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The Degree of Integration of Visual Thinking Skills in Mathematics Curriculum Content and its Relationship with Productive Motivation among Fifth-Grade Students in the Kingdom of Saudi Arabia

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Abstract. The current study aimed to identify the degree of integration of visual thinking skills into the mathematics curriculum content and its relationship to productive motivation among fifth-grade primary school students in the Kingdom of Saudi Arabia. To achieve the study objectives, two study tools were developed: a visual thinking skills scale consisting of four (4) skills, each with a set of specific indicators totalling (16) items, and a productive motivation scale consisting of four (4) skills, each with a set of specific indicators totalling (28) items. The study sample included 252 male and female teachers, comprising 140 male teachers and 112 female teachers, who were randomly selected during the third semester (1446 AH). The results showed that the overall averages of visual thinking skills were high, with the highest skill being the ability to read visual shapes, followed by the skill of perceiving and interpreting relationships, then the skill of analyzing visual shapes, and the skill of inferring meanings. The overall averages of productive motivation were high, with students' tendency to perceive meaning in mathematics ranking first, followed by learners' perception of themselves as effective learners and practitioners of mathematics, then their perception of the usefulness and value of mathematics, and finally, the belief that the effort expended in learning mathematics yields results. There was a statistically significant positive relationship between all visual thinking skills and dimensions of productive motivation. The study recommended integrating visual thinking skills and enriching mathematical and realistic activities in mathematics curricula.

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1. Introduction

The world is witnessing advancements in the educational field. The recent scientific and intellectual developments in our society, along with the increasing knowledge growth, have led countries to strive for the enhancement of their educational systems. Additionally, there has been a shift in teaching and learning methods as well as the skills that learners must master, prompting a re-evaluation of curricula at all levels of general education. This requires rapid development in line with the latest scientific advancements and educational methodologies. The scientific and technological changes have also led to the evolution of teaching and learning methods in mathematics, which is considered a fundamental knowledge area for learners, contributing to problem-solving in everyday life and lifelong learning.

Currently, the Kingdom of Saudi Arabia is experiencing significant and rapid scientific development across all areas of life, especially in the fields of science, mathematics, engineering, communications, and information technology. These developments have had positive effects on various aspects of life, including schools, which are regarded as educational social institutions. This has prompted educators to take advantage of these advancements and elevate educational practices by keeping pace with innovations and technological developments, preparing individuals to engage in them in order to advance society and achieve desired goals (Al-Qudah et al., 2014).

In light of the Kingdom's Vision 2030 in education, which aims to elevate contemporary educational practices by making the learner the centre of the educational process, with a focus on building their skills, refining their personality, instilling confidence, and fostering creativity, it is essential to pay attention to the skills that aid in the learning process. The Committee on Education at the National Research Council (NRC) in the United States has presented numerous studies in cognitive psychology and the teaching and learning of mathematics. After considering what individuals currently need in terms of mathematical knowledge, understanding, and skills, they developed a comprehensive and nuanced perspective on what success in learning mathematics entails, which they referred to as mathematical proficiency.

This proficiency means learning mathematics efficiently and successfully. It consists of five main components: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (NRC, 2001, p. 115). The understanding of mathematical concepts is the foundational building block upon which mathematical knowledge is constructed. It serves as the basis for all other components of mathematical proficiency. The importance of students grasping mathematical knowledge and concepts stems from their role as the fundamental basis for generating new mathematical knowledge. Consequently, developing an understanding of mathematical concepts enables students to comprehend the foundation of this

knowledge, recognize common characteristics, and establish connections and relationships among its components. This leads them to apply it effectively in various situations and use it efficiently to solve problems they may encounter (Al-Salahi, 2020).

Furthermore, thinking skills are essential for every individual living in contemporary society, as they help people to adapt to their environment and achieve their aspirations. These skills also enhance an individual's self-confidence, improve their ability for self-directed learning, and elevate their educational level (Mustafa, 2017).

The study emphasizes the importance of nurturing thinking skills in mathematics education, as well as visual thinking, which involves the learner's observation and contemplation of drawings and shapes. This process includes analyzing their components and understanding the relationships between them. Visual thinking is considered one of the methods that contribute to the retention of learning outcomes, as it is associated with the sense of sight and visual discrimination of images and shapes. This is an important factor for solving many problems related to understanding abstract concepts that require specific thinking skills.

Al-Mutaib et al. (2023) contend that visual thinking embodies mathematical concepts for the learner and helps them acquire, represent, interpret, and comprehend information, thereby enhancing visual memory. This mental skill aids individuals in solving problems that require constructing meaningful knowledge. It focuses on clarifying the relationships between concepts, principles, and theories. Possessing this skill means having the cognitive capacity to solve problems in new situations. Al-Shobaki (2010) states that visual thinking is an individual's ability to engage with tangible materials and distinguish them visually, enabling the perception of spatial relationships, interpretation and analysis of information, clarification of ambiguity, and deriving meaning.

The document on the Standards for Mathematics Learning issued by the Education and Training Evaluation Commission (2019) emphasizes achieving mathematical proficiency, which is the ultimate goal of learning mathematics, through the learner's understanding of fundamental mathematical concepts and applying that knowledge to solve problems in real-life contexts at home and in the community. It also fosters the learner's productive motivation for mathematics, which is considered the emotional component of mathematical proficiency and one of its most important elements.

