The Digital Story in Mathematics for Developing Mathematical Imagination and Numerical Intelligence among Primary School (Impulsive/Reflective) Students.

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مستخلص البحث:

هدف البحث الحالي إلى دراسة أثر التفاعل بين القصة الرقمية في الرياضيات والأسلوب المعرفي [الإندفاع/ التروي] لتنمية التخيل الرياضياتي والذكاء العددي لتلاميذ الصف الأول الابتدائي ، وتكونت عينة البحث من أربعة مجموعات تجريبية [ضابطة(١)(مندفعون /تقليدي)- ضابطة (٢) (متروون / تقليدي)- تجريبية (١) (مندفعون / قصة رقمية)- تجريبية (٢) (متروون / قصة رقمية)] وعددهم (٣٠) تلميذاً، ولتحقيق هدف البحث تم تصميم وحدة للأعداد والعمليات عليها في ضوء القصة الرقمية في الرياضيات، واختبار للتخيل الرياضياتي، واختبار للذكاء العددي، وكشفت نتائج البحث عن وجود أثر لاختلاف نمط التدريس (القصة الرقمية/ التقليدي) على التخيل والذكاء العددي لصالح القصة الرقمية، وأثر لاختلاف الأسلوب المعرفي (اندفاع/ تروي) على التخيل والذكاء لصالح التروي، وعن وجود أثر للتفاعل بينهما على التخيل والذكاء العددي لصالح (المتروي الذي يدرس بالقصة الرقمية)، وكذلك عن وجود علاقة ارتباطية موجبة ودالة بين التخيل الرياضياتي والذكاء العددي، عليه يوصي البحث بضرورة الأخذ في الاعتبار بالأسلوب المعرفي عند إعداد مقررات الرياضيات لمواجهة الفروق الفردية ، وكذلك الاعتبار بالمحتوى الرقمي في الرياضيات فهو امتداد وتجسيد للطبيعة المحيطة بالمتعلم حيث تحتوى على مواقف وأنشطة وتدريبات تتطلب استيعاب أفضل وأعمق، وبشكل مختلف وأكثر جاذبية عن النمط التقليدي أو حتى المحتوى الالكتروني النمطي كما أنه يؤدي إلى بناء أنشطة تعتمد على التخيل الرياضياتي التي تساعد في تعميق المفاهيم والعلاقات والتفكير الرياضياتي بصورة خاصة.

Abstract:

The Digital Story in Mathematics for Developing Mathematical Imagination and Numerical Intelligence among Primary School (Impulsive/Reflective) Students

The present research aimed at investigating the effect of the interaction between the digital story in mathematics and the (impulsive/reflective) cognitive style on the development of mathematical imagination and numerical intelligence among primary school first graders. The sample involved 30 students assigned to four groups: control group 1 (impulsive / traditional), control group 2 (reflective / traditional), experimental group 1 (impulsive / digital story), and experimental group 2 (reflective / digital story). To meet the objective of the study, the researcher designed a unit on numbers and operations on them, a mathematical imagination test, and a numerical intelligence test. The results of the present research indicated that teaching style differences (digital story / traditional style) had an effect on imagination and numerical intelligence in favor of the digital story style. Teaching style differences had an effect on imagination and numerical intelligence in favor of reflectivity. Teaching style differences also had an effect on imagination and numerical intelligence in favor of those reflective students who study using the digital story. Results also indicated that there was a positive and significant correlation between mathematical imagination and numerical intelligence. Therefore, the researcher recommends the following: (1) taking the cognitive style into account when developing mathematics courses to confront individual differences; and (2) taking mathematical digital content into account as it is an extension and embodiment of the environment surrounding the student because it contains situations, activities and exercises which require better and deeper comprehension and which are different and more attractive than the traditional style or even the typical electronic content. It also leads to constructing activities that rely on mathematical imagination and help deepen concepts and relations, specially mathematical thinking.

Introduction:

Societies are now witnessing a leap in technical innovations in general and technical innovations associated with the field of education in particular. This requires rapid movement towards the establishment of a learning environment able to employ these innovations, and to take advantage of them in the field of learning mathematics in a proper way which enables us to overcome many challenges, and still remains less costly compared to the traditional forms of technological content.

Although the appearance of the concept of digital story is old, as it appeared with the beginning of 1990, it is considered a new educational tool at least in the field of learning mathematics. The study of El-Shemi **(2009, 4)** suggests that it is considered a prolific area for the idea of positive communication with the educational content and expanding the scope of educational abilities for innovation, where they do not rely solely on a broad plate of technological tools [text, sound, animation, ..] but they rely on integrating both to reach for a coherent content which gives a new idea or concept.

Gail **(2008, 7)** indicates that the digital story and classroom learning have a lot of things in common, the most important of which is meaning-making through which the student can participate with the teacher in its production and usage in different educational situations. Robin **(Robin, 2008, 9)** confirms through some studies that have depended on the idea of digital story in the content that they promote student participation in learning seriously, in the light of the mental level he has, where some delve into the content, others innovates in the presentation style, or the expression of knowledge and engaging in the idea or concept more seriously.

Mathematics, as an abstract science, is basically knowledge organized in a structure which has its origins, organization, structure and sequence, starting with incomplete knowledge until it gets integrated and reaches generalizations and results that depend on the generation of ideas and mathematical structures reflecting creativity, imaginativeness and intuition **(Abu-Zina, 2010, 17)**. Imagination in mathematics exists with varying degrees in all its branches **(Phillip & et al., 2010, 3)**. As Juhar and Younis **(2010)** also show, imagination plays a fundamental role in solving any mathematical problem or situation where it begins with conjuring images stored in the mind without any role for senses in this case, and these images turn into more abstract linguistic pictures in the final stages of resolving the situation. It varies, of course, from one individual to another where one reaches creativity and viewing things and concepts in different ways. For example, the discovery of Gauss beyond the relationship between numbers was an imaginative creative action by collecting numbers from (1-10) when he was six years old.

The development of the imagination skill is necessary in mathematics in particular, because the start comes from imagination, and with the availability of some simple experiences, you may develop into creativity. The study by **(Mansour & Sherbini, 2011)** refers to this matter, where they argue that the child imagines before he speaks; when he is two years old, his imagination becomes 2% of his speech; when he is four years old, his imagination becomes 9% of his speech and occupies a space of his activity continuously; he then develops with it until he reaches creativity stage show in his ability to install a new image which may not exist in reality.

Some studies which focused on the skill of imagination **(Al-Gazar & Abdul Rahman, 2003) (Partin, 2009) (Juhar&**

Younis, 2010) confirm that the learner who possesses a high imaginative ability was more successful in educational situations that depend on thinking and activity than those who possesses lower imaginative ability. It also confirms that imaginary images of the learner play a key role in learning, where they are stored in brain and adjusted during retrieval in various images, and that imagination can embody some of the concepts in a new form. Although the skill of imagination is important at all levels of learning, its importance increases in the elementary stage, where learning in this stage depends on: feeling, imagination, and experience to a large extent, which requires the usage of activities and learning strategies offering the content in a way which releases the imagination of the learner to see the abstract concepts and relations, especially in mathematics, in a way that develops the process of thinking, which is fundamental in his learning of mathematics. As suggested by some studies **(Bechara & AboDarwish, 2008) (Mansy & Al-Mounir, 2011)**, the learner's ability to imagine begins to decrease at the end of that stage, where his thinking tends to deadlock in the light of his interest in judging solutions and attitudes (critical thinking), which leads him to neglect the imagination skill that develops his creativity, his ability to offer diverse solutions, and precise attention **(Phillip& et al., 2010, 5)**, which requires the provision of appropriate educational environment that motivates the imagination of the learner and develops his imagination skill. When the researcher extrapolated some studies **(Egan, 2008) (Al-Gazar & Abdul Rahman, 2003, 137-138) (Al-Paul, 2011, 23-25),** he found that the digital story is related to the skill of imagination among primary school students where:

- A learner engages in meaningful learning by using a story which motivates his imagination by forming mental images for some abstractions and concepts surrounding him.
- Egan **(2008)** found that children in the initial stages of learning have a high ability to evoke mental images of things they did see before and that they already have abstractive concepts of binary opposites (concept and nonexistence), where they do not follow the traditional model [objectives, content, methods, ..., appraisal] in which the learner as demonstrated by this study **(Egan, 2008)** may base a concept or a relationship on a tale or a story.
- The language or pattern of a story (audible, readable, visible) does not only reflect abstractive ideas and information, but it also reflects the feelings and emotions which send signals to the learner's imagination before his mind, in addition to its end that may be different from what has been expected, where the teacher may ask his students to imagine the end of the story, which is then compared to the actual end of the digital story that may appear in a simple mathematical situation or problem **(Egan, 2005)**.
- The broad areas of digital story and its unique ability to raise the learner's imagination contribute to the learner's acquisition of new experiences and develop his ambitions, which relieve tension and achieve the desired balance.
- A study **by (Wu & Yang, 2009)** suggests that the learner likes hearing stories and watching presentations through the story, where audible words or readable symbols, which are basically concepts, turns into scenes and people seen by the learner through the power of imagination and more clearly.

