

## Learning styles according to Entwistle model and their relationship to mathematical excellence among scientific fifth-grade female students

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**Abstract:** The objective of the present study is to determine the nature and direction of the correlation between mathematical excellence and learning styles as defined by the Entwistle, model in fifth-grade scientific female students. The descriptive correlational approach was implemented by the two researchers to accomplish the research objectives. A scale was developed to assess the learning styles of female students in the sample in accordance with the Entwistle, model. : (Knowledge, understanding, application, analysis, synthesis, evaluation, systematic thinking, creativity), and the research community was determined by the female students of the scientific fifth grade in the morning preparatory and secondary schools of the General Directorate of Education of Baghdad/Al-Karkh I, which were chosen randomly and consisted of (204) students, the data were statistically analyzed using the (23-SPSS) program, and the t-test was employed to calculate the arithmetic mean, the hypothesized average of the scale, the standard deviation, the Cronbach alpha equation, and the Pearson correlation coefficient of the students in order to confirm the validity and reliability of the two tools. The researchers obtained a variety of results, such as the statistically significant correlation between mathematical excellence among fifth-grade scientific female students and each learning style according to the Entwistle, model. This suggests that the female students in the study have well-developed mathematical excellence. The researchers propose that comparable investigations be implemented at different educational levels.

**Keywords:** *Entwistle, Learning styles, Mathematical excellence, Model.*

### 1. The Research Problem

Learning is an extremely complex and difficult process, as it represents the environment in which learners are able to listen attentively, reflect deeply, read, speak, and write by using many methods and activities such as problem solving, simulation, small groups, and other activities that require learners to apply what they have learned in external and internal life (: Myers & Jones (p.10: Quoted from Jameel, 2021, p. 4) Every person possesses a unique learning style, which involves the adaptation and processing of information and knowledge. This process enhances their comprehension and awareness, enabling them to effectively tackle educational circumstances and problems and find solutions to them . One of the models that classify learners according to the learning styles they possess is the Entwistle model, as it sees the possibility of classifying the factors that effect learning styles and processes into two categories, The first concerns the teacher personal characteristics and their impact on adopting a specific learning style, and the second concerns the learner and includes previous knowledge, mental ability, and motivation. Whether external or internal, and the learner's educational interests and anxiety, these factors combine to determine the learning style and thus determine the learning outcomes and their levels (Entwistle, N., 1981, p. 40), The learning process is effected by several factors, including the different learning styles adopted by students. Recently, interest in studying learning styles and their impact on students' academic performance has increased. Modern education has witnessed an increasing

focus on how to develop learning styles that suit the needs of individual students and help them achieve academic excellence, especially in areas that require high intellectual abilities such as mathematics, which is considered one of the educational subjects that requires critical and analytical thinking, This model highlights how students interact with educational materials differently based on their learning style, which makes understanding learning styles and their relationship to mathematical excellence crucial (Entwistle, 1981, pp. 45-67).

Schools face challenges in achieving mathematical excellence, especially among students in advanced grades, including identifying effective learning styles that enhance mathematical understanding and analytical abilities. The lack of compatibility between the teaching methods used and the different learning styles leads to a low level of mathematical excellence among learners (Biggs, 1983, 123-145).

Given the fast-paced and ever-changing nature of our modern era, which is marked by rapid technological advancements, scientific discoveries, and industrial growth, as well as the information revolution and the vast expansion of knowledge, it is crucial for workers to have the necessary skills to effectively navigate this environment. This includes being proficient in using modern technologies, possessing problem-solving abilities, and demonstrating creativity. Therefore, schools should prioritize teaching students the essential mathematical skills that are required for work Life and future jobs to align the goals and outcomes of education with the needs of the labor market.

From the above, it is an obligation for people to develop and improve educational curricula and teaching methods, and to investigate educational approaches that achieve long-term educational goals, especially in mathematics, which is the basis and essence of science and a fertile field for developing students' interests and inclinations, and providing opportunities for mental growth in their understanding, skills, and abilities that they need in real-life situations. Upon reviewing Entwistle, research and studies on learning styles and assessments applied to university students and learners in training courses, the researcher discovered a scarcity, if not absence, of studies and research on these topics in the field of mathematics at the local and Arab levels.

Based on their expertise in the field of education, the two researchers observed that mathematics teachers often neglect the important principle of considering individual differences among students, despite it being a fundamental objective of both general and special education goals and curricula, Also, this disparity in the achievement level of students, in addition to the anxiety they experience in exam situations, is a reason for their low achievement rates, in addition to the fact that it does not reflect their true abilities, and its reason can be attributed to the special learning style of each of them. Based on the above, the research problem is summarized in answering the next question:

(Is there a correlation between each learning style according to the Entwistle, model and the mathematical excellence of the scientific fifth-grade female students?)