Productive motivation goes beyond a positive inclination towards learning mathematics; it includes the application and belief that effort in learning mathematics is fruitful and beneficial. Thus, productive desire motivates perseverance in learning mathematics and the recognition of its usefulness in daily life (NRC, 2001, p. 131). Siegfried (2012) mentioned that productive motivation is the hidden thread of success in learning mathematics and is

essential for achieving the other components of mathematical proficiency. Students who have developed productive motivation towards mathematics are confident in their knowledge and abilities; they believe that mathematics can be learned with increased effort and experience. This goes beyond the ability to understand, calculate, and solve; it focuses on the affective aspects and positive attitudes towards learning mathematics, with the belief that mathematics is logical and that they can discover it (NRC, 2001).

The productive mathematical motivation represents a fundamental emotional aspect of mathematical proficiency and is one of its five components as defined by the NRC for achieving success in learning mathematics. Productive mathematical motivation is characterized by its focus on the emotional side and affective attitudes toward mathematics, in contrast to the other components of mathematical proficiency that emphasize cognitive aspects (Rohman et al., 2023, p. 651). Productive motivation encourages perseverance in learning mathematics and fosters a sense of its usefulness in daily life (NRC, 2001, p. 131). The NRC defines it as students' inclination to see meaning in mathematics, recognizing that it is useful and important, believing that continuous effort in mathematics makes learning fruitful, and the learner's self-perception as an effective learner and practitioner of mathematics (NRC, 2001, p. 131).

Watson (2015) defines it as a set of beliefs that guide and influence how students engage with mathematics, while Jacobson and Kilpatrick (2015) define it as the usual tendency to view mathematics as reasonable, useful, and worthy of attention, along with a belief in diligence in learning mathematics. Badawi (2019) defines it as the learners' tendency to see meaning in mathematics and perceive it as useful and worthy of interest, believing that continuous effort in learning mathematics pays off, and viewing oneself as an effective and active learner of mathematics. The importance of developing a productive motivation lies in its ability to help students become more independent and creative in solving mathematical problems, as well as enhancing their conceptual understanding, procedural fluency, strategic competence, and logical adaptability (Rohman et al., 2023).

One of the most significant motivators for students learning mathematics is their complete conviction that they can learn and recognize the great value of what they are learning (NRC, 2001). They will become confident in their mathematical knowledge and abilities, making significant progress in problem-solving. Consequently, they will have built one or more components of mathematical proficiency. They will affirm the value of the effort they put into solving mathematical problems and recognize their ability to think through challenging mathematical tasks and how to approach them (Siegfried, 2012).

Additionally, productive motivation enhances students' confidence in their mathematical capabilities and develops their problem-solving skills in real-life situations (Badawi, 2019). The principles of the National Council of Teachers of Mathematics (NCTM) emphasize the importance of presenting tasks that challenge students' thinking, instilling confidence in their ability to tackle

difficult problems, and fostering motivation to explore mathematical ideas. This generates motivation for perseverance, as students should view complex mathematics as a challenge that encourages ongoing discoveries. When a task is difficult, students can engage with it and work diligently to solve it, leading to a desire to continue and expand their involvement in mathematics (NCTM, 2013, p. 49).

Watson (2015) mentions that productive motivation consists of three components: self-efficacy, which represents the student's belief in their ability to learn mathematics effectively and successfully, leading them to see themselves as effective and successful learners in mathematics. They believe they possess the knowledge, skills, and ability to use them effectively in solving mathematical problems. Additionally, the perceived usefulness of mathematics reflects the student's belief about the nature of mathematics as being useful, logical, realistic, and worthy of interest. Finally, perseverance for success in mathematics represents the student's beliefs about the importance of persistence and effort in learning mathematics, even when faced with obstacles and challenges, and achieving success in solving mathematical problems and tasks.

2. Theoretical Framework

Previous studies have demonstrated the importance of conducting this research, as Al-Oudat (2023) conducted a study aimed at identifying the visual thinking skills included in social studies textbooks for sixth grade in Jordan. The study sample consisted of sixth-grade social studies textbooks in Jordan, which include books on history, geography, and national education. To achieve the study's objectives, an analysis card was prepared that includes a list of proposed visual thinking skills to be included in social studies textbooks.

The results of the study showed that visual thinking skills were distributed across five areas: the ability to recognize visual forms, analysis of visual forms, the skill of relating connections in visual forms, the skill of perceiving and interpreting ambiguity in visual forms, and the skill of extracting meanings from visual forms. The ability to recognize visual forms ranked first with a percentage of 33%, followed by the skill of relating connections in visual forms at 24%. However, the skills of perceiving and interpreting ambiguity in visual forms and extracting meanings from visual forms ranked last with a percentage of 12%.

Rohman et al. (2023) conducted a study aimed at developing a tool to measure productive motivation skills among elementary school students. The study employed a descriptive methodology, and the sample consisted of 99 students randomly sampled from fourth and fifth grades across four elementary schools in East Java. The results indicated that the developed tool for measuring productive motivation skills demonstrated reliability, with the reliability test results showing a Cronbach's alpha coefficient of 0.85. The tool comprises 22 statements that assess productive motivation skills based on five (5) indicators: enthusiasm, self-confidence, perseverance, curiosity, and willingness to participate. This study concludes that the developed tool for measuring productive motivation skills can be used as an assessment instrument in

learning that focuses on fostering productive motivation among elementary school students.