- A study by **(Al-Paul, 2011)** emphasizes the link between linguistic and symbolic development and mental imagination, where the development in language and the usage of symbols by a learner in the primary grades leads to an increased ability to evoke mental images for things not really existing, and he feels as if the concept or the number talks to him, and these images often come from the impact of images in the book, which he often forms when he watches digital stories.

Mathematics has experienced in the last quarter of the last century successive waves of change and development. Nevertheless, numbers and mathematical operations remained a fixed center around which all topics rotate in its orbit. Numbers and their processes are still considered the essence and meaning of mathematics with all its branches till now. Mathematics is a universal language which derives its letters from the numbers of counting, its words from numbers. We can enrich this language by increasing the understanding of this system. Its reliability relies upon its usefulness and the ability to employ it in different situations. Mathematics is that branch which examines numerical systems and relationships between numbers, but the part which is interested in this system which is developed by the development of humanitarian thought is called the numerical intelligence.

Al-Maghrabi **(Al-Maghrabi, 2012, 15)** emphasizes that the numerical system becomes complicated and incomprehensible if it is not presented in a successful way that cope with the mental development of the learner; because numbers have various representations and many aspects where the understanding of numbers includes not only perceiving the number, but it extends also to include the complex system of interrelated relationships between them. This understanding and perception, as emphasized by the study of **(Willson, 2011, 5)**, is not owned by a large section of students in a satisfactory or acceptable manner. As a result, the teacher has to provide students with various broad activities in order to help them develop the meaning they acquire through relationships between numbers and concepts related. Its abstractive nature, however, may narrow the idea of expanding its activities, but the direction towards using advanced technology makes it closer to reality, or the usage of directed imagination to make it closer to the imagination of the learned child which may start with him in the primary grades **(Bekhit & Ibrahim, 2012)** .

In order to ensure the success of the learner in the study of a particular educational program, the features and capabilities he possesses as an individual should be recognized, where cognitive styles are considered one of the most important preparations, since they include all cognitive and perceptual domains, which enables them to give a more comprehensive and effective description of the individual learner, especially in the initial stages of **(Ibrahim, 2011)**.

We can explain the differentiation between individuals in the cognitive processes through these cognitive styles. The more differentiated the individual's cognitive structure is, the more ability he will have to respond in a distinctive way in different situations, while the lower differentiated the individual's cognitive structure is, the lower his response is. Both (Witkin, et. al.) **(Ibrahim, 2008)** refer to the term 'cognitive style' as follows:

"a method means a special characteristic of the individual and a cognitive style is a hypothetical structure which mediates the presence of stimuli and generating appropriate response for it; therefore it distinguishes an individual from another in perceiving and addressing environmental stimuli and describes them and determines the type and shape of response, then the stimulus is developed, stored and encoded until it is called when different situations require that".

In this context, the (impulsive/reflective) cognitive style is considered one of the most important cognitive styles, which had been focused on by the educational studies. As indicated by some of these studies **(Attia, 2008) (Ahmed, 2008) (Ibrahim, 2011) (Zidane, 2011)**, the style (impulsivity/reflectivity) is linked to the tendency to deliberation or impulse before responding to a task of solving a situation or problem with dubious response. In the sense, this dimension describes the tendency to patience with regard to the validity of solving the problem under special circumstances, when several possible alternatives are available, which is one of the cognitive styles relevant to learning practical and mathematical skills, so it was used by the researcher as an independent variable to classify learners and to develop the skill of imagination and numerical intelligence in mathematics. Several studies which include **(Attia, 2008) (Ahmed, 2008) (Ibrahim, 2011) (Zidane, 2011)** addressed the impact of the interaction between the technological course variable and the cognitive style (impulse versus deliberation).

As a result, the current research is considered one of the interactive researches between willingness (impulsivity/ reflectivity) and educational processing (traditional teaching versus digital story) where they seek to provide the suitable processing for a larger sector of learners, since interactive researches are no longer regarded as researches requiring feedback about findings through the classification of students into groups and providing each group with appropriate learning resources and teaching strategies, but they are centered around looking for a good content design which benefits a wide section of learners. This means that learners tend towards the educational content to the extent that their willingness enables them to interact with, and to the extent that develops the qualitative variables related to the quality and the form of displayed content.

Awareness of the problem:

(EL-Shami, 2011, 14) confirms that a child must see and listen, obtain impressions and keep them in his memory in order to develop his imagination in the primary grades, where the degree to which the available information for the child is more diverse (more than one picture for the same concept), his impressions will be unique and he will be able to assemble images expressing this concept better. Although the development of the imagination skill in mathematics plays a significant role in most mathematical operations, its role as a skill goes beyond the traditional model [goals, content, style, ...]. As proved by **(Egan, 2008)** studies, the learner may build a concept or a relationship of his imagination in the light of a story, but the studies which addressed this issue in the field of mathematics are very few compared to its importance.

There is no doubt that imagination exists. It starts from mere remembering of events and pictures, ends up with creativity, and even takes a new trend as a result of mental openness in the light of enormous technical innovations surrounding the learner. Also, the studies of **(Juhar & Younis, 2010**) and **(Partin, 2009)** showed that its role in mathematics is fundamental, especially in the primary grades, in bringing around abstract concepts and enriching the mental images of concepts and relations, which helps in generating ideas as well as higher skills of capabilities beyond the knowledge like controlling attention and concentration. Accordingly, the studies of **(Shine & Saleh, 2010), (Ambo Saaidi & Baloushi, 2011) and (Juhar & Younis, 2012)** emphasized that the learner's poor ability to represent some concepts from reality, and even his limited freethinking needed from him in the early learning of mathematics in primary grades in addition to his poor ability to reassemble some images about the concept; all of which are related mainly to his poor skill of imagination. These studies also suggested that developing the imagination skill has been neglected especially in mathematics, and emphasized that it begins to fade partially until it comes to an end by the end of the primary stage.

In the light of the researcher's visit to the field [1], he presented some rationed numerical activities which included some numerical intelligence situations. After observing the learners in a rationed individual way during working on these activities in several schools: he realized actually that primary school students are poor in evoking, reassembling and representing some images about a particular mathematical concept or even launching an idea about using a number or a concept in a new way stemming from his imagination. Also, they have a weakness in distinguishing relationships that may link numbers, and slowness in the process of classification, arrangement, and sequencing. Any change in the simple mathematical situation means that the wheels of thinking stopped, where they tend to save simple calculations. After extrapolating some studies **(Al-Maghrabi, 2012) (Al-Khatib, 2011) (Hafid, 2013)**, the researcher found that they confirmed the presence of a decline in these mathematical operations, which become active to reach the concept of numerical intelligence upon which thinking processes at most mental levels and stages in mathematics are based.

1 The researcher supervises the Faculty of Education undergraduate and post-graduate students, Department of Mathematics.

Some justifications for the current research problem can be identified in the following:

- What has been affirmed by some previous studies in the field of mathematics about the poor imagination skill found in activities and mathematics textbooks in the primary stage, and the capacity for effective communication between mathematics as activities and practices and the numerical situations which may appear in life activities in mathematics, and the reasoning between numbers and perceiving the interrelationships between them, where the concept of numerical intelligence is a natural development for these operations, as we will clarify in the theoretical presentation.
- The difficulty of acquiring the skill of mathematical imagination in the light of current mathematical curricula in their traditional ways; the need for the presence of numerical intelligence situations prepared in untraditional ways as they are needed where they reflect good perception and communication with the numerical system, which is the basis for mathematical operations moving with the learner as he studies mathematics; and the presence of some studies which emphasized the role of technology in reshaping, formulating curricula, and highlighting them in a new way, the researcher is motivated to adopt the approach of digital story in mathematics as an attempt to develop these skills.
- Although some foreign studies in the field of mathematics exists, the study of **(Helen, 2014)** came out which aimed at formulating a strategy to develop creative imagination for some mathematical skills, specifically in third and fourth primary grades activities to compensate the abstraction of concepts that underlie these skills including differentiation and life situations. Also, the study of **(Arielle, 2015)** came out

which was an analytical study aimed to transform mathematics and its content in the primary stage into acceptable logic for the learner child through renewed imagination which depends on the nature of intuitive mathematics around us without relying on specific teaching methods. In addition, the study of **(Patras, 2015)** appears which suggested how to plan for moderate imagination in mathematics in the primary school, and incorporated a lot of moderate imagination plans as a way of support for the imagination of the child at this stage. As far as the researcher knows, no study however came out to explain the impact of interaction between the content of a digital story in mathematics and the cognitive style (impulsive/reflective) to develop the skill of imagination and numerical intelligence in mathematics at the primary stage. In the light of the previous discussion, the current research discussed the impact of digital story in the content of mathematics with regard to its interaction with the cognitive style (impulsive/reflective) on developing the skill of imagination and numerical intelligence in mathematics.