## 2. The Significance of the Research

Mathematics is a cognitive system that has a well-defined structural structure. It helps students develop their ideas, build their personality, and enhance their abilities to create and innovate. Additionally, it provides opportunities for students to gain practical experience in the field of mathematics (Abu Zeina, 1994, p. 14), The importance of mathematics is highlighted in that it is considered one of the basic pillars in the scientific construction of learners, and as a support for other sciences to achieve their goals. The levels of scientific construction among learners and their stages of development are important indicators of the success and implementation of educational programs, this structure develops gradually and takes a long time for learners to master. It represents the development of their scientific potential and the pursuit of mental and cognitive growth, as secondary school students are able to absorb quantitative and qualitative scientific knowledge, as well as recognize and understand knowledge components such as concepts, facts, and laws as mentioned in study (Jawad,2022) . Scientific theories, the development and scientific acceleration in scientific discoveries in our modern, advanced era forced the educational system to respond to these changes, through learners acquiring

learning skills on their own to deal with the various sources of scientific knowledge. He also stressed that the acceleration in scientific discoveries stimulated scientific systems all over the world to compete to take the lead in achievements in various scientific fields, it is not surprising that attention is directed to education and that it is considered primarily responsible for the numbers of individuals to face future challenges.

also it was pointed out that the development of the individual and his ability to learn on his own is a vital requirement in education in our contemporary time (Al-Sharrah, 2002, p. 12), and that all components of the educational system, which include school decisions and regulations, are responsible for preparing learners in a way that enables them to keep pace with the rapid change in developments, which contributes to developing students cognitively and providing them with the capabilities that enable them to comprehend modern data. (Al-Sharrah, 2009, p. 64), Knowing the learning styles of the teacher and the learners is one of the basic things for effective learning to occur, as it provides equal opportunities for all learners to demonstrate and use all their learning abilities. Teachers' knowledge of their students' learning styles helps in preparing more effective and meaningful educational experiences, As for learners, knowing their learning styles helps them identify their strengths and weaknesses, work efficiently when they are directed, and develop effective cooperative relationships between them during field work, It also effects the type and amount of their learning, as well as their acquisition of the thinking skills and mental abilities that they develop. Learners' awareness and confidence in their learning patterns and reaching them is considered the first step in achieving a better learning environment. (Robertson, et al, 2011, pp11-100)

Learning styles increase learners' ability to absorb, criticize, and generate new ideas and help them play their positive role in participating in the learning process (Al-Salami, 2012, p. 17), the possession of self-skills by learners and their ongoing practice enable them to engage in self-learning at any time and throughout their lives, both within and outside of educational institutions. This concept is known as continuous education (Al-Harbi, 2018, p. 80), One of the learning models that explained the learning styles of learners is the Entwistle model, as it was built on the basis of the relationship of learning styles to its results, and was designed to have trends linked to a number of motives that lead to learning styles that learners use in various learning situations and lead to several levels, including understanding. These trends are:

1- An orientation towards personal meaning: which is for the learner to have his own meaning for what he is learning.

2- An orientation towards reproducing knowledge: which is the learner reproducing the learning content in his personal style.

3- Achievement orientation: It appears in the grades the learner obtains as a result of developing his skills.

(Atiyeh, 2016, pp. 79-98)

According to the Entwistle model, it shows three styles of learning according to the learners' preference, which are:

First - A deep learning style: learners are characterized by their intense desire to search for meaning, and not to deliver information directly, but rather by thinking and scrutinizing this information before accepting it, and their attempt to link new learning with previous experiences they possess and their ability to link and integrate ideas to reach evidence and prove new information.

Second - a superficial learning style: This is characterized by learners who have a negative attitude towards studying and whose goal of learning is to achieve success, as they memorize information related to their performance in exams, and rely on clear instructions and logic for learning, which leads them to the process of memorizing educational content with the concepts it contains. Facts and information, and remember them well.

Third - a strategic learning style: in which excellence is the primary goal of learning, as they manage their time and organize their studies to complete their educational tasks efficiently and exert

their utmost effort in order to obtain the highest grades and excellence (Ali and Al-Mashhadani, 2014, p. 100).

From the above, it can be noted the importance of the Entwistle, model for learning styles, which prompted the researcher to adopt it as a subject for studying learning styles according to the research sample, as it is an extremely important sample, which is the fifth scientific grade, as the learners realize in it the components of their personality and their self-confidence, Piaget describes it as the stage of abstract operations, which begins from the age of eleven years onward, during which learners are able to practice abstract thinking, use logical thinking, analyze hypotheses, and reach conclusions, inferences, and generalizations (Melhem, 2006, p. 250), It is suitable for studying their learning styles according to the Entwistle, model, and the learners' excellence in these processes is considered indicators of their mathematical excellence, as excellence is a mental process that goes through several stages that require a set of mental abilities, the distinguished learner is the one whose performance is distinct from that of his peers in one or more of the mental abilities, creativity, high achievement, the use of distinguished skills, commitment and perseverance, high motivation, flexibility and independence in thinking, etc , Subsequently, the significance of the investigation is as follows:

- 1- The novelty of the current study, as there are no Iraqi or Arab studies, especially in the Iraqi environment, that dealt with its variables. It is the first study that links learning styles according to the Entwistle, model and mathematical excellence among scientific fifth-grade female students.
- 2- Enriching educational literature in the field of student learning patterns according to the Entwistle, model.
- 3- The results of the current study may help educational specialists in preparing training programs to enlighten teachers on the importance of taking into account students' patterns in their methods of presenting and explaining mathematics.
- 4- Helping mathematics teachers identify the learning patterns of scientific fifth-grade students paying attention and taking into account individual differences among students in the education process.
- 5- Providing a measure of learning styles according to the Entwistle, model for scientific fifth-grade students in mathematics.
- 6- Providing a test for mathematical excellence in mathematics for scientific fifth-grade students.

### 3. Research Objectives

Objective of the current research:

- 1- Know the learning styles according to the Entwistle model that female students in the scientific fifth-grade prefer.
- 2- Measuring mathematical excellence among scientific fifth-grade students.
- 3- Know the nature and direction of the correlation between each type of learning according to the Entwistle model and the mathematical excellence of scientific fifth-grade female students.