Previously, Jassim and Jassim (2020) conducted a study aimed at investigating the extent to which visual thinking skills are included in the mathematics textbook for fourth-grade primary students. To achieve the study's objective, a list of main visual thinking skills and their sub-skills was prepared. The study found that all main visual thinking skills were included in the textbook, with the highest percentage (44.04%) achieved for the skill of interpreting information in visual form, ranking first. This was followed by analyzing visual shapes at a percentage of 31.35%, ranking second, then the skill of reading visual shapes at a percentage of 12.71%, ranking third. Finally, the skill of inferring meanings from visual forms achieved a percentage of 11.86%. This indicates that visual thinking skills are present in the content of the mathematics textbook for fourth-grade primary students, albeit at varying percentages.

Furthermore, Al-Qurashi (2020) conducted a study aimed at identifying the level of productive motivation towards mathematics among students in the first, second, and third grades of middle school in Taif City. It examined whether there are statistically significant differences attributed to the differences in grade level. To carry out the study, the researcher designed a scale consisting of 51 items distributed across three (3) axes. The study was applied to a sample cluster randomly selected from four educational offices in Taif City, consisting of 360 students.

The results of the study indicated that the axis of the importance of mathematics in life among middle school students was at a medium level, the axis of the ability of middle school students to practise mathematics was also at a medium level, as was the axis of the attitudes of middle school students towards mathematics. The overall scale of productive motivation towards mathematics was at a medium level. There were no statistically significant differences between the means of the study sample's responses regarding the level of productive motivation among students attributed to differences in grade level.

In addition, Kousa (2019) conducted a study aimed at identifying the degree of availability of visual thinking skills in the sixth-grade mathematics curriculum in the Kingdom of Saudi Arabia. To achieve the study's objectives, a list of visual thinking skills from the sixth-grade mathematics curriculum was prepared. The results of the study showed varying levels of attention to the availability of visual thinking skills. The skill of reading visual shapes was available at a high percentage, the skill of analyzing visual shapes was available at an average percentage, while both the skill of interpreting information from visual shapes and the skill of inferring meanings were available at a low percentage.

Al-Maliki (2019) conducted a study aimed at revealing the effectiveness of a proposed strategy based on Marzano's model of learning dimensions and metacognitive skills in enhancing academic achievement and productive mathematical interest. The qualitative approach was used in developing the

proposed strategy and in understanding the opinions of the study sample regarding the strategy, while the quantitative approach was employed through an experimental design. The study utilized a set of materials and tools which included a teacher's guide for the strategy, and two quantitative instruments: an achievement test and a productive interest scale. Additionally, two qualitative tools were used: an interview and participant observation. The study sample consisted of 45 second-grade middle school students from Al-Dair Middle School, which is affiliated with the Education Office of Al-Dair Governorate under the Jazan Education Administration. The experimental group comprised 32 students, while the control group included 33 students.

The study found a statistically significant difference at the level of $\alpha \geq 0.05$ between the mean scores of the students in the experimental and control groups in the post-application of the achievement test in favour of the experimental group. Moreover, there was a statistically significant difference at the level of $\alpha \geq 0.05$ between the mean scores of the experimental group students in the pre- and post-application of the productive interest scale in favour of the post-application. Many students from the study sample expressed their satisfaction with the strategy, stating that it was beneficial and useful, and that more effort could be made in learning mathematics in this way, as it also helped them build confidence and self-reliance.

Nateel (2018) conducted a study aimed at identifying the extent to which mathematics textbooks for lower primary education include visual thinking skills and the degree to which students acquire these skills. The study relied on a descriptive analytical methodology. To achieve the study's objective, a content analysis tool and a test for visual thinking skills were developed. Among the key findings of the study was that mathematics textbooks for lower primary grades, from first to fourth grade, included some visual thinking skills, which were as follows: visual discrimination skill at a rate of 50.65%, information representation skill at a rate of 31.78%, and information interpretation skill at a rate of 17.58%. However, the content did not include the skills of connecting relationships, analyzing information, or extracting meanings.

More recently, Al-Afifi (2022) conducted a study aimed at identifying the impact of using enjoyable learning strategies in teaching mathematics on the development of productive motivation among first-grade middle female students in Makkah. The study tools included a productive motivation scale, a teacher's guide, a student guide, and a presentation using Microsoft PowerPoint to be presented to the experimental group of students. A random sample of 68 students was selected and divided into two groups (experimental and control). The tool was applied pre-test to verify the equivalence of the two groups, and then it was applied post-test. The results of the study indicated that enjoyable learning strategies have an effect on improving the productive motivation among the students.

2.1 Commentary on Previous Studies and Their Relation to the Current Study

A review of previous studies indicates that the topic of this research, namely the degree of integration of visual thinking skills in the mathematics curriculum content and its relationship to productive motivation among fifth-grade students in the Kingdom of Saudi Arabia, has received significant attention from researchers. This reflects the importance of this field and the ongoing interest in it within academic circles. The current study shows similarities with previous studies in its focus on the same topic, despite variations in their approaches and the aspects they address.

Previous studies have contributed to enriching the theoretical framework and constructing the study's tools, as well as providing a basis for comparing their results with those of the current study. This study is distinguished from other previous studies by the nature of the study population, the sample size, and the university where it was conducted, which adds a unique character to it and enhances its educational value.

2.2 Study Problem

The study focused on visual thinking skills and productive motivation in the fifth-grade mathematics curriculum, considering these as important mathematical communication skills that receive global attention for their role in scientific and technological development. The Saudi Ministry of Education has prioritized mathematics education, working to develop its curricula based on the McGraw-Hill global series to improve learning outcomes. Al-Harbi's study (2011) indicated a low level of visual thinking skills among students, as national assessments revealed that 53% and 61% of the test sample students in the elementary and middle stages, respectively were below the proficiency threshold in mathematics.