Research problem:

The previous discussion shows that the research problem can be summarized in the difficulty of acquiring the skill of imagination in the light of the current content of mathematics, despite the urgent need for this skill as a basis for building mathematical representation operations out of abstraction, which is an important stage at the beginnings of learning mathematics; and a slowness and decline in dealing with numerical situations and operations which then become active and end up with the numerical intelligence which reflects the perception and understanding of the numerical system which appears during effective communication between mathematics as numerical activities and situations and life activities in mathematics, which is considered a basis for mathematical operations for primary students in the first grade at Al-Baha region. [which is also showed by the results of the exploratory experiment in addition to some observations by the researcher during his field supervision so that the results are not dependant only on exploratory experimentation which confirmed the existence of this weakness and decline]; and then the researcher tries to use the digital story in mathematics to develop the skill of mathematical imagination and numerical intelligence among primary students in the first grade who have a cognitive style (impulsive/reflective).

Research Objectives:

The current research aims to:

1. Identify the impact of interaction between the style of digital story in mathematics and the (impulsive/reflective) cognitive style on the development of the skill of mathematical imagination among primary students in the first grade where the imagination skill in mathematics begins with the learner before he even perceive mathematical abstractions through representation and mental images which may start by remembering and end by creativity concerning concepts, and then he will have solutions for all updates in mathematics.
2. Identify the impact of interaction between the style of digital story in mathematics and the (impulsive/reflective) cognitive style on the development of the numerical intelligence among primary students in the first grade, which represents effective communication between mathematics as activities and practices and the numerical situations which may appear in

life activities in mathematics, which is related to its capacity for reasoning between numbers and perceiving interrelationships between them, and the possibility of obtaining information connecting them.

3. Find the nature of correlation between the grades of students in the experimental group in the post application of the mathematical imagination skill test and their scores in the numerical intelligence test in mathematics

Research questions:

The present research attempts to find an answer to the following main question: "How is the content of digital story in mathematics designed and used in light of its interaction with the (impulsive/reflective) cognitive style to develop the skill of mathematical imagination and numerical intelligence among primary school first graders?" From the answer to this main question, the researcher can find answers to the following sub-questions:

1. What is the impact of teaching style differences [digital story/traditional teaching] in mathematics on developing mathematical imagination and numerical intelligence skills among primary school first graders?
2. What is the impact of cognitive style differences (impulse versus deliberation) on developing mathematical imagination and numerical intelligence skills among primary school first graders?
3. What is the impact of the interaction between the teaching style [digital story/traditional teaching] in mathematics and the cognitive style (impulse versus deliberation) on

developing mathematical imagination and numerical intelligence skills among primary school first graders?

4. What is the relationship between mathematical imagination and numerical intelligence skills in mathematics among among primary school first graders?

Research hypotheses:

The research attempts to test the validity of the following hypotheses:

1. There are no statistically significant differences between the average scores of the control group students [(who study the concept of numbers and their operations in the traditional way) and experimental group students (who study the unit using the digital story)] This occurs due to the differences in the teaching styles without taking into consideration the cognitive style on the mathematical imagination skill post-test.
2. There are no statistically significant differences between the average scores of control group students [(who study the concept of numbers and their operations in the traditional way) and experimental group students (who study the unit using the digital story)] This occurs due to the differences in the teaching styles without taking into consideration the cognitive style on the numerical intelligence post-test in mathematics.
3. There are no statistically significant differences between the average scores of students in the experimental group 1 [(impulsive students studying by the digital story) and students in the experimental group 2 (reflective students studying by the digital story)] This occurs due to the

differences in the cognitive style (impulse versus deliberation) without taking into consideration the teaching style on the mathematical imagination skill post-test.

4. There are no statistically significant differences between the average scores of students in the experimental group 1 [(impulsive students studying the digital story) and students in the experimental group 2 (reflective students studying by the digital story)] This occurs due to the differences in the cognitive style (impulse versus deliberation) without taking into consideration the teaching style on the numerical intelligence post-test in mathematics.
5. There are no statistically significant differences between the average scores of students in control group 1 and control group 2 [who study in the traditional style (impulsivity vs. reflectivity)] and students in experimental group 1 and experimental group 2 [who study using the digital story (impulsivity vs. reflectivity)] This occurs due to the interaction between the teaching style (digital story/traditional teaching) and the cognitive style (impulse versus deliberation) in the mathematical imagination skill post-test.
6. There are no statistically significant differences between the average scores of students in control group 1 and control group 2 [who study in the traditional way (impulsivity vs. reflectivity)] and students in experimental groups 2 and 2 [who study using the digital story (impulsivity vs. reflectivity)] This occurs due to the interaction between the teaching style (digital story/traditional teaching) and the cognitive style (impulse versus deliberation) on the numerical intelligence post-test.

7. There were no statistical correlation between the scores of students in the mathematical imagination skill post-test and their scores on the numerical intelligence test in mathematics.

Definition of Terms[2]:

The digital story in mathematics

It is "an integrated educational pattern which transmits the knowledge through a sequence of events made through a scenario for the educational content in mathematics with the aim of transmitting a new idea or developing some learning aspects which are included within the educational content".

It can be defined operationally as "an educational scenario in mathematics which expresses the vocabulary of a teaching unit through some figures and images of reality, which are favored by primary school first graders to express a concept or relationships within the numbers system, which then becomes a unit of a particular kind; has a beginning paving the way for an idea, and a center including an educational problem or situation, and an end solving the educational problem or situation".

The (impulsive/reflective) cognitive style

It is "a variable through which we can distinguish between those who contemplate a solution for an idea or activity before confirming it, and those who respond immediately for the first solution occurs to him, and expresses the individual's special way in dealing with information, whether receiving or giving them. It

[2] There is a detailed theoretical part to define all research variables (the digital story in mathematics – the cognitive style (impulse versus deliberation) – the skill of mathematical imagination – the numerical intelligence in mathematics) within the theoretical context for the research with conclusion for each.

is measured on the basis of two dimensions (latency/ accuracy), the learner with a cognitive style (impulsive) is the one who tends to respond rapidly to situations and commits larger number of mistakes, while the learner with a cognitive style (reflective) is the one who tends to give a response after a suitable amount of time in contemplating the essence of the available alternatives in solving the new situation, and commits fewer number of mistakes".

Mathematical Imagination Skill:

It is "a mental activity resulting from the retrieval processes of past experiences and concepts, and the integration and assembling within the learner's memory to produce other forms and new concepts, which can be measured by getting verbal or nonverbal responses from the learner expressed in forms and some simple operations using standards prepared specifically for this purpose".

Numerical Intelligence in Mathematics

It is "a part of logical mathematical intelligence which includes only some abilities depending on numbers and the relationships between them like classification, arrangement and summarization more clearly. It is linked to mental calculation and perceiving the significance of numbers and operations related without addressing the computational performance and its steps. It also goes beyond this to the understanding of the numerical system which appears in the results of mathematical activities in the connection between mathematics as a science and daily life activities".

Research procedures:

The research proceeds according to the following steps:

1. In order to make the research theoretical study, to identify the methods of preparing the electronic content in the light of digital story concept, and to prepare the mathematical imagination skill test and the numerical intelligence test in mathematics, some literatures, researches and studies have been viewed which addressed the issue of constructing a digital content; and which addressed the issue of mathematical imagination skill and numerical intelligence in mathematics.
2. Choosing the unit "Numbers and operations on them" being studied by primary students in the first grade, analyzing its content to design the activities and tasks necessary for teaching it through the digital story style, and then presenting it to a group of arbitrators whose opinions were useful in preparing (the content scenario for the unit), and ensuring the reliability and validity of the analysis.
3. Constructing the digital content in light of the style of digital story in mathematics and then preparing its construction steps in light of:
   - Determining the overall objectives of the unit prepared digitally.
   - Determining the scientific content achieving the objectives.
   - Determining the procedural objectives of the lessons presented through the digital story.
   - Educational designing of the digital story in mathematics which includes making a scenario for mathematics in the unit in light of specific steps.
   - Designing its overall shape including interaction interfaces and ending with its production.

- Controlling the digital story content through presenting it with a validity card; judging it by specialists in the field (methods of teaching mathematics, and the educational technology).
- Setting the digital unit (in light of the digital story) in the experimental stage to ensure the validity of its usage with the research sample.

4. Setting the research tools which included:
   - Testing the mating between familiar figures [The second image which suits primary school students]. (Prepared by Al-Faramawy)
   - Testing the skill of mathematical imagination for primary students at the first grade. (Prepared by the researcher)
   - Testing the numerical intelligence in mathematics for primary students at the first grade. (prepared by the researcher)

We presented [the skill of mathematical imagination test - the numerical intelligence in mathematics test] to the arbitrators and the amendment in light of their views, and then the confirmation of their reliability and consistency through applying them to a group (other than the experimental group) to measure the coefficients of validity, reliability and internal consistency of dimensions in both tests.