### 4. Research Hypotheses

1- There is no statistically significant difference at the significance level (0.05) between the arithmetic mean of the grades of scientific fifth-grade female students (from the research sample) in the deep learning style in the learning styles scale according to the Entwistle model that was prepared for this purpose and the hypothesized average of the style.

2- There is no statistically significant difference at the significance level (0.05) between the arithmetic mean of the grades of scientific fifth-grade female students (from the research sample) in the superficial learning style in the learning styles scale according to the Entwistle model that was prepared for this purpose and the hypothesized average of the style.

3- There is no statistically significant difference at the significance level (0.05) between the arithmetic mean of the grades of scientific fifth-grade female students (from the research sample) in the

strategic learning style in the learning styles scale according to the Entwistle model that was prepared for this purpose and the hypothesized average of the style.

4- There is no statistically significant difference at the significance level (0.05) between the arithmetic mean of the grades of scientific fifth-grade female students (from the research sample) in the Mathematical Excellence Test and the hypothetical mean of the test.

5- There is no statistically significant correlation at the significance level (0.05) between the deep style according to the Entwistle model and mathematical excellence among scientific fifth-grade female students (from the research sample).

6- There is no statistically significant relationship at the significance level (0.05) between the superficial pattern according to the Entwistle model and the mathematical excellence of scientific fifth-grade female students (from the research sample).

7- There is no statistically significant relationship at the significance level (0.05) between the strategic style according to the Entwistle model and mathematical excellence among scientific fifth-grade female students (from the research sample).

## 5. Limits of Research

### 5.1. The Limits of the Research as Shown Below

1- Female students of the scientific fifth grade in the morning preparatory and secondary government schools in the Baghdad/Al-Karkh First Education Directorate for the academic year 2023-2024.

2- Learning styles according to the Entwistle model (deep style, superficial style, and strategic style).

3- Developed thinking skills for mathematical excellence according to Document (4) of the Scottish Government's Teaching and Learning Curriculum for mathematical Excellence (Education Scotland, 2009) & (SG, 2014, p.4) (knowledge, understanding, application, analysis, synthesis, evaluation, systematic thinking, creativity).

## 6. Defining Research Terms

### 6.1. Learning Styles According to the Entwistle Model

- (Entwistle, 2012): These are different ways in which the learning environment effects the quality of students' learning. (From Entwistle, 2012, pp7-108)

The two researchers define learning styles according to the Entwistle, model as:

It is the ways in which scientific fifth-grade female students (from the research sample) deal with their educational tasks, and in which they demonstrate their distinguished abilities and skills in mathematics, represented by the grades they obtain on the learning styles scale according to the Entwistle, model.

### 6.2. Mathematical Excellence

Defined by the Scottish Government (Scottish Government, 2014, p. 10): It is the ability of students to acquire mathematical knowledge and skills appropriate to the requirements of the twenty-first century, and to have confidence in using them in real life situations and other areas in which mathematical applications appear, and to be able to provide answers. They offer many new alternatives to solve issues and problems and provide appropriate evidence and arguments for the solution. They are curious to investigate and search for new information.

The two researchers define mathematical excellence operationally as:

The scientific fifth-grade female students (from the research sample) possess higher-order thinking skills represented by (knowledge, understanding, application, analysis, correlation, evaluation, systematic thinking, creativity), which can be used in real life situations and other fields in which mathematical applications appear, It is measured by the score obtained by female students in the mathematical excellence test prepared for this purpose.

## 7. Theoretical Background

### 7.1. The Concept of Learning Styles

It is important to mention that the concept of learning styles originated from Carl Jung (Jung, 1927), who observed significant variations in how learners process information and make decisions. He is credited with being the progenitor of the theory of learning styles, what aroused the interest of educators in the way students deal with educational situations in the classroom is recognizing the importance of the results of the research of specialists in the fields of psychology, individual differences, and learning styles, who concluded that all learning styles meet two basic aspects:

A - Focus on processes: Learning styles encompass the methods via which students absorb and process knowledge, including how they input received information into their cognitive system and their perception and processing of this information.

B - Focus on personality: Learning style theorists believe that learning is a process resulting from the student's personal work and his unique thoughts and feelings. They also point out that learning styles are related to students, and they are considered an important aspect of the educational process. Teachers must have adequate knowledge of their students' cognitive, emotional, and social traits, which Together, they constitute the learning styles they prefer (Al-Alwan, 2010, pp. 3-4), Cognitive psychologists, including Gregorc, 1979, have come up with a system of thought about how and why the human mind performs its functions and its self-reflection, which is represented by the actions and behavior that a person performs. He also refers to studies and research that were concerned with learning styles, as they dealt with the human mind and the way it works, which includes understanding and processing the information Torrance (1982) also used thinking and learning styles as a synonym for information processing styles in children, and he believes that the individual tends to use one of the two hemispheres of the brain in the process of processing information, in addition to their interest in the functions of the brain as a whole (the right and left hemispheres) in the thinking process (Qatami et al., 2000). , pp. 503-509).

New concepts have emerged that distinguish between individual differences in the educational field, which have gained the attention of educational psychologists, and are represented by the concept of learning styles. This concept reflects the pluralism in forms of learning between learners and groups in general, and among the students themselves in particular. Just as students differ in their mental, physical, and emotional abilities, so do they. They differ in their preferred learning styles (Posner, 2004, pp 24-30) & Rees, 2002: pp 20-23).