The NCTM (2000) recommended the importance of developing students' visual thinking skills as a primary goal of mathematics learning. In addition to confirming studies by Abu Jalba (2017), Al-Asiri (2018), Ashoush (2015), Kariri (2016), Khattab (2013), and Shehata (2014) on the importance of developing visual thinking skills, this study aims to highlight the extent to which visual thinking skills are incorporated into the mathematics curriculum and its relationship with productive motivation among fifth-grade students. It also examines the role of the textbook as an important element in improving educational outcomes by analyzing the extent to which it includes visual thinking skills.

It further examines the degree of positive student interaction with visual aids such as images and graphs compared to text-based exercises to enhance understanding and contribute to the retention of information in memory for a longer period. This indicates the close relationship between visual aids and visual thinking, as well as the intensity of students' attention, interaction, and engagement when using images, graphs, shapes, and illustrative videos compared to exercises that contain only text and numbers. The study demonstrates the strong relationship between images, visual thinking skills, and

productive motivation, as well as the retention of information in students' memory for a longer duration.

2.3 Study Questions

The study is based on the following questions:

Question 1: What is the degree of integration of visual thinking skills in the mathematics curriculum for fifth-grade students in the Kingdom of Saudi Arabia?

Question 2: What is the degree of productive motivation in the mathematics curriculum for fifth-grade students in the Kingdom of Saudi Arabia?

Question 3: Is there a statistically significant correlation between the degree of integration of visual thinking skills in the mathematics curriculum and productive motivation among fifth-grade students in the Kingdom of Saudi Arabia?

2.4 Study Objectives

The study aims to achieve the following:

1. To identify the degree of integration of visual thinking skills in the mathematics curriculum for fifth-grade students in the Kingdom of Saudi Arabia.
2. To determine the level of productive motivation in the mathematics curriculum among fifth-grade students in the Kingdom of Saudi Arabia; and
3. To investigate the existence of a statistically significant correlation between the degree of integration of visual thinking skills in the mathematics curriculum and productive motivation among fifth-grade students in the Kingdom of Saudi Arabia.

2.5 Importance of the Study

2.5.1 Theoretical Importance

The current study aims to define the extent of the integration of visual thinking skills in the mathematics curriculum content and its relationship with the productive motivation among fifth-grade students in the Kingdom of Saudi Arabia. Furthermore, it seeks to provide feedback on the availability of visual thinking skills in mathematics textbooks and to equip mathematics teachers in the use of images, illustrations, and concept maps in developing visual thinking skills, as well as assessing their students in light of these skills.

Moreover, it aligns with modern trends in mathematics teaching and learning, which emphasize the importance of developing visual thinking skills among elementary school students. Finally, it contributes to the understanding that productive motivation enhances students' appreciation of mathematics as a subject they need in their lives, as it helps improve the way students engage with mathematical tasks, their confidence and perseverance, and their interest and inclination to generate their own ideas.

2.5.2 Practical (Applied) Importance

The study benefits curriculum planners and developers in elementary mathematics by highlighting the role of scientists and specialists in discovering mathematical concepts, aligning with the Kingdom of Saudi Arabia's Vision

(2030) in fostering motivation for innovation and discovery among our students. In addition, it can assist mathematics teachers, supervisors, and those involved in the educational process by providing a guide for teachers to teach mathematics, enhancing the understanding of mathematical concepts and fostering productive motivation.

2.6 Study Limitations

2.6.1 Human, Spatial, and Temporal Boundaries

The current study was limited to mathematics teachers in public schools affiliated with Al-Qunfudhah Education Administration during the third semester (1446 AH).

2.6.2 Objective (Procedural) Boundaries

The current study focused on identifying the degree of integration of visual thinking skills in the content of the mathematics curriculum and its relationship to productive motivation among fifth-grade students in the Kingdom of Saudi Arabia. Two study tools were developed: a visual thinking skills scale consisting of four (4) skills, each with a set of specific indicators totalling 16 items, and a productive motivation scale consisting of four (4) skills, each with a set of specific indicators totalling 28 items. The validity and reliability of both tools were confirmed.

2.7 Terminological and Procedural Definitions

2.7.1 Visual Thinking

Amer and Al-Masri (2016) define visual thinking as a system of processes that translate an individual's ability to read visual shapes and convert visual language into written or spoken verbal language, extracting information from it. The current study defines it as an internal process that involves mental imagery and employs other processes related to the remaining senses; this is to integrate the student's visual perceptions with the cognitive experiences they possess.

2.7.2 Visual Thinking Skills

These are a set of competencies that enable the learner to recognize, understand, and interpret images and visual shapes, such as the skill of reading visual shapes, the skill of interpreting information in visual form, the skill of analyzing visual shapes, and the skill of inferring meanings (Kousa, 2019). The current study defines them practically as a set of skills included in the content of the fifth-grade mathematics textbook, represented in the skills of reading visual shapes, interpreting information in visual form, analyzing visual shapes, and inferring meanings.

2.7.3 The Content of the Fifth-Grade Mathematics Curriculum

This term refers to a collection of mathematical concepts and skills designed to develop students' numerical, geometric, and logical thinking, and to strengthen their ability to apply mathematics in solving real-life problems, in line with the educational standards set by the Ministry of Education.

2.7.4 Productive Motivation

Chua (2021) defines it as the continuous inclination of the learner to perceive mathematics as useful and worthy of attention, leading to diligence and belief in their self-efficacy. This study defines it as a set of beliefs based on the learner's perception of the meaning of mathematics as realistic, useful, and worthy of effort in learning, and that ongoing effort in learning it is fruitful, along with the learners' view of themselves as an active learner and proficient practitioner of mathematics. This study further defines it practically as a fifth-grade student's tendency to see mathematics as important, useful, and meaningful, contributing to solving everyday problems, and their confidence in themselves and their effort in solving problems and tasks related to the educational unit on operations with decimal fractions, believing that this is fruitful and beneficial in real life. It is measured by the score the student receives on the productive motivation scale.