5. The experimental design[3] for the research which included:

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[3] Identifying the research method, describing the main sample, and the period of the experiment will be mentioned during the experimental part of the research

Table (1): Experimental design for the research "factorial design 2*2"

Teaching Method / Cognitive Style	Traditional Method	Digital Content (Digital Story)
Impulse	Control group (1)	Experimental group (1)
Deliberation	Control group (2)	Experimental group (2)

- First control group: impulsive students studying in the traditional way.
- Second control group: reflective students studying in the traditional way.
- First experimental group: impulsive students studying by the digital story.
- Second experimental group: reflective students studying by the digital story.
- Pre- application of the research tools on the groups
- Calculating the results of applying the research tools statistically (pre-application) to verify the equivalence of the research groups.
- Teaching the unit for the control group (1) and the control group (2) [in the traditional way] and for the experimental group (1) and the experimental group (2) [in light of the digital story] during the second term 2016/2017.
- Post-application of the research tools on the groups.
- Monitoring the results, processing them statistically, and explaining them in light of the theoretical background and previous studies.
- Making some recommendations and proposals in light of the results of the research.

Significance of the research:

The present research is significant in that:

1. It helps math's teachers at the primary stage through presenting the content of mathematics by the digital story style, which relies not only on technical tools [voice, images, animations, …..], but also delve into the content, innovates in the presentation style, provides the opportunity to express the knowledge through a new vision, where it combines the art of telling old narratives and the broad panel of technological tools which are processed educationally because the basis here is the educational aspect, not the technological one. It helps the teacher to form a meaning for the content through precise and directed scenario. It represents a record for the learners' thinking where the teacher can use the digital story in evaluating the progress of his students towards the learning goals.
2. It helps in reformulating mathematics in a new modern way which takes into account the educational aspect: where the idea of digital story came out to reach a pattern close to reality to a large extent, and not far from the learner's culture, especially in the early grades of education, where mathematics has been taught as symbols and terminology through memorization and indoctrination in addition to some routine exercises without linking it to reality or daily life usage. Also, the digital story has the ability to organize the cognitive structure and some thinking aspects, and to provide meaningful learning through mathematical representations.
3. It helps the learner at this stage where the digital story in the field of mathematics might contribute to the following:

- It helps the learner reorganize the subject and to draw it in a new cognitive map.
- A digital story offers creative options to help the learner to understand mathematics better where the mind is organized better when you use a digital story **(Egan, 2008, 4)**.
- It enables the learner to perceive different experiences, to encode them into ideas and concepts, and to construct them inside the memory in an ordered and organized manner to become a part of his cognitive structure.
- Introducing mathematical concepts within the literary text as a story helps the learner to understand the meaning of mathematical abstractive facts and relationships such as: the initial count, algorithms, and even numbers **(Balakrishnan, 2008, 6)**.
- Using the digital story in learning mathematics enables them to enjoy first, and to motivate them to think afterwards, which provides a coherent and meaningful content for mathematics for learners in the primary grades, and gives them representations for mathematical situations, which is consistent with Ozubl theory (Meaningful learning).
- A digital story fosters a child's imagination in primary schools, where learning a child does not always proceed from sensible to abstract and from known to unknown; where **(Egan, 2008, 5)** found that a primary school student possesses a high ability to evoke mental images never seen before which he uses then to develop his mathematical imagination as shown through the digital story.

4. This research deals with the imagination skill in mathematics variable, where it is a rare variable in some Arab studies

specialized in learning mathematics. In addition, the research deals with the issue of preparing a test in the imagination skill in mathematics, a test in the numerical intelligence, and studying the relationship between them in light of the cognitive style (impulse versus deliberation), which opens a field to study these categories with other variables in mathematics as future studies.

5. It opens a field for other researchers to conduct researches and studies regarding the use of digital story in learning mathematics, where in particular it has not been used a lot in the field of learning mathematics.

The theoretical framework for the research "The digital story in mathematics for the development of mathematical imagination and numerical intelligence among primary school (impulsive/reflective) students.

The researcher aims from reviewing this theoretical framework to discover the role of electronic digital story in mathematics to develop the ability of students [impulsive/reflective] to imagine in mathematics and to develop their numerical intelligence. As a result, the theoretical framework included "the digital story in mathematics"; "the mathematical imagination and numerical intelligence - impulsive/reflective - in the cognitive style among primary school students.

❖ The digital story in mathematics

Although storytelling as a teaching approach is old, but the technology brought it back to life in a different way characterized by modernity, and this is through the electronic digital story; which is considered an effective way to learn and works to promote students participation in learning effectively **(El-Shemi, 2009, 3)**, where it leads to profoundness in the content, creativity in the presentation style, and the opportunity to express knowledge through a new vision **(Susan, 2007)**.

☒ The concept of digital story

Although the appearance of the digital story in the educational process is old (1990), it has no precise definition other than the following where it is defined as a natural extension for the traditional storytelling **(Renee & Matusov, 2008)**. A set of definitions regarding the digital story based on the past definition have emerged as follows:

1. A model combining the ancient art of storytelling with a broad plate of technological tools (voice, image, animations) which are processed educationally because the basis here is the educational aspect, not the technological one. **(Adobe System Incorporated, 2006, 3)**
2. It is a term used for the purpose of exchanging knowledge and values among learners in the classroom. **(Gail, 2008, 2)**
3. It is a pattern of telling the educational content in the light of digital technology through the coherent elements of voice and expressive drawings. **(Janet, 2006, 5)**
4. It is a collection of tales related to the educational content which works as an electronic medium with the addition of some effects including voice, drawings, and images. It relies on a dramatic line and aims at education and edification. **(Moses& Salama, 2004, 467)**
5. It is a unit of a particular type able to identify the emotional sense for its constituents. It has a beginning which paves the way for of an idea, and a center including an educational problem or situation, and an end solving the educational problem or situation". **(Egan, 2003, 4)**

The researcher may conclude from the past definitions the following points about the digital story:

- It is one of the technological knowledge tools currently available providing integration and association between knowledge and imagination, where they constitute the emotional understanding of students for the content. Also, the realistic images of its fictional content can be formed using the technique.
- It is considered a special type of learning and one of the interesting artistic forms for children and primary grade students, which is characterized by pleasure with ease, clarity and a tool for presenting knowledge in a simple way.
- A digital story and learning share making sense, where both represents a record for the learners' thinking where the teacher can use the digital story in evaluating the progress of his students towards the learning goals.
- Since the story depends on the learner's imagination or perception of characters who make the idea or perform the educational situation through a scenario which conveys the learner in an imaginary journey, and motivates him to construct mental images for what he watches and hears, the researcher was forced to use it in developing imagination mathematically for the child through an integrated mathematical pattern in light of the educational scenario in mathematics.

As a result, the concept of digital story in mathematics is "an integrated educational pattern transmitting the mathematical knowledge through a hierarchy and sequence of events and processes, which are formulated through a scenario for the educational content with the aim of transmitting a new idea or building relationships and generalizations about a mathematical situation or issue or developing some learning aspects which are included within the educational content".

☒ **The educational importance of digital story in mathematics:**

Since the digital story in mathematics encourages the student to communicate and interact at multiple levels leading to an increase in the area of interaction in collaborative learning environments, we can conclude its importance as follows **(Al-Paul 2011, 4-21) (Moses& Salama, 2004, 488) (Zazkis & Liljedahl, 2009)**:

1. It helps students to perceive the concept or idea in a dynamic context within the mathematical situation.
2. It gives them the opportunity to develop a meaning for the concept or to get a new idea in the displayed content.
3. It enriches mathematical topics with literary texts which try to help in overcoming the idea of single solution [which might develop the skill of mathematical imagination- adopted by the research].
4. When the story includes a mathematical topic or concept, the student is integrated in a powerful way within the concept or the relationship, which gives him an opportunity to link the ideas with the outside world in a meaningful way which enables him to build a meaning for mathematical concepts within an integrated context with real things surrounding him in a life image with mathematics.
5. It must also be noted that if the digital story in mathematics is controlled educationally in a good learning environment:
   - It will interest students to learn various concepts and to interact with various mathematical situations.

- It will help the memory to remember and memorize through visual and audio effects available within them.
- It will reduce the tension of students by creating a comfortable and supportive environment within the classroom.
- It will offer ways to think and act as the heroes of the story did [with primary school students]
- It will enthuse young students specifically through an interesting educational scenario linking between motor and interactive concepts and the student in various mathematical situations and activities.
- It will present stories involving examples which express (concepts - numbers - abstract relations) which will help the student to relax because they offer something which can be kept even when you move into a general theory or details of relationships and generalizations [such as the relations between numbers**] (Al-Paul, 2011, 29)**.

☒ **Justifications of digital story as an educational approach in mathematics:**

- As mathematics has been taught as symbols and terminology through memorization and indoctrination in addition to some routine exercises without linking it to reality or daily life usage, the idea of digital story came out to reach a pattern close to reality to a large extent, and not far from the learner's culture, especially in the early grades of education.
- The child in the initial stages of education perceives many concepts through hearing stories, and in particular those which include images, drawings, and animated concepts, which may add to the concept meaning what we want from

them in the advanced stages of mathematical content **(Back & Lee, 2008, 11)**.