The term "learning styles" refers to a variety of activities and behaviors that consistently occur over time. By increasing a learner's awareness of their own learning style, it can lead to improved performance and the development of their self-identity. This self-awareness becomes important when dealing with different life situations (Al-Atoum, 2012, p. 317). Numerous studies have indicated the possibility of benefiting from applied fields in studying learning styles, as they have shown the high ability of learning styles to predict the behavior of learners, and they can provide applied benefits in several fields, including training and education, where different styles impose different cognitive preferences for students and trainees, enabling the trainer or teacher to be able To give the material and manage the sessions in a way that suits their learning styles.

The study conducted by (Murray & Perrz, 2015, p. 111-125: quoted from Jameel, 2021, p. 4) also showed that each learner has a special and different style from others in receiving, processing, and retaining information, and the learning process improves when the learners' tasks assigned to them fit their styles. Individual educational, which leads to obtaining positive learning results based on the interaction of the learner's personal characteristics and the variables of his educational environment.

Training based on preferred learning styles is one of the modern methods used in the concept of modern training and aims to provide a distinct educational environment that matches the needs of each student in light of the different learning styles of learners. The training environment and its content are prepared in ways that are compatible with their differences in ways of receiving and processing

information, aiming to Taking into account individual differences in their learning styles (Al-Mallah, 2017, p. 26).

### 7.2. Entwistle Model

According to Entwistle, learning styles are described as adaptive processes suitable for individuals that make them responsive to various stimuli in the learning environment in a way that suits their emotional, physical, and social characteristics (Entwistle, 1981, p3).

Entwistle has worked as a professor of education and director of the Learning and Teaching Research Center at the University of Edinburgh since 1968. His interest has been in student learning in higher education and he has directed major studies that have contributed significantly to understanding how teaching and assessment effect the quality of learning. His areas of interest are student learning and educational psychology, He presented his model to explain student learning. It is a model based on linking learning styles and the level of its outcomes, which are represented by the students' levels of understanding of information. It contains three trends linked to different motivations that result in specific learning styles that the learner uses in various learning situations during the learning process and lead to different levels of understanding, which are: An orientation towards personal meaning, an orientation towards reproduction, an orientation towards achievement, based on previous trends, Entwistle believes that there are three learning styles: (deep, superficial, and strategic) (Entwistle, et al, 1997). Entwistle (Noel Entwistle, 1981, p. 285) classified learning styles as learners' orientations in dealing with and processing information. These orientations are determined according to motives and goals that lead the learner to adopt different strategies and study methods. They are the individual's preferred methods for perceiving and processing information during the learning process, and they explain How learners perceive, interact and respond to the learning environment.

### 7.3. Trends According to the Entwistle Model

1- Personal meaning orientation: This phenomenon occurs when the learner's motivation is intrinsic and leads them to adopt a profound learning approach. In this approach, the learner constructs a comprehensive understanding of the material they are studying, retains new information, and connects it with their existing knowledge or experiences. Additionally, they concentrate their attention on the components that constitute the evidence and establish connections between this evidence and the conclusion. This results in a profound level of comprehension.

2- Reproduction orientation: It arises when the individual's motivation is external and the fear of failure prevails, so the dominant pattern will be adopted , which is the process learning pattern, where the individual focuses his attention on the pieces of evidence and the steps of the proof, in addition to inability to link the evidence and the conclusion, which leads to incomplete understanding, which results from the lack of insight. When the motivation is anxiety, the learner adopts a superficial learning style, where the student remembers the information and it interferes with the learning process, which subsequently leads to a level of superficial understanding.

3- Achievement orientation: Motivation here is represented by hope and the desire for success and excellence, and the prevailing pattern is (the strategic pattern), which leads the learner to obtain high grades (Ibrahim, 2011, p. 165).

Based on these trends, Entwistle believes that there are three types of learning, which are as follows:

### 7.4. Deep Learning Pattern

People with this style make an effort to understand and apply what they have learned in real life situations while thinking about how to apply it (Entwistle & Ramsden, 1983, p. 154). It is the style that searches for personal meaning, self-development, producing ideas, and comparing what students learn with their previous experiences to enrich their understanding, where the Deep learners are excited about new ideas, They are always curious and constantly reproduce, and through the assessments

conducted by Entwistle, of the general impression of aspects of the deep style, he found that they depend on searching for personal meaning, using previous experience, linking facts to conclusions, and using similarity, resemblance, evidence and proofs, as students in this style use similarities. In composing and describing the topics presented to them, focusing on presenting ideas briefly, with their interest in the interconnections and internal relationships of the topic under study, as well as finding meaning and interacting with the connection actively (Abu Hashem, 2000, p. 243).

#### 7.5. *Superficial Learning Style*

Through the assessments conducted by Entwistle of the general impression of superficial students, he found aspects that indicate this pattern, including the search for facts, anxiety about the possible outcome of the situation, memorization efforts, reliance on clear and specific curricula, forming a general picture of the subject, their inability to identify the important parts of it, and difficulty. In linking ideas, students with this style begin with learning attitudes and their intention to complete the requirements of the task, they are characterized by focusing on the separate components and ignoring the integrated picture of the subject. They face difficulty in understanding the materials studied and distinguishing between the principles. They memorize information in order to value their efforts. They prefer lectures because they provide them with a simplified set of ready-made information to learn. Entwistle (1991, p. 202).