2.7.5 Fifth Grade

This is an academic year in the elementary stage, where students study a set of fundamental educational subjects. Typically, students in this grade are between 10 and 11 years old. This grade follows the fourth grade and precedes the sixth grade, and it is considered an important stage for building essential skills and expanding knowledge.

3. Methodology

3.1 Methodology and Procedures

This section includes a description of the study population, its sample, the study tool, methods for verifying validity and reliability, study variables, and the statistical procedures used to answer the study questions.

3.2 Study Methodology

To achieve the objectives of the study, the correlational descriptive method was employed.

3.3 Study Population and Sample

The study population consisted of all mathematics teachers in the schools affiliated with Al-Qunfudhah Education Administration, with a sample size of 252 teachers, comprising 140 male teachers and 112 female teachers. They were selected using simple random sampling (1446 AH), as shown in Table 1:

Table 1: Distribution of the Number of Sample Members according to Gender Variable

| Variable | Variable Levels | Sample | Percentage (%) |
|----------|-----------------|--------|----------------|
| Gender | Male | 140 | 55.6 |
| | Female | 112 | 44.4 |
| | Total | 252 | 100 |

3.4 Procedures for Preparing the Study Tool

To achieve the study's objectives, two study tools were developed: a Visual Thinking Scale for the fifth-grade mathematics curriculum and a Productive Motivation Scale for the fifth-grade mathematics curriculum in the Kingdom of Saudi Arabia. These were prepared by following the steps below:

3.4.1 Visual Thinking Scale

After reviewing the previous literature, visual thinking skills in the mathematics curriculum were identified, along with the specific indicators for each skill. The scale consists of a total of four (4) skills, with each skill having a set of specific indicators totalling (16) items. The following Table 2 illustrates the distribution of skills and items.

Table 2: Distribution of Visual Thinking Scale Skills in the Mathematics Curriculum Content

| | Skills | Number of Indicators |
|---|--|----------------------|
| 1 | Skill of reading visual forms | 4 |
| 2 | Skill of analyzing visual forms | 4 |
| 3 | Skill of perceiving and interpreting relationships | 4 |
| 4 | Skill of inferring meanings | 4 |
| | Overall mean of visual thinking skills | 16 |

The degree of availability of each skill's components should be determined by calculating the arithmetic means and standard deviations for each skill and for each related component.

3.4.1.1 Internal consistency validity (construct validity)

Internal consistency was verified using Pearson correlation coefficient to calculate the correlation coefficients between the score of each statement in the questionnaire related to different skills and the total score of the corresponding skill, as well as the total score of the questionnaire as a whole. This was done to ensure the coherence and homogeneity of the statements within each dimension. The results of the Pearson correlation coefficient calculations are presented in Table 3:

Table 3: Correlation Coefficients between Scores of Items and Skills, as well as the Total Score for Each Skill and for the Questionnaire as a Whole for Visual Thinking Skills

| Skill of Reading Visual Forms | | | Skill of Analyzing Visual Forms | | | Skill of Perceiving and Interpreting Relationships | | | Skill of Inferring Meanings | | |
|-------------------------------|----------------------------|------------------------------|---------------------------------|----------------------------|------------------------------|--|----------------------------|------------------------------|-----------------------------|----------------------------|------------------------------|
| Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score |
| 1 | .698* | .596** | 5 | .735* | .577* | 9 | .806* | .711* | 13 | .588* | .301* |
| 2 | .486* | .453** | 6 | .646* | .573* | 10 | .716* | .675* | 14 | .744* | .525* |

| | | | | | | | | | | | |
|---|-------|--------|---|-------|-------|----|-------|-------|----|-------|-------|
| 3 | .860* | .540** | 7 | .735* | .499* | 11 | .570* | .384* | 15 | .722* | .526* |
| 4 | .748* | .375** | 8 | .815* | .725* | 12 | .402* | .370* | 16 | .735* | .598* |

**Statistically significant at the significance level (0.01)

It is noted from Table 3 that all correlation coefficients between the scores of the items for each skill, the total score for the respective skill, and the overall score for the questionnaire as a whole for the visual thinking scale in the mathematics curriculum for fifth grade are positive correlation coefficients that are statistically significant at 0.05 and 0.01 levels of significance. This confirms the consistency, homogeneity, and coherence of the items with each other.

3.4.1.2. Reliability of the Questionnaire

The reliability of the scores of the questionnaire axes was verified using Cronbach's alpha reliability coefficient, based on the results from applying the questionnaire to the exploratory sample. The results are presented in the following table:

Table 4: Cronbach's Alpha Reliability Coefficient for the Visual Thinking Scale in the Mathematics Curriculum Content for Fifth-Grade Students

| Skills | Cronbach's Alpha |
|--|------------------|
| Skill of reading visual forms | 0.764 |
| Skill of analyzing visual forms | 0.706 |
| Skill of perceiving and interpreting relationships | 0.702 |
| Skill of inferring meanings | 0.739 |
| The scale as a whole | 0.825 |

It is evident from Table 4 that all the correlation coefficients using Cronbach's alpha for the sub-dimensions are acceptable values for the final application of the visual thinking scale in the content of the fifth-grade mathematics curriculum, with the scale as a whole reaching 0.825 and the sub-skills ranging between 0.702 and 0.764.

