact of using motion infographics through social media in developing practical computer skills. His study found statistically significant results in favor of the post-application, indicating the positive impact of motion infographics on the development of practical computer skills.

Moreover, the t-test analysis revealed significant differences between the two groups in the post-test, indicating the effectiveness of motion infographics in improving programming skill

performance. These findings align with the research conducted by Gebre (2018), which demonstrated the effectiveness of motion infographics in enhancing students' skillful performance. The study is also consistent with the work of Kibar and Buket (2014), who emphasized the ability of motion infographics to visualize information, helping students in absorbing practical skills and applying them effectively. Additionally, Bicen and Beheshti (2017) highlighted the contribution of motion infographics with textual details in improving students' skillful performance.

Based on these findings, this study encourages educational institutions and decision-makers to embrace modern digital technologies and develop curricula by incorporating educational content based on the principles of educational design in educational technologies. It also encourages teachers to utilize new technologies for more effective learning of programming skills. Furthermore, it calls for further experimental studies based on instructional design, as it is a significant concept in educational technologies. In practice, it is reasonable to advocate for the inclusion of motion infographics in high school curricula to assist students in developing their programming skills through interactive applications of educational content. Additionally, it can provide guidance to curriculum designers in general education to incorporate motion infographics in designing curriculum content.

## 5. Conclusion

This study investigated the significance of motion infographics in enhancing the programming skills of high school students. The results of the experiment demonstrated that the group utilizing motion infographics achieved significantly higher scores on the achievement test and performance observation compared to the control group. Based on these findings, it is recommended to conduct training workshops that focus on designing and producing educational content using motion infographics. Teachers should incorporate motion infographics into their teaching of the Digital Technology course as well as other courses. Additionally, the design of general education course textbooks should be reviewed to incorporate motion infographics and present content in an attractive manner. Furthermore, it is suggested that further research be conducted to explore the effects of different design variables on motion infographics. This may include investigating the appropriate display period for content and the optimal amount of text to be used. Additionally, conducting a study on the impact of motion infographics on different student groups, such as gifted students or those with learning difficulties, would be beneficial. Also, conducting comparative studies on the effect of using motion infographics with other techniques to develop programming skills deserves further exploration.

Overall, this study highlights the potential of motion infographics as a powerful tool for enhancing programming skills in high school students. By implementing the recommendations and conducting further research, educators and researchers can continue to explore and maximize the benefits of motion infographics in educational settings.

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