#### 7.6. *Strategic Learning Style*

This pattern appears in the ability of learners to follow the methodology and organize their time and efforts and the places they use to study. Their goals are clear and related to the academic subjects. They work hard to provide appropriate conditions for successful study. Their motivation includes hope and desire for success and excellence. Their self-confidence is high. The strategists focus on achievement and management. They have good time, work efficiency, and self-organization (Entwistle, 1981, p. 112), and their intention is to obtain the highest possible grades. They are also characterized by high effort and use of previous tests to predict current test questions (Entwistle, 1991, p. 202).

The two researchers believe that the difference in students' learning styles requires developing their ability to gain experiences, extract facts for themselves, and develop their personalities with all their characteristics and aspects, which will help them succeed in the future and prepare them to face different life situations in light of the scientific and technological developments of the modern era. It is also possible for the learner to possess more than one style, such as the learner possessing the deep style and the strategic style, which leads the learner to be creative, distinguished, and innovative, which makes him an example to follow. He can also possess the superficial style and the strategic style, and this makes him successful in his field of work and holds leadership positions, and it is not possible that the learner possesses both deep and superficial patterns, as this is due to his psychological, emotional, and physical tendencies that have been created with him since childhood, as mentioned previously.

#### 7.8. *Mathematical Excellence*

Many developed countries have sought to implement curricula of excellence due to their active and effective learning and evaluation processes, which allow the student to choose an appropriate path through experiences that challenge his latent energy and are new that he has not experienced before, and are based on modern and contemporary principles that have helped in achieving complete and comprehensive learning and growth for all students. And It is possible to be applied to all public educational levels (Scottish Executive, 2004).

Document No. (4) of the Scottish Government to build curricula for excellence (Scottish Gov., 2009) indicated the meaning of excellence, which is that students possess the basic skills for success in the process of learning, work and life, and that they have a sound and effective practical model through their focus on arithmetic, health and well physical structure, well-being and scientific awareness, the excellence curricula included many skills, which are called skills for learning, skills for life, and skills for



work, divided according to age stages and can be developed by all students, which are based on several overlapping skills, including educational and personal, so that students become active and effective in their lives, and major skills such as arithmetic Information technology, communication, problem solving, interaction with others, and professional skills that are unique to a specific sector or profession (Scottish Government, 2009, p. 17).

Mathematics has permeated all aspects of modern life and its importance continues to develop the world of work. Mathematical abilities have also become necessary for an individual's personal life and its improvement. Therefore, excellence in mathematics not only enhances the economic prosperity of each country. The important parts of mathematical abilities in mathematics are more than the extent of knowledge and fluency of numbers, It includes the use of learning, work, and life skills and their application in the real world. Examples of this include the most appropriate use of information and communications technology (ICT), appreciation of the importance of evidence, critical thinking, and openness to alternatives and new ideas ( Report of the Mathematics Excellence Group, 2011, p. 1-2)

### 7.9. *Elements of Excellence*

Mathematical excellence includes several elements, including:

- 1- Motivation, imagination, and participation in mathematics and its use in learning, life, and work.
- 2- Including effective experiences in teaching and learning mathematics.
- 3- A complete and clear understanding of mathematical knowledge, concepts, and skills and their uses in the real world, including basic arithmetic skills and the appropriate use of techniques.
- 4- Emphasizing effective evaluation as it represents the bridge between teaching and learning, through which the distinguished teacher makes sure of the experiences his students have achieved before moving on to teach them other new experiences.
- 5- Emphasizing effective evaluation as it represents the bridge between teaching and learning, through which the distinguished teacher ascertains the experiences his students have achieved before moving on to teach them other new experiences.
- 6- Nurturing and developing teachers with regard to appropriate basic mathematical and educational knowledge and skills through planning to ensure high quality permanent professional development.
- 7- The importance of external visions and providing support by companies, institutions, officials and teaching societies (Maths Excellence Group, 2011, p. 3).

### 7.10. *The Scottish Government's Excellence Curriculum*

The Scottish Government has defined the concept of excellence in mathematics as the ability of learners to acquire mathematical knowledge and skills that suit the requirements of the 21st century, and to have confidence in using them in realistic situations in which mathematical applications appear in other fields and they are able to provide many answers and new alternatives to solve problems, provide evidence and arguments that suit solutions, and are curious to search and investigate new information (Scottish Government, 2014, p. 10).

The Scottish Education Council has limited mathematical excellence to learners' ability to understand the numerical system and use knowledge, patterns and relationships in solving mathematical problems, understanding form and space in relation to visual and spatial perception, understanding measurement and its applications, and applying mathematical skills in the context of mathematical problems and other curricula and everyday contexts (Education Scotland, 2015, p. 59), the curriculum that was prepared for excellence takes into account that the learning process takes place at varying rates, and the curriculum outcomes and levels of students' experiences will reflect it and that they will be described from the viewpoints of the students themselves. These outcomes and experiences will reflect the extent to which the objectives of the curricula that seek to achieve maximum learning capabilities, these outcomes are concerned with achieving four basic capabilities in all curriculum as

indicated by the (Programmed Board The Curriculum Review, 2006, p. 12) and (Christie & Boyd, 2017, p. 2), which are:

- 1) Successful learners: This increases motivation and enthusiasm towards learning, and learners reach the level of achievement and openness to modern ideas and thinking methods.
- 2) Confident individuals: by increasing self-esteem, a sense of mental, physical and emotional comfort, acquiring correct and good values and beliefs, and high levels of optimism and ambition in the future.
- 3) Responsible citizens: by directing them to respect the ideas and opinions of others and their commitment to the responsibilities of participating in the political, social, economic and cultural matters of society.
- 4) Active contributors: They are distinguished by their love of adventure, challenge, and flexibility in thinking, and are self-reliant.