3.4.2 Productive Motivation Scale

After reviewing the previous literature, the skills of productive motivation in the mathematics curriculum were identified, along with the specific indicators for each skill. The scale consists of a total of four (4) skills, with each skill having a set of specific indicators totalling 28 items. The following Table 5 shows the distribution of the skills and items.

Table 5: Distribution of Productive Motivation Scale Skills in the Mathematics Curriculum

| | Skills | Number of Indicators |
|---|---|----------------------|
| 1 | The student's tendency to see meaning in mathematics | 7 |
| 2 | Recognizing that mathematics is useful and worthy of interest | 7 |
| 3 | Believing that effort in learning mathematics pays off | 7 |
| 4 | Learner's self-perception as an effective learner and practitioner of mathematics | 7 |
| | The skills as a whole | 28 |

The degree of availability of each skill's items is determined by calculating the arithmetic means and standard deviations for each skill and its associated items.

3.4.2.1 Internal consistency validity (construct validity)

Internal consistency was verified using Pearson correlation coefficients to calculate the correlation between the score of each item in the different skills with the total score of the skill to which the item belongs and with the total score of the questionnaire as a whole. This was done to ensure the coherence and homogeneity of the items within each dimension. The results of the Pearson correlation coefficient calculations are presented in Table 6:

Table 6: Correlation Coefficients between Scores of Items and Skills, as well as the Total Score for Each Skill and for the Questionnaire as a Whole for Productive Motivation Skills

| The Student's Tendency to See Meaning in Mathematics | | | Recognizing that Mathematics is Useful and Worthy of Interest | | | Believing that Effort in Learning Mathematics Pays Off | | | The Learner's Self-Perception as an Effective Learner and Practitioner of Mathematics | | |
|--|----------------------------|------------------------------|---|----------------------------|------------------------------|--|----------------------------|------------------------------|---|----------------------------|------------------------------|
| Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score | Item Number | Correlation with Dimension | Correlation with Total Score |
| 1 | .542* | .584* | 8 | .563* | .502* | 15 | .577* | .595* | 22 | .430* | .363* |
| 2 | .749* | .582* | 9 | .582* | .450* | 16 | .560* | .540* | 23 | .474* | .395* |
| 3 | .743* | .520* | 10 | .723* | .506* | 17 | .452* | .508* | 24 | .533* | .456* |
| 4 | .703* | .538* | 11 | .765* | .577* | 18 | .688* | .450* | 25 | .624* | .602* |
| 5 | .788* | .629* | 12 | .780* | .596* | 19 | .539* | .415* | 26 | .725* | .641* |
| 6 | .486* | .425* | 13 | .762* | .574* | 20 | .575* | .352* | 27 | .692* | .593* |
| 7 | .446* | .484* | 14 | .667* | .622* | 21 | .524* | .316* | 28 | .653* | .599* |

**Statistically significant at the significance level (0.01)

It is noted from Table 6 that all correlation coefficients between the item scores for each skill and the overall score for that skill, as well as the overall score for the questionnaire as a whole for the scale of productive motivation in the fifth-grade mathematics curriculum, are positive correlation coefficients that are statistically significant at 0.05 and 0.01 levels of significance. This confirms the consistency, homogeneity, and coherence of the items with each other.

3.4.2.2 Reliability of the Questionnaire

The reliability of the questionnaire's dimensions was verified using Cronbach's alpha reliability coefficient, based on the results of administering the questionnaire to the exploratory sample. The results are presented in Table 7:

Table 7: Cronbach's Alpha Reliability Coefficient for the Productive Motivation Scale in the Fifth-Grade Mathematics Curriculum

| Skills | Cronbach's Alpha |
|---|------------------|
| The student's tendency to see meaning in mathematics | 0.766 |
| Recognizing that mathematics is useful and worthy of interest | 0.815 |
| Believing that effort in learning mathematics pays off | 0.707 |
| Learner's self-perception as an effective learner and practitioner of mathematics | 0.773 |
| The scale as a whole | 0.894 |

It is evident from Table 7 that all the correlation coefficients using Cronbach's alpha for the sub-scales are acceptable values for the final application of the produced motivation scale in the fifth-grade mathematics curriculum. The scale as a whole reached 0.89) and sub-skill values ranged between 0.707 and 0.815.

3.5 Study Variables

A. Main Variables

1. Visual thinking skills and
2. Productive motivation.

B. Secondary (mediating) variable

1. Gender – two categories: male, and female.

3.6 Statistical methods used in the study

Arithmetic means and standard deviations were utilized. Cronbach's alpha formula was employed to find the internal consistency coefficient, while Pearson correlation was used to determine the validity coefficient of the internal consistency of the study tool.

4. Results and Discussion

The study aimed to reveal the extent to which visual thinking skills are integrated into the mathematics curriculum content and its relationship with productive motivation among fifth-grade students in the Kingdom of Saudi Arabia. To achieve the study's objectives, it sought to answer the following questions, as indicated:

4.1 Question 1:

What is the degree of integration of visual thinking skills in the mathematics curriculum content for fifth-grade students in the Kingdom of Saudi Arabia? To answer the first question, arithmetic means and standard deviations were calculated. The degree of integration of visual thinking skills in the mathematics curriculum content for fifth-grade students in the Kingdom of Saudi Arabia was assessed, the results of which are depicted in Table 8.