- Some believe that the digital story may be a way for developing certain behaviors in the so-called hidden curriculum and some aspects of imagination which undoubtedly develop the creativity of the child **(Khalaf, 2006)**.
- In addition to some educational aspects that may be left by the digital story in teaching mathematics where it has the ability to organize the cognitive structure and some thinking aspects, and to provide meaningful learning through mathematical representations inside the educational situation.
- Also, the multiplicity of digital story patterns [audio/ visual/ written] may cover a larger area of mathematical concepts and relationships and meet all learning styles [Some like reading, others prefer listening, while primary school students prefer the visual aspect] and so on.

☒ **The criteria of digital story to suit mathematics in the primary stage:**

Some studies like **(Jason, 2008) (El-Shemi, 2009) (Zazkis & Liljedahl, 2009) (Al-Paul, 2011) (Thetese & Joseph, 2013)** suggest that there are seven effective and fundamental elements which must exist in the digital story to suit primary school students, namely:

- **A Point of View:** In this way, the story is not presented abstract without telling facts and relationships, where it must assume a certain idea needed to be delivered to the young learner.

- **Interesting Question:** An interesting question is asked to capture the individual learner's interest through which we can hold their interest throughout the presentation until we answer his question at the end of the presentation.

- **Emotional Content:** The emotional content appears through effects, the narrator's voice tone, and music, which increases the area of interest for students at this important stage.

- **Voice:** It is the essence of digital story, where it is not just a comment on the story here; but it is the main engine for it, so we have to make a good choice of voice, which is usually registered more than once until we choose the best status of voice.

- **Soundtrack:** It is a sincere expression of the goal of the story, where it may transmit the young learner from one case to another, with the addition of some kind of anticipation always. We should take care to a large extent when we employ the soundtrack where it may backfire and disperse the student away from the subject of the lesson.

- **Economy:** It is the biggest problem facing the production of digital story, where the story designer seeks to use multimedia as many as possible (voice, animations, interactive situations, ...), while it can be produced using a limited number of multimedia and relying on the written text sometimes, the idea depends only on the nature of the content and the targeted learning category. In some cases, we may not present all ideas accurately in detail within mathematical situations.

- **Pacing:** A clear pace should be present to view the digital story, where the pace transmits the student from one case to another, which is often linked to the speed of events, the rate of sound and the period of the idea or the concept presentation. We should be precise in accelerating, slowing down, running, and turning off the presentation of digital story elements when needed.

☒ After extrapolating the previous studies, the researcher may conclude some suitable criteria for the digital story for teaching mathematics:

- The course of event (concerning the mathematical concept or term) within the digital story is the one which raises interest and attention of learners and raises the questions necessary for the continuation of attention till the end.
- A binary opposition [concept - alternative concept] helps in guiding the idea through creating internal struggle inside the individual learner, because the story in which the conflict is not resolved moves the learner from just listening to working and experimentation so that it can solve a certain mathematical problem.
- Imagination: It enables the learner to evoke mental images in his mind for the story words and concepts where its impact sometimes may be better than realistic images: where the concept may speak, move, and introduce itself, which is needed by the learner sometimes.
- Finally, the digital story which can be used in education is the one which meets the mental, psychological and emotional demands for the targeted category, in line with the nature of the educational content itself, where mathematics has a special nature often close to abstraction, but it is closer to realistic representation even more than other sciences.

☒ **Stages of [producing/presenting] the appropriate digital story for mathematics in the primary stage:**

The study conducted by **(David & Joe, 2014, 6)** shows some steps of the digital story production:

1. **Writing the story text:** In which the main idea of the story is identified, and is formulated in more than one way to reach a final image that fits students in the targeted group.
2. **Preparing the scenario:** Which determines the basic form of the digital story and the multimedia elements that will be used.
3. **Preparing the portrayed scenario:** In which we determine the text and multimedia in specific places in the story with accurate details which contribute to facilitate the implementation of the following steps.
4. **Obtaining the sources:** We actually get here the required media either from the internet or through the supporting devices like the scanner or the digital camera and others.
5. **Production:** The digital story production occurs here using the appropriate programs like the movie maker or photo story or other programs.
6. **Sharing:** Sharing occurs by making it available to the learner on the Internet or the intranet of an educational institution or any other sharing method.

We must take into account experiencing the linguistic dictionary of the targeted category during the digital story construction and other considerations such as the nature of the educational subject itself. As some emphasizes, mathematics differs from others and needs representation from the reality largely and clearly to overcome abstraction which dominates.

With regard to the process of presenting the content in the digital story, there is no standardized way for presentation, where mostly it may be the following one:

- An approach to the emergence of a certain problem or issue or educational situation through presenting an interesting preliminary situation.
- A detailed presentation of the problem, until all its details become exactly clear, through which many questions are asked, and answering them quietly, with stopping the presentation whenever possible to clarify some issues.
- Providing some solutions which includes the information needed to be clarified for the learner
- An end to the story (An end to the problem, or the educational situation) and confirming what has been presented and to be learned from the story.

El-Shemi **(2009)** and Wu & Yang **(2009)** emphasized that there are no fixed criteria for the digital story production, where the availability of the aforementioned seven elements of the story is enough to judge its effectiveness. These standards exist with varying ratios which vary according to the nature of the educational content itself and the targeted category of the digital story.

With regard to the patterns of the digital story content presentation, Jason **(2008)** and Thetese & Joseph **(2013)** suggest that there are three patterns concerning it:

- **Audible Pattern:** It is the oldest pattern which contributed to the collection of a lot of information, which is still stuck in the mind. Whatever the development of technology reaches, the audible pattern remains well and fits most educational categories due to its ability to create mental images from the concepts heard in the story content. It is also considered the closest and most widely accepted among students who do not tend to read or face difficulties in reading.

- **Visual Pattern:** It has became the prevalent pattern in the digital story, especially with young people in the initial stages of education who can't read and write and who need visual and audible stimuli and other elements of attracting the attention of learners. As is the case in mathematics, the visual pattern also gives a great opportunity for the content presentation diversity and overcoming the abstract character.
- **Written Pattern:** It is not less important than the previous patterns, but it suffers negligence to a large extent, although it is considered the continuous pattern with the learner throughout his learning journey. It is important because it develops the learner's ability to draw out the underlying meaning of terms and concepts from the written text, and the attempt to make effort to perceive and understand the concepts and information included. It is considered a clear challenge to the learner's thinking.

With regard to the arrangement of patterns within the digital story according to their importance: The nature of the educational subject, the goal of the digital story itself, and the nature of the targeted category (primary school students or higher stages - ordinary or disabled learning) stand as a barrier and a specific determinant to the nature of the required pattern in every digital story being presented.

☒ Digital story and the concept of imagination among primary school students:

Organizing the knowledge and putting it in a fictional template makes it more effective in the learner's mental abilities and enables him to remember it more than any other form of knowledge, where it presents a series of events and images underlying certain educational and emotional aspects through a set of characters and events affecting the perceiver's mind in a way which facilitates the memorization process and develops imagination for the learner.

After extrapolating some studies **(Egan, 2008; Al-Paul, 2011, 23-25)**, the researcher found that the relation between the digital story and the skill of imagination among primary school students appears in:

- The learner engages in meaningful learning by using a story which moves his imagination by forming mental images for some abstractions surrounding him.
- "Egan" **(Egan, 2008)** found that children in the initial stages of education have a high ability to evoke mental images of things they did see before and that they already have abstractive concepts of binary opposites (concept and nonexistence), where they do not follow the traditional model [objectives, content, methods, ..., appraisal] in which the learner as demonstrated by this study **(Egan, 2008)** may base a concept or a relationship on a tale or a story.
- A story with its elements and technical components will have the ability to motivate and develop the learner's imagination so that he can find himself in its characters (some concepts and mathematical terminology), and the description of its events helps him to form a visual image for these characters,

which are basically concepts, which makes the learner more attentive and influenced to the degree that he becomes incorporated and influenced by the story **(Amin, 2001)**.

- A digital story may contain surprises which contribute to the revitalization of the learner, which forces him to hear, hold and restore it from his memory when needed.
- A story language or pattern (audible, written, visual) does not reflect only abstract ideas and information, but it reflects also feelings and emotions sending signals to the learner's imagination before his mind, in addition to its end that may be different from what has been expected, where the teacher may ask his students to imagine the end of the story, which is then compared to the actual end of the digital story **(Egan, 2005)**.
- The broad areas of digital story and its unique ability to raise the learner's imagination contribute to the learner's acquisition of new experiences and develop his ambitions, which relieve tension and achieve the desired balance.
- A study by **(Wu & Yang, 2009)** shows that the learner likes hearing stories and watching presentations through the story, where audible or readable words, which are basically concepts, turns into scenes and people seen by the learner through the power of imagination and more clearly.
- A study by **(Al-Paul, 2011)** emphasizes the link between linguistic and symbolic development and mental imagination, where the development in language by a learner in the primary grades leads to an increased ability to evoke mental images for things not really existing, and he feels as if the concept or the number talks to him, and these images often come from the impact of images in the book, which he often forms when he watches digital stories.