#### 7.11. *Standards of Mathematical Excellence*

In its report, the Scottish Government (The Scottish Government, 2009, p. 38) and Griffith University (Griffith University, 2019, p. 10) point out the standards of excellence in student performance during the learning process and the appropriate procedures in classroom teaching, which are:

- 1- The teacher improves teaching procedures through critical reflection processes and the use of evaluative approaches to improve the level of learners' performance.
- 2- Students use experiences and results to process information in order to interpret and enhance statistical information, while emphasizing it to make decisions.
- 3- The content is presented free of repetition and filler, linking the experiences that students learn and ensuring that it includes many and varied topics.
- 4- Make evaluation before, during, and after teaching an activity that supports the educational process.

#### 7.12. *Curriculum and Excellence*

Curricula for excellence had a role in developing the educational process with regard to its components, especially learners and parents. The values and objectives of the curricula that were prepared for excellence were taken into account when multiple changes and developments occurred that effected all components of the educational system for learners so that they would achieve the following:

- 1) High levels of achievement by focusing curricula prepared for excellence on learning goals and activities, which are followed by tests that are repeated during the study.
- 2) The student advances from one level of study to the next level better.
- 3) Identifying different patterns of achievement and accomplishment.
- 4) He is exposed to assessment methods that support active learning.
- 5) Having a wide range of attractive and enjoyable activities during the learning process.

(Reda Massad, 2017, pp. 283-284)

The two researchers adopted the excellence skills contained in Document (4) of the Scottish Government's teaching and learning curriculum (Scottish Government, 2009), where the excellence curriculum for the upper stage, which is the preparatory stage, was built around developing eight thinking skills, which are: (knowledge, understanding, application, analysis, interconnection, Evaluation, systematic thinking, creativity) as it is appropriate for the research sample in terms of age group and school stage.

From the above, the two researchers believe that the student's ability to use and develop his knowledge, understand the numerical system, discover patterns, relationships and connections, develop the dimensions and skills of mathematical thinking, and achieve students' positivity and activity during classroom lessons, which leads to stimulating the student's creative performance and thus makes him

mathematically distinguished, and enhances his confidence and awareness of the role he plays in daily life in The shadow of modern scientific and technological progress.

### 7.13. Previous Studies

First: Studies that dealt with learning styles according to the Entwistle, model

- -Study by Ali Muhammad Ahmed, (2020): The study was conducted in Egypt and was titled “The Effect of Learning Styles on Achievement in Mathematics among Secondary School Students,” on a sample that included (300) male and female students in which the researcher used questionnaires as a tool for testing achievement, and the results resulted in the existence of a relationship. A statistically significant correlation between learning style and educational achievement in mathematics.

Second: Studies that dealt with mathematical excellence:

- -Study by Saeed Hussein Hamdallah, (2021): This study was conducted in Iraq entitled “Mathematical excellence among mathematics teachers and its relationship to the achievement of their students. The study was applied to a sample of mathematics teachers (males and females) with a size of (126). The researcher applied a test for mathematical excellence, and the results of the study were that there was no statistically significant difference between the average of male and female teachers and a decrease in the level of actual performance.

## 8. Research Methodology

1- **Research methodology:** The two researchers adopted the descriptive, correlational research method, which is the most appropriate to achieve the research objectives because it suits the nature of the research.

2- The research community: It includes female students of the scientific fifth grade of preparatory and secondary morning schools in the General Directorate of Education of Baghdad / Al-Karkh Al-I, and its asset is (2126) students distributed among (55) schools.

3- **Research sample:** The size of the basic research sample was determined using the (Stephen Humpston) equation, where the sample size was (204) female students. Table 1 shows this:

**Table 1.**  
Distribution of sample members.

Preparatory/Al-Farooq	62
Preparatory/Al-Anfal	54
Secondary/ Al-Khadraa	32
Secondary/Al-Jameaa	56
	204

4- **Research tools:** The two researchers built two research tools:

First: Learning styles scale according to the Entwistle model: After reviewing the literature and previous studies, the two researchers intended to build a scale to measure learning styles according to the Entwistle model in the research sample. The goal of the scale was determined, which is to identify scientific fifth grade students' possession of learning styles according to the Entwistle model, based on the definition adopted by the two researchers contained in defining the terms in Chapter One, The concept of each learning style, along with its indicators, was presented to arbitrators specialized in the field of teaching methods of mathematics and psychological and educational sciences. The scale consisted of (40) items distributed among the three styles, with (12) positive items for the deep style. The score for this style ranged between (12-60). (The lowest score is (12) and the highest score is (60) with a hypothetical average of (36), The superficial style had (12) negative items, its score ranged between (12-60), with (12) representing the lowest score and (60) the highest score, and (16) positive

items for the strategic style, with scores ranging between (16-80) a score representing (16) the lowest score and (80) the highest score, with a hypothetical average of (48), and Table 2 shows this:

**Table 2.**  
Learning styles scale according to the Entwistle model.

	Style	Indicators	No. items	Total of items
1	Deep	Interest in searching for personal meaning	4	12
		Organizing and linking new ideas to previous experiences	4	
		Using evidence, logic, and confirmation	4	
2	Superficial	The ability to memorize and remember	4	12
		Forming a general picture of the topic and not being able to renew important parts	4	
		Difficulty connecting ideas	4	
3	Strategic	Make a great effort to learn and get high grades in the exam	4	16
		Organized study	4	
		Time management	4	
		Work efficiently	4	