Table 8: The Arithmetic Means, Standard Deviations, and Degree of Integration of Visual Thinking Skills in the Mathematics Curriculum Content for Fifth-Grade Students in the Kingdom of Saudi Arabia

| Number | Skill | Arithmetic Mean | Standard Deviation | Score | Rank |
|--------|--|-----------------|--------------------|--------|------|
| 1 | Skill of reading visual forms | 3.99 | 0.71 | High | 1 |
| 2 | Skill of analyzing visual forms | 3.36 | 0.66 | High | 3 |
| 3 | Skill of perceiving and interpreting relationships | 3.39 | 0.63 | Medium | 2 |
| 4 | Skill of inferring meanings | 3.31 | 0.64 | Medium | 4 |
| | Overall mean of visual thinking skills | 3.51 | 0.50 | High | |

The results in Table 8 indicate that the overall average of visual thinking skills among fifth-grade students in the Kingdom of Saudi Arabia reached 3.51 at a high degree. The table also shows that the arithmetic means for the integration of visual thinking skills in the mathematics curriculum ranged between 3.31 and 3.99 for the sub-skills. The skill of reading visual forms ranked highest with an arithmetic mean of 3.99 and a high degree, followed by the skill of perceiving and interpreting relationships in second place with an arithmetic mean of 3.39 and a high degree. The skill of analyzing visual forms was in third place with an arithmetic mean of (3.36) and a medium degree, while the skill of inferring meanings ranked last with the lowest arithmetic mean of (3.31 and a medium degree.

Visual thinking is one of the higher-order thinking styles that enable learners to achieve a comprehensive and interconnected understanding of academic subjects, which contributes to enhancing their abilities for independent learning and developing collaborative work skills. Visual thinking is regarded as a fundamental educational goal with effects that extend across various curricula, owing to its close connection with teaching methods, educational activities, and assessment tools.

It contributes to improving the quality of learning by supporting processes of reflection, analysis, and interpretation, and enhances learners' interaction and active participation within learning environments, thereby opening up wider horizons for understanding, expression, and communication. The results of this question align with the findings of both Al-Oudat's study (2023) and Kousa's study (2019), which aimed to identify the degree of availability of visual thinking skills in the sixth-grade mathematics curriculum in the Kingdom of Saudi Arabia.

4.2 Question 2:

What is the degree of productive motivation in the mathematics curriculum among fifth-grade students in the Kingdom of Saudi Arabia? To answer this question, the arithmetic means, and standard deviations were calculated, as well as the degree of productive motivation in the mathematics curriculum among fifth-grade students in the Kingdom of Saudi Arabia. Table 9 illustrates these results:

Table 9: Arithmetic Means, Standard Deviations, and Productive Motivation Scores in the Mathematics Curriculum for Fifth-Grade Students in the Kingdom of Saudi Arabia

| Number | Dimensions | Arithmetic Mean | Standard Deviation | Score | Rank |
|--------|---|-----------------|--------------------|--------|------|
| 1 | The student's tendency to see meaning in mathematics | 3.69 | 0.73 | High | 1 |
| 2 | Recognizing that mathematics is useful and worthy of interest | 3.32 | 0.57 | Medium | 3 |
| 3 | Believing that effort in learning mathematics pays off | 3.22 | 0.46 | Medium | 4 |
| 4 | Learner's self-perception as an effective learner and practitioner of mathematics | 3.66 | 0.59 | High | 2 |
| | Overall mean of productive motivation | 3.47 | 0.49 | High | |

The results in Table 9 indicate that the overall average of productive motivation in the mathematics curriculum for fifth-grade students in the Kingdom of Saudi Arabia reached 3.47, which is considered high. The table also shows that the arithmetic means of the productive motivation scores for the sub-dimensions ranged between 3.22 and 3.69. The dimension of the students' tendency to see meaning in mathematics ranked first with the highest arithmetic mean of 3.69 and a high degree.

This was followed by the learners' self-perception as an effective learner and practitioner of mathematics in second place with an arithmetic mean of 3.66 and a high degree. Next, recognizing that mathematics is useful and worthy of interest ranked third with an arithmetic mean of 3.32 and a medium degree. Lastly, believing that effort in learning mathematics pays off ranked last with the lowest arithmetic mean of 3.22 and a medium degree.

Productive mathematical motivation is a fundamental element in developing mathematical proficiency, as it contributes to enhancing students' independence and creativity in problem-solving. Its importance stems from its role in building self-confidence and belief in one's ability to understand and learn mathematics through perseverance and effort. Developing this motivation leads to a positive emotional interaction with mathematics, transcending mere knowledge to a belief in its value and usefulness in real life.

The mathematics teacher plays a pivotal role in fostering this motivation among students by providing a safe environment, presenting real-world problems, and connecting mathematics to students' lives and interests. This process requires the teachers to possess productive motivation themselves and to employ flexible teaching practices that promote professional growth and positive attitudes toward learning mathematics.

Productive motivation is reflected in the mathematics curriculum content by linking problems to the students' real-life context and environment, integrating

it with other subjects, and using familiar images and drawings. This motivation is also linked to the students' motivation to exert effort and enjoy learning mathematics, which helps them overcome negative feelings resulting from difficulties and contributes to activating other components of mathematical proficiency. The results of this question align with the findings of Al-Qurashi's study (2020), which aimed to identify the level of productive motivation towards mathematics among students in the first, second, and third grades of middle school in Taif. Additionally, it relates to the study conducted by Al-Afifi (2022), which aimed to investigate the impact of using enjoyable learning strategies in teaching mathematics on the development of productive motivation among first-grade middle female students in Makkah.