- As a result, the imagination can be the backbone of teaching and learning process, if taken into account and entered into some student activities supported by methods and strategies developing its dimensions.

A digital story requires the classroom teacher to conduct certain procedures to help in the development of imagination of the learner, including:

- Reformulating the content in a fictional form and choosing the appropriate preparation style for it [the digital story scenario represents this formulation].
- Moving inside the digital story, stopping at each important point or situation, and asking the student to express the situation his own way, as if he takes the place of the character (the concept) in the story.
- Asking the learner to perform the role of some characters in the story in a way which shows to what extent the learner benefited from the course of events.
- The inclusion of digital story by certain activities which encourage the learner to imagine a mathematical concept or relationship, to describe what it says about itself in a non-stereotyped way, and the possibility of making drawings from the learners' imagination to these relationships whenever possible.

☒ **The experiments of some countries with the digital story for the educational content:**

- The first of these experiments is the Master program in E-Learning at Edinburgh University, United Kingdom (Britain). This program includes 12 courses, which had been introduced through the digital story strategy, and provides selfassessment tools, rooms for dialogue, and other applications, which had been distributed over the weeks of study. In each week, each student has to write a topic in the discussion forum related to the course, which must include an analysis to the digital story content **(Hamish, 2009)**.

- The academic technology center experiment at Cornell University, New York, where the center undertakes the employment of educational technology by the faculty members in their courses. The initiative concerned the production and employment of digital storytelling, which took the form of short video files with audio commentary and other multimedia, which resulted in reduced time learning and quick perception and offered a period of time for more practical exercises **(Edu Cause learning Initiative, 2009)**.
- Formulating (6) courses by using the digital story in a project between Georgetown University of Washington, and Humboldt University of Berlin, and studying the impact of digital technology on teaching. After two years (2011), the opinions from students and faculty members had been collected which confirmed that the courses were characterized by strict organization and attraction towards the scientific content **(Georgetown University, 2009)**.

Some studies including The study of **(El-Shemi, 2009)** which aimed to study the impact of changing the web-based digital storytelling style on the acquisition and development of critical thinking skills and the attitudes towards these skills for a sample of (40) students at the first and second year at the faculty of specific education – Educational Technology department at Al-Fayoum. The study findings showed that it is possible to develop critical thinking skills, achievement and attitudes toward digital stories through teaching using any of its patterns (visual, audible, written), that the visual style was better in attitudes toward it, and that the written one better in developing achievement. The study also recommended activating computer labs to contribute to the production of digital stories with all its patterns, and adopted the establishment of units to produce digital stories for various stages in conjunction with electronic curricula production centers.

The study of **(Al-Paul, 2011)** which aimed to examine the impact of digital story strategy in learning mathematics on achievement and motivation towards learning mathematics for a sample of (68) students at Faisal Al-Hussni school in Ramallah, Palestine. The study findings suggested that there were statistical significance difference between students' motivation towards mathematics and the increase in achievement in favor of the group which studied using the digital story. The study also recommended the inclusion of digital story in preparing primary school curricula and the conduct of more researches concerning it.

The study of **(Washington, 2005)** and **(Hauscarriague, 2008)** agreed with **(Al-Paul, 2011)**, which confirmed that the use of stories in teaching mathematics increases the motivation of students to learn mathematics.

☒ The role of digital story in learning mathematics:

The National Council of Teachers of Mathematics (NCTM) adopted mathematical standards for primary school grades, which call that students should have an opportunity to use their language as a form of writing, communication and talking, for their ideas to communicate together.

Since the story has the capacity to achieve this communication **(Schank, 2008)** and **(Al-Paul, 2011)**, the role of digital story in the field of teaching mathematics might be:

1. A digital story offers creative options to help the learner to understand mathematics better where the mind is organized better when you use a digital story **(Egan, 2008, 4)**.
2. It enables the learner to perceive different experiences, to encode them into ideas and concepts, and to construct them inside the memory in an ordered and organized manner to become a part of his cognitive structure.
3. Introducing mathematical concepts within the literary text as a story helps the learner to understand the meaning of mathematical abstractive facts and generalization such as: the initial count, algorithms, and even numbers **(Balakrishnan, 2008, 6)**.
4. Using the digital story in learning mathematics enables them to enjoy first, and to motivate them to think afterwards, which provides a coherent and meaningful content for mathematics for learners in the primary grades, and gives them representations for mathematical situations, which is consistent with Ozubl theory (Meaningful learning).
5. A digital story fosters a child's imagination in primary schools, where learning a child does not always proceed from sensible to abstract and from known to unknown; where **(Egan, 2008, 5)** found that a primary school student possesses a high ability to evoke mental images never seen before which he uses then to develop his mathematical imagination as shown through the digital story.

❖ Imagination in mathematics

Any creative work depends primarily on imagination, where the learner perceives what happens, imagines what could be achieved, and even may reach to conclusions, which appear to be right without being able to explain its rationales, where he depended on imagination which is the magical power which transcends the world of truth and reality to look at new relationships, methods and ideas **(Al-Gazar& Abdul Rahman 2003, 119)**.

The study of **(Mansour & Sherbini, 2011)** pointed out that the child imagines before he speaks; when he is two years old, his imagination becomes 2% of his speech; when he is four years old, his imagination becomes 9% of his speech until it occupies a space of his mental activity so he parts with reality and often contradicts with it; his imagination may develop into creative imagination shown in his ability to assemble and create new images which may not exist in reality. This helps him in building his mathematical knowledge through developing his skill of imagination, as the research will show.

☒ The concept of imagination skill

The definitions of imagination varied depending on the direction of one's definition, therefore by extrapolating most studies, some of these definitions were classified as follows:

1. Imagination as a mental process:

- A higher mental process based in its essence on establishing new relations between previous experiences where it organizes them in the form of images the individual has never experienced before **(AL-Gazar& Abdul Rahman 2003, 124)**.
- A mental process based on establishing new relations from previous experiences where it organizes them in forms and images the individual has never experienced before **(Phillps & et al., 2010)**.

- A mental process which occurs inside the mind of the individual to imagine how things are likely to be, based on previous experiences to understand the past and to improve his reality **(Decety, 2004, 5)**.
- A mental process which can highlight what has been formed in imagination by mixing images and integrating them which is called the imaginary object **(Boutros, 2004, 594)**.
- A mental process which enables the individual to generate multiple responses to specific stimuli, which relies on transferring stimuli to mental images in the brain according to a set of cognitive processes. Also, the availability of prior knowledge for the individual about certain situations or ideas enables him to exercise imagination in an appropriate manner **(Nofal, 2008, 63)**.

2. Imagination as a pictorial thinking:

- It means thinking about images formed for things and issues which have been identified in a sensory way **(Leboutillier & Marks, 2008, 2)**.
- It refers to mental images which lead to an understanding of ideas and perception of what happens, and the internal mental ability to imagine the subject or the external event inside the memory, which reflects interaction between inner thoughts of the individual and the displayed concept **(Rasinski, 2014, 6)**.
- It is a pictorial process which helps the individual to understand some characteristics of objects or concepts in which the individual uses comparisons and issuing judgments and interpretations **(Helen, 2014, 7)**.
- Accordingly, when objects and concepts are characterized by simplicity and lack of details when presented, it is possible to

retrieve their images easily than complex objects or most complicated ones.

3. **Imagination as a meaningful activity:**

- It is the process of reconstructing previous experiences in new patterns of perceptions or mental images about issues or situations we have already experienced **(Sherbini & Sadik, 2002, 101)**.
- A meaningful activity which includes the imagination of things and events that exist or don't exist depending on past experiences the individual learner has already experienced **(Bekhit & Ibrahim, 2012, 243)**.
- A process of creating and innovating new images through which we may retain the same objects which were absent or through which we may invent new images **(Mohamed, 2005, 134)**.

After extrapolating the previous studies, the researcher concluded the following points about imagination:

- It involves unleashing ideas without taking into account logic or reality surrounding the learner.
- The student may perceive an idea through imagination which has no existence; therefore it is one of the types of innovation.
- Retrieving previous images sometimes and using it for a new situation or subject may be useful in the present.
- A mental representation of objects or events which don't exist, which includes visual images as well as images associated with other areas and emotions.

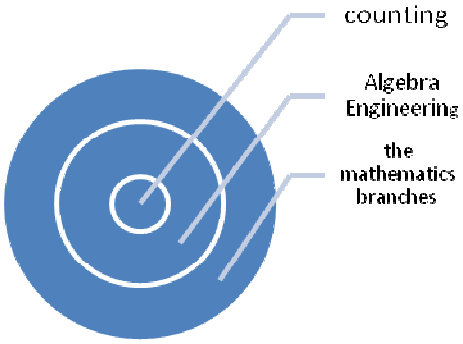
Accordingly, the researcher concluded the following definition for the skill of the imagination as "a mental activity resulting from retrieval processes for past experiences and concepts and an integration and assembling within the learner's memory to produce another new forms and concepts, measured by obtaining verbal or non-verbal responses from the learner expressed in forms and some simple processes in a measurement prepared specifically for this purpose.