The two researchers applied the scale on Sunday and Monday (April 7 and 8, 2024) on the first exploratory sample to determine the clarity of the scale's instructions and calculate the total time for answering it. It consisted of (24) female students and was applied to the second exploratory sample, which consisted of (77) and they were chosen randomly from the research community and not from its final sample. The correlation coefficient was calculated between the score of each item in the same type and the total score for that, which indicates the internal consistency of the scale, and the two researchers adopted The (Cronbach's alpha) equation to find the reliability of the scale for each style, and the reliability coefficient for the deep style was (0.79), the superficial style (0.79), and the strategic style (0.92), which indicates the validity of the scale, as the result matched what was reported in the study of (Hassan, 2011, p. 447). The scale was finally applied to the final sample of (204) female students, and the scale was applied to the final sample during the period 5/2/2024 - 5/6/2024, taking into account the surrounding circumstances of vacation, student exemption, etc. during application.

Second: Mathematical Excellence Test: The two researchers adopted the excellence skills developed in Document (4) of the Scottish Government's Teaching and Learning Curriculum for mathematical Excellence (Education Scotland, 2014) & (SG, 2009, p4), which are: (knowledge, understanding, application, analysis, synthesis, evaluation, systematic thinking, creativity, The test consisted of (27) objective items and (25) essay items, so the total number of test items became (52) items, as in Table 3.

**Table 3.**  
Mathematical excellence test.

Skills	Indicators	Number of test items	The sum of the items for each skill
Knowledge	Discover new information through What is available	2	8
	Verify the validity of the results you reach	2	
	Communication (Reading, writing, speaking)	2	
Understanding	Explaining, developing and	2	10

	demonstrating knowledge		
	Discuss the answers or solutions provided	2	
	Give examples	2	
	Comparison	2	
	Summing up	2	
Application	Apply knowledge in different situations	2	6
	Identify similarities	2	
	Distinguish the differences	2	
Analysis	induction	2	4
	Inference	2	
Synthesis	Connect ideas and create a new concept	2	6
	Interconnections	2	
	Integration	2	
Evaluation	Critical evaluation with evidence	2	8
	Justification	2	
	Reflect and plan next steps	2	
	Predicting assumptions, meaning that the student determines the assumptions that are suitable as a solution to the mathematical problem	2	
Systematic thinking,	System analysis	2	8
	Predicting consequences	2	
	Synthesis and reflection	2	
	Visualization and integration	2	
Creativity	Brainstorming	2	4
	Create something new	2	
Total	8 skills	26 indicators	item 52

Instructions for the ideal response to the excellence test were prepared and presented to arbitrators specialized in the field of mathematics teaching methods. The grades given to the items were of two types: the first was graded (0-1), which is objective, and the second was graded (3), which is essay. The total grade for the tests ranged between (0 - 102) degrees, and the hypothetical average for the test was (52) degrees. The two researchers applied the test on April 7 and 8, 2024, to the first exploratory sample, which consisted of (24) students, and it was applied to the second exploratory sample, which consisted of (77). The two researchers applied the test on Wednesday to Sunday the 10<sup>th</sup> till the 14<sup>th</sup> of April 2024, on a second exploratory sample consisting of (77) female students who were randomly selected from the research community and not from the final sample. The formula for finding (the coefficient of ease and difficulty) for the substantive paragraphs and the special formula for the essay paragraphs was followed. The difficulty coefficients for the paragraphs ranged between (0.2317-0.447) and their ease coefficients ranged between (0.55-0.76). The equation related to the excellence coefficient for the substantive and essay paragraphs was relied upon, and the results ranged between (0.23 - 0.46), after the equation for the effectiveness of incorrect alternatives for the two groups (higher and lower) was used, and the effectiveness of each paragraph was extracted. All ratios were negative, and this indicates that the alternatives are effective. The reliability coefficient of the mathematical excellence test was calculated using the Cronbach's alpha equation, as it is suitable for both objective and essay paragraphs. The reliability coefficient reached (0.96), and this result is considered good and acceptable as mentioned in study (Hassan& Fairs,2019,p.94).

## 9. Results and Analysis

### 9.1. Results

- 1- The results showed that the female students possess both deep and superficial learning styles according to the Entwistle model.
- 2- The results showed that female students do not have a strategic style for learning according to the Entwistle model.
- 3- Female students possess developed thinking skills for mathematical excellence.
- 4- There is a strong and positive correlation between the deep and superficial learning styles according to the Entwistle model and mathematical excellence among fifth-grade female students (from the research sample).
- 5- There is a strong, positive correlation between the strategic style of learning according to the Entwistle model.

### 9.2. Results Analysis

1- The results showed that the students possessed both deep and superficial learning styles according to the Entwistle, model, and the reason for this may be due to the following:

A- Motivations may differ among female students, as some may be motivated to learn in order to achieve academic success, while others may be motivated by their passion for a specific subject.

B- Personal preferences, as individual interests differ among students, which effects the way they prefer to learn and absorb information.

C- Interaction with female teachers: The way female teachers interact with female students can effect their learning styles, as support and positive guidance enhance their specific learning styles.

D- Teaching and assessment methods can encourage different learning styles. For example, traditional assessments may encourage memorization-based learning, while projects and research may encourage deep learning.