4.3 Question 3:

Is there a statistically significant correlation between the degree of integration of visual thinking skills in the mathematics curriculum content and the productive motivation of fifth-grade students in the Kingdom of Saudi Arabia? To answer this question, the Pearson correlation coefficient was extracted between the degree of integration of visual thinking skills in the mathematics curriculum content and the productive motivation of fifth-grade students in the Kingdom of Saudi Arabia. Table 10 presents these results:

Table 10: Pearson Correlation Coefficient between the Degree of Integration of Visual Thinking Skills in the Mathematics Curriculum Content and the Productive Motivation among Fifth-Grade Students in the Kingdom of Saudi Arabia

| Visual Thinking Skills / Productive Motivation | Skill of Reading Visual Forms | Skill of Analyzing Visual Forms | Skill of Perceiving and Interpreting Relationships | Skill of Inferring Meanings | Overall Mean of Visual Thinking Skills |
|---|-------------------------------|---------------------------------|--|-----------------------------|--|
| The student's tendency to see meaning in mathematics | .704** | .357** | .271** | .539** | .591** |
| Recognizing that mathematics is useful and worthy of interest | .503** | .589** | .568** | .614** | .676** |
| Believing that effort in learning mathematics pays off | .550** | .646** | .638** | .625** | .730** |
| Learner's self-perception as an effective learner and practitioner of mathematics | .475** | .490** | .626** | .672** | .668** |
| Overall mean of productive motivation | .736** | .677** | .680** | .800** | .871** |

**Statistically significant at the significance level (0.01)

The results presented in Table 10 indicate a statistically significant positive correlation between all visual thinking skills in the mathematics curriculum and the overall score of visual thinking skills, as well as between all dimensions of productive motivation and the overall score of productive motivation in the

mathematics curriculum among fifth-grade students in the Kingdom of Saudi Arabia. The correlation coefficient between the overall average of visual thinking skills and the overall average of productive motivation was 0.871, while the correlation coefficients between visual thinking skills and dimensions of productive motivation ranged from 0.271 to 0.672. All values were statistically significant at the significance level of 0.01. The positive correlation suggests that as visual thinking skills in the mathematics curriculum increase, there is a corresponding increase in productive motivation in the mathematics curriculum among fifth-grade students. Conversely, a decrease in visual thinking skills in the mathematics curriculum leads to a decrease in productive motivation in the mathematics curriculum among fifth-grade students, and vice versa.

Visual thinking contributes to clarifying concepts and developing cognitive skills by organizing information and generating relationships through imagination and observation. This enhances knowledge acquisition and improves the quality of learning while considering the diversity of learners' styles and stages. Meanwhile, productive motivation is reflected in the learners' view of mathematics as a logical and useful science connected to reality, as well as in their motivation, confidence in their abilities, and willingness to accept mistakes and learn from them.

Visual thinking is closely linked to productive motivation, as each supports mathematics learning and improves its quality through different yet complementary mechanisms. It develops cognitive skills such as observation, inference, and analyzing relationships between shapes and concepts. It also helps connect information through visual stimuli that facilitate understanding and imagination, thereby enhancing achievement and satisfaction with learning. Additionally, it provides opportunities for interaction with digital tools and educational programmes that support deep understanding. On the other hand, productive motivation helps make the learner more willing to exert effort and overcome difficulties by relating mathematics to the student's reality and integrating real-life problems, images, and drawings relevant to their environment, which generate motivation and enjoyment in learning.

Accordingly, visual thinking is considered a cognitive tool that facilitates the processing of concepts, while productive motivation represents the emotional aspect that supports persistence and perseverance. The integration of these two elements enhances the use of other components of mathematical proficiency, such as conceptual understanding, procedural fluency, and strategic competence, making learning deeper and more effective. The results of this question align with the findings of Al-Maliki's study (2019), which aimed to investigate the effectiveness of a proposed strategy based on Marzano's model of learning dimensions and metacognitive thinking skills in developing academic achievement and productive mathematical motivation.

5. Conclusion

The results of the study revealed that the content of fifth-grade mathematics textbooks lacks visual thinking skills. Textbooks which incorporate the teaching

of visual thinking skills would contribute to addressing low achievement among students and improving their understanding of mathematical concepts. The study further revealed that there is a deficiency among teachers in employing visual thinking skills, the result of which negatively impacts their ability to utilize these skills during mathematics instruction.

In addition, the study results indicated that the design of educational activities plays a role in developing the four visual thinking skills: reading shapes, analyzing them, interpreting relationships, and inferring meanings. However, it appears from the study that the practice of teaching mathematics is currently primarily through rote learning, without adopting modern teaching methods. The need to focus on understanding mathematical concepts and fostering active engagement is thus highlighted.

6. Recommendations

Based on the study results, the following recommendations are offered: Firstly, it is necessary to develop the content of fifth-grade mathematics textbooks to enhance the integration of visual thinking skills, contributing to addressing deficiencies and improving students' understanding of mathematical concepts.

Secondly, educational activities should be redesigned to integrate diverse activities that develop the four visual thinking skills: reading shapes, analyzing them, interpreting relationships, and inferring meanings.

Thirdly, training programmes need to be organised for teachers to enhance their knowledge of visual thinking skills and their importance, as well as developing their ability to employ these skills in teaching mathematics.

Fourthly, teaching methods should be adopted that focus on understanding mathematical concepts and fostering active interaction, which enhances learner motivation and self-confidence, and cultivates their motivation to learn mathematics. Finally, realistic mathematical enrichment activities need to be designed, both individual and group-based, that are related to the learners' lives, contributing to enhancing their motivation and developing their productive motivation to learn mathematics.

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