As for the characteristics of the imagination skill, the studies conducted by **(Schunk, 2009), (Phillps & et al., 2010), (Bechara& et al., 2010), (Juhar& Younis, 2012)(Bekhit & Ibrahim, 2012)** pointed out that the characteristics of imagination are as follows:

- Imagination appears clearly in pre-school children.
- A higher mental process based on remembering to retrieve the mental images of past experiences.
- Appears in a new product by establishing new relationships and ideas from past experiences.
- Imagination provides the mind with things to think about, while knowledge and concepts provide the mind with tools to describe the outputs of this imagination, followed by modeling, transforming, understanding and using them.
- Imagination and creativity are considered two interactive mental processes; where imagination is the basis for innovation and creativity [imagination: a mental process of how things are likely to be, while creativity: a thinking pattern which integrates past experiences with new ones (which come from imagination) which results in other unfamiliar ideas.
- It helps the individual to go beyond the limits of reality, time and space, connects between the past by retrieving images, the

present by incorporating them with available things, and the future by imagining how objects and concepts will be.

- It is an expression for the mental image in creativity and thinking to solve different problems and situations.
- Literature of imagination indicates that it may disappear and diminish completely if it is not developed and enriched through well designed programs, despite its clarity at the age of 5-6 years.
- Imagination has its clear ratio in mathematics:



(Phillps& et al., 2010, 3)

Fig 1: Ratio of Imagination with respect to the areas of math

The nature of imagination and its mechanism:

Some researchers **(Partin, 2009, 217) (Bechara & et al., 2010)** tried to find the place of imagination process within the learner's mental processes group.

The closest perception is:

- Imagination is an automatic process which does not hold a reflective nature, and has no relation with the surrounding environment so it is free from it. It is considered a result of self-development, and is generated inside the individual as a spiritual power.

- Another perception believes that the process of imagination is considered a synthesis for the other psychological processes, where it may be a synthesis for the understanding and will, or a synthesis for the perception, memory and creativity.
- Or that imagination represents perceptions linking the past and the present in the broadest sense of these perceptions.

The assumptions of the process of imagination itself include:

- **Coincidence Assumption:** Assumption which believes that findings are considered the result of certain accidental perceptions, realizations and interpretations of the individual for the circumstances surrounding him in a certain situation.
- **Reconstruction Assumption:** Assumption which believes that imagination depends on mixing, reassembling and arranging emotions and perceptions in a trial and error way.
- **Model Assumption:** Assumption which believes that mental processes like thinking, perception and imagination are considered dynamic models of reality, where the cognitive aspect sets models for the outside world, and creates images for things that do not exist, which we may obtain through activity. It believes that imagination is responsible for controlling and creating a model to the world of things difficult to achieve through logic and reality.

In order not to get confused; we can say that thinking differs from imagination, where thinking aims to solve a specific problem, while imagination in its precise sense and higher mature image takes place of thinking, where it presents its fundamental basis by collecting, reorganizing and presenting the elements of past experience in a new form. Imagination thus contributes to thinking, and benefits in situations which need thinking to solve problems, which was confirmed by **(Lian, 2010, 1-8)** where he believes that imagination is a form of thinking that goes beyond the limits of reality determined by the society.

☒ Imagination process development stages:

After extrapolating some literature of imagination **(El-Shemi, 2011)** and **(Lian, 2010, 1-8)**, we can distinguish four stages in which the process of imagination develops:

1. **The stage of delusion (3-5 years):** Delusive imagination in which the child doesn't perceive things as they are and his imagination is limited to the environment where he lives.
2. **The stage of free imagination (5-8 years):** A student imagination tends to go beyond the surrounding environment and the reality he lives, his curiosity grows, his imagination becomes centered around things and concepts, and his passion for imaginary and realistic stories increases [It is the most closest stage to the current research, therefore the current research tends to use these processes on concepts and abstractions in mathematics through the digital story, through which these concepts and abstractions may speak in the context of well prepared activities and lessons].
3. **The stage of championship (8-12 years):** In this stage, the student is interested in reality and facts, rushes upon games which require a skill, his thoughts become centered around championship and adventure, and leaves excessive imagination.

4. **The stage of idealism (12-15 years):** In this stage, the individual moves from realism to idealism, and tends to read more stories.

Most studies suggest that the ability of the individual to imagine begins to diminish and decline when he is nine years old. As a result, it must be surrounded by care and development through well designed and prepared programs, which is sought by the current research, where the process of imagination adds to the learner's thinking, where some studies suggest that imagination is a key partner in building higher-order thinking skills. In addition, it integrates past perceptions and reassembles them in images closer to reality as a beginning for everything in the learner's cognitive structure.

☒ **Imagination process types:**

Lian **(2010, 1-8)** suggests that imagination processes have various types, which can be classified according to the nature of imagination, its purpose, and so on, and can be reviewed in light of :

1. The nature of imagination:

- **Reproductive Imagination:** It means retrieving images and experiences related to a subject without modifications mentioned, like the retrieval of an image of a pyramid or a cone without identifying the pyramid or the cone, where it depends here on the information and the experiences of an individual and his mental image and the scope of its capacity and variety which allows him to retrieve them from the memory. It depends also on the situation which evokes related images and ideas.
- **Creative Imagination:** It means assembling the mental images of past experiences with one another, and producing

new images from them characterized by authenticity (unfamiliar and unduplicated)

A creative imagination is closer to the study of mathematics which appears within it through several methods:

- **Affixation:** Affixing or combining two figures or more to obtain a new image.
- **Confirmation:** Focusing on a certain idea or aspect of a situation or something, just like in cartoons.
- **Modeling:** It depends on a model repeated in reality just like in characters' stories.
- **Measuring:** It means assembling images which look like things in reality.

- **Emotional Imagination:** It means ordering images of past experiences according to the emotional attitudes and willingness not depending on a base or logical link, through which he composes sentences and ideas which are blended together, which is a form of emotional imagination.
- **Anticipatory Imagination:** It means imagination which tends to anticipate the future especially those related to the achievement of a certain goal, or the imagination of a process or movement or step which may contribute to the achievement of a certain goal or reaching a conclusion to solve a problem in mathematics.

2. The purpose of the process of imagination:

- **Intentional Imagination:** It is an imagination which is directed towards the achievement of a clear emotional goal to form mental images of experiences, therefore the effort and activity performed by the individual is voluntary and intentional to achieve the goal and to achieve the task, as in the reproductive and creative imagination.

- **Unintentional Imagination:** Mental images are formed here without seeking to achieve a specific goal.

3. **The subject of the process of imagination:**

- **Technical Imagination:** In order to produce a technical work, taste it and understand its meaning.
- **Scientific Imagination:** It occurs in some hypotheses to find new facts and imagine the ways which achieve the validity of hypotheses as for scientists and their inventions.
- **Practical Imagination:** In order to master and control any crucial work or subject like the imagination of the shape of a particular machine.
- **Philosophical Imagination:** As the philosopher who goes beyond the limits of science, organizes and arranges postulates through his point of view to reach certain views.

☒ **Developing the imagination skill in mathematics:**

The study of **(Bechara & et al., 2010)** emphasized that the skill of imagination appears clearly with a pre-school child (3-5 years) where we find him begins to create ideas through which he approaches life situations to the extent that he sometimes get confused, then the skill grows as shown in the process of imagination development stages until it diminishes again as pointed by most related literatures. As imagination is an essential part of forming the conceptual thinking and activity of the individual learner and is linked to learning before the process of speaking itself and language acquisition, some studies **(Salem, 2009) (Mansy & Al-Mounir, 2011) (Bekhit & Ibrahim, 2012) (Juhar & Younis, 2012)** emphasized that it is possible to develop the skill of imagination through learning and training according to the following:

- **Learning through reality:** It involves using experiences related to reality. It involves also processing reality, interacting with it and identifying the characteristics of these experiences and playing with them.
- **Learning through reality to provoke perception and build cognitive concepts**: It involves providing realistic and concrete experiences related to the learner's senses [like the concepts which exist in our daily life where the rectangle is represented by the door, and so on ...].
- **Learning through pictures to provoke perception about cognitive concepts:** It involves using physical images and certain methods: Models of numbers, symbols, figures, drawings and slides for relationships and concepts, and others.
- **Learning through pondering to provoke perception and build cognitive concepts**: An individual exercises imagining things and representing it using certain words and symbols. It is an advanced type of developing the skill of imagination methods.
- **Learning through abstract pondering:** An individual's thinking tends to be above abstract thinking which applies to imagining a group shape, ellipses and hyperbolas in mathematics which tend to abstraction.

Accordingly, the researcher believes that the closest methods of developing the skill of imagination here are those related to images to provoke perception about the cognitive concepts; where the use of digital stories which are based on some mathematical concepts and relationships based on actual reality the learner experiences in the primary grades stage taking advantage of modern technology characteristics in setting concepts and terms in images closer to the learner where:

- Imagination of a child in the primary grades stage takes a new curve due to openness in light of innovations and technological development, so they must be linked with what they imagine to happen, which opens wide horizons of imagination and innovation **(Bekhit & Ibrahim, 2012)**.
- For the required imagination to occur, the learner must see, hear and get impressions about some abstract concepts and relationships in mathematics, and keep them in his memory, provided that they address a number of senses; the more information he has and the richer his life experiences about abstract concepts are; the more diversified his impressions will be, and the more abilities he will have to assemble images, and his imagination will be excellent and creative **(El-Shami, 2011)**.
- The learner at this stage is interested in mental images other than those drawn for him by others or those drawn by his imagination of limited experiences related to his own classroom environment or limited cognitive structure, where he proceeds with his imagination to stories which may take him to distant horizons [concepts which speak, tell, or moves in unfamiliar places].

☒ **The importance of the skill of imagination in teaching mathematics:**

After extrapolating some studies **(Shine & Saleh, 2010) (Juhar & Younis, 2012)**, the researcher concluded the importance of the imagination skill in mathematics:

- **Increasing the cognitive mastery:** Using the activities of imagination helps the individual to increase his knowledge of basic issues and concepts, develop some technical and manual skills associated with these concepts, which is considered an essential and effective element in the thinking and mental activity system of the individual.
- **Ability of the learner to think freely:** It reflects the learner's imagination about the existing concept that cannot be reached, as well as the nonexistent term or relationship, which means that he goes beyond the limits of reality, time and space moving objects, concepts, relationships, numbers, and other things with him.
- **Ability of the learner to solve problems and situations:** Activating the skill of imagination means analyzing the mental image he has and reassembling it to reach a new form or idea which fills the gap about a certain concept or relationship or solves a certain mathematical situation which needs the new perception obtained by the learner.
- **Imagination's correlation with the retrieval of stored images** about some concepts and reassembling them means that imagination is the holographic perception of concepts and the activation of performance and creativity around it.
- **Ability of the learner to represent reality:** Some attitudes and perceptions can be represented through the activities of the imagination skill through a perceptual representation of reality. Accordingly, the learner exercises how to form concepts in mathematics in light of this representation in different attitudes and situations.
- **Developing the ability of the learner to expect:** Where training the learner to imagine the steps or procedures of

establishing a mathematical concept or relationship or solving a mathematical problem, and accepting his views without judging or criticizing them contributes to the development of his ability to forecast the solutions for some mathematical situations later.

- ♦ **Imagination provides the learner's brain in mathematics with stored relations, concepts and images.** We can describe the results of this imagination including new models, relationships and drawings in mathematics through his cognitive structure.
- ♦ Both **(Ambo Saaidi & El-Baloushi, 2011, 324)** suggest that imagination in mathematics helps in:

- Approaching abstract concepts and precise processes of various phenomena.
- Thinking deeply of the mathematical concepts and figures.
- Enriching the mental images of the learner which is considered the basis for the process of generating creative ideas.
- Developing the learner's motivation by changing the routine, and giving him a sense of the enormous inventory of mental images he has.
- A study by **(Helen, 2014)** proved that imagination develops mathematical probabilistic thinking of the learner.

Some studies came to refer to the skill of imagination in the educational process, including the study of **(Abu-Riash & El-Safi, 2005)**, which aimed to identify the impact of a training program based on directed imagination in developing self-efficacy among a sample of (100) students in the fourth primary grade in Jerash governorate at Jordan. Its results confirmed the effectiveness of the training program based on directed imagination in developing perceived self-efficacy for the experimental group other than the control one. The study of **(Salem, 2009)** aimed to identify the effectiveness of education based on directed imagination in developing the skills beyond the knowledge for a sample of (100) schoolgirls at the elementary stage in Mecca. The study revealed the presence of statistically significant differences in favor of the set of students who studied by the strategy of directed imagination on a self-report scale (which was prepared by the researcher for skills beyond the knowledge).

In the field of mathematics, the study of **(Juhar & Younis, 2012)** came, which aimed to identify the impact of training on the mathematical problem using a strategy supported by directed imagination to solve the problems of physics for students in the preparatory stage on a sample of (59) students in the fifth grade at the central school of Mosul. The results revealed the presence of statistically significant differences between the two groups of research in the test of solving the problems of physics in favor of the group supported by directed imagination, The study of **(Helen, 2014)** aimed to develop a strategy to develop creative imagination in certain mathematical skills such as differentiation and establishing life attitudes for the geometric figures in the activities of the third and fourth primary grades to compensate for the abstraction of concepts and terms upon which these skills are based, The study of **(Arielle, 2015)** was an analytical study which aimed to transform mathematics and its content in the primary stage into acceptable logic for the child learner through a renewed imagination based on the intuitive nature of mathematics around us without relying on specific teaching methods. Actually, the study was able to analyze numerous studies about the concept of imagination in mathematics, where it confirmed the reliability of some intuitions and life attitudes that can be used in developing some aspects of imagination. Finally, it pointed the reliability of technology in representing some attitudes, concepts, and complex relationships for the young child in the primary grades stage.

The study of **(Patras, 2015)** addressed how to develop plans for moderate imagination in mathematics for the primary school. The study incorporated a lot of plans as a kind of support for the child's imagination at this stage, some of which can be implemented in participation with the teacher while others seem more complex which need a specialist in the areas of teaching methods and psychology. The study emphasized that it is not necessarily to adhere to these plans where they are considered a kind of directed training for primary school students. It also noted that the classroom environment plays an important role in developing the skill of imagination, that digital environments which rely on advanced technology may play a role in developing imagination in certain natural sciences associated with reality and the daily life of the student. It also incorporated mathematics specifically among these sciences.

- **Numerical intelligence in mathematics:**

Mathematics is a universal language which derives its letters from the numbers of counting, its words from numbers, its mathematical phrases from organizing different operations and identifying numerical relations. We can enrich this language by perceiving and developing this system. Its reliability depends on its usefulness and the ability to employ it in different situations. Mathematics is that branch which examines numerical systems, situations, relationships between numbers and related mathematical operations [Addition – Subtraction – Multiplication

- Division]. It is interested in the numerical system which is developed historically by the development of humanitarian thought.

☒ **The concept of numerical intelligence:**

Some studies write "numerical intelligence ... or ... logical mathematical intelligence" without referring to any differences. As a result, the researcher believes that he must start from numerical perception and computational performance due to the accuracy of relationship between both and numerical intelligence, where all of them are basically part of logical mathematical intelligence:

With the rapid scientific developments and with adopting the idea that numbers have several representations and images never introduced before over the ages of mathematics in a way expressing the need for it, the National Council of Teachers of Mathematics **(NCTM)** in the years (1989, 1991, 1995) announced adopting the concept of numerical perception and computational performance under the headings:

- Fifth criterion: The relationship between numbers and numerical perception.
- Seventh criterion: Calculation, Estimation, and Computational Performance **(El-Khatib, 2011, 2285)**.

Numerical Perception: It is a kind of thinking used to describe the process of mental calculation and the ability to acquire basic facts and skills, solve numerical problems. It has features outlined without details in [perceiving the significance of numbers - perceiving the impact of operations on numbers – the numerical mark differentiating numbers].

On the other hand, the **computational performance** refers to the necessary steps required to reach the result of arithmetic calculations accurately and precisely, while the **numerical situation** refers to new and distinct problems which talk about practical life which often come in a test of numerical situations prepared in advance.

In light of the above points, the study of **(El-Maghrabi, 2012, 37)** suggests that the concept of numerical intelligence is a natural progression for those outlined concepts, where numbers have several representations, images and faces. Understanding numbers therefore includes perceiving not only the number but also the complex system of interrelationships including (greater than and smaller than), differentiating relationships and patterns between concepts and numbers, and how to use numbers to get out of a certain situation in mathematics.

As pointed out by **(Ali, 2005, 269)**, logical mathematical intelligence is the use of numbers effectively and differentiating relationships between concepts. The study of **(Badr, 2003) (Morgan, 2005) (Hafid, 2013)** agreed with Ali that logical mathematical intelligence includes the ability to logical and numerical reasoning and thinking cognitively in the models of numbers, and that it includes pre-number concepts such as classification; there is no doubt that numerical intelligence is an essential part of logical mathematical intelligence where it has its characteristics and determinants, both together are part of general intelligence known as multiple intelligences by Gardner **(Gardner, 2005)**.

After extrapolating some studies **(Ali, 2005) (El-Khatib, 2011) (El-Maghrabi, 2012) (Hafid, 2013)**, we can conclude some common characteristics between numerical intelligence and logical mathematical intelligence:

- Ability of the individual to use numbers effectively which appears in its abstract relations, classification, summarization and generalization.
- Differentiating the relations linking numbers by using reasoning, deduction and logic.
- People who have this (numerical – logical mathematical) intelligence tend to: work with numbers, think about what connects them and analyze the mental calculation processes and their accuracy.
- A good understanding of numerical systems and dealing with every day or life numerical situations the learner experiences well.
- The presence of underlying skills such as: classifying, arranging, and performing various calculations
- They represent effective communication between mathematics as activities and exercises, and