E- Previous successes and failures in previous educational experiences effect students' choice of learning styles that they feel were effective for them. (Entwistle & Ramsden, 1983, pp. 45-60)

F- Social support, as support from friends, family, and colleagues can encourage female students to adopt specific learning styles. (Entwistle & Peterson, 2004, pp30-40)

According to the researchers, this diversity of factors allows different students to rely on different learning styles that suit their personalities, environments, and previous experiences.

2- The results indicate that most female students do not have a strategic learning style, and this can be attributed to several factors according to the Entwistle model. Some of these factors include:

A- Lack of awareness and self-preparedness: Female students may lack awareness of the importance of effective learning strategies, or they may not have sufficient motivation to adopt such strategies.

B- Unsupportive learning environment: If the learning environment is not stimulating or does not provide the necessary support, students may find it difficult to develop and use effective learning strategies. An unsupportive learning environment can include a lack of positive interaction with teachers, or a lack of appropriate educational resources.

C- Academic pressure: Excessive academic pressure may lead students to rely on superficial learning methods instead of deep or strategic learning strategies. High-frequency assessments and intense study demands can lead students to favor memorization over a deep understanding of the material.

D- Difference in teaching methods: Incompatibility of teaching methods with students' needs can prevent them from adopting strategic learning strategies. Traditional teaching that focuses on repetition learning and memorization may discourage critical thinking and independence in learning (Entwistle, 1981, p. 110).

According to the researchers' opinion, it is preferable for female students to adopt the deep style of learning, because it leads to a deeper understanding of the academic subject and the ability to apply, analyze, and criticize. The superficial style may lead to memorizing information without truly understanding it.

**3-**Female students' possession of mathematical excellence can be explained by several educational, social and psychological factors, including:

A- Academic support: Girls may receive academic support and encouragement from parents and teachers, which enhances their self-confidence and academic abilities.

B- Positive role models: The presence of positive role models of successful women in the fields of mathematics and science can inspire girls and push them to achieve outstanding performance.

C- Educational environment: Schools and educational programs that focus on achieving gender balance and providing equal opportunities that may contribute to enhancing girls' performance in mathematics.

D- Psychological factors: Girls may have organizational skills, concentration, and logical thinking abilities that help them excel in mathematics.

E- Studies and research: Some studies indicate that girls may be more inclined to use deeper learning strategies such as understanding and analysis rather than memorization and repetition.

These and other factors may contribute in an integrated way to achieving mathematical excellence among female students.

**4-** The deep style of learning has a strong positive relationship with mathematical excellence, and the reason for this may be due to the following:

A- Some female students who follow a deep style of learning and understanding show higher levels of performance and achievement in mathematics.

B- This style enhances higher thinking skills such as analysis, synthesis, and using knowledge in creative ways.

C- The strategic style of learning was moderately positively related to mathematical excellence:

D- Some female students who follow a strategic style of self-regulation for learning show higher levels of performance in mathematics.

E- This style enhances perseverance, motivation, and effective planning to solve complex mathematical problems.

**5-**The superficial style of learning was positively associated with mathematical excellence. This may be due to the fact that some female students who follow a superficial style of learning focus on memorization and repetition without a deep understanding of mathematical concepts, which limits their analytical and creative abilities in this field.

**6 -** The strategic style of learning has also been positively associated with mathematical excellence, and the reason for this may be due to the following:

A- Some female students who follow a strategic style of self-regulation for learning show higher levels of performance in mathematics.

B- This style enhances perseverance, motivation, and effective planning to solve complex mathematical problems.

**7-** The existence of a strong correlation between the strategic learning style and mathematical excellence among female students can be explained in several ways, even if they do not have the strategic learning style as a permanent characteristic. Here are some possible causes:

A- The influence of the educational environment: The educational environment or teachers may encourage effective learning strategies, which leads to outstanding mathematics performance among female students. Possibly Teaching methods are presented to encourage the use of learning strategies such as good organization, planning and self-evaluation.

B- External motivation: Female students may be motivated to perform well in mathematics due to external pressures or motivations such as parental expectations, academic awards, or the need to achieve good results in order to enroll in certain university majors.

C- Continuous evaluation and feedback: They may receive continuous evaluations and feedback that help them improve their mathematical performance even though they do not have a consistent strategic learning style.

D- Deep understanding of the subject: Even without using structured learning strategies, female students may have a deep understanding of mathematical concepts, which helps them excel in this field.

These factors can interact together, which contributes to the formation of a strong correlation between the strategic learning style and mathematics excellence among female students.

## 10. Conclusions

In light of the results achieved by the research, the following can be concluded:

- 1- The high abilities of mathematical excellence among the female students in the research sample.
- 2- There is a strong and positive contribution of learning styles according to the Entwistle, model (deep, superficial, and strategic) to mathematical excellence.

## 11. Recommendations

1- Directing the Ministry of Education towards paying attention to learning styles and urging the development of the deep learning style in particular and its adoption by students in their learning process, as stated in the two researches (Majeed, & Hassan, 2023).

2- Preparing training and educational programs by the Preparation and Training Center of the General Directorate of Education in Baghdad / Al-Karkh Al-Awwal for teachers to pay attention to the preferred learning styles of students and take into account the individual differences between them.

3- Assigning students to submit research projects to enable them to explore topics independently and in detail.

4- The daily, monthly and final tests should include a realistic cumulative question from the areas of life that is related to the academic subject and that its score should be in addition to the total test score to indicate the student's excellence in answering it, especially in mathematics.

## 12. Proposals

1- Teachers use problems that require deep analysis and an integrated strategy for solution, and present challenges that require students to apply mathematics to understand its systems.

2- Conduct similar studies at other educational levels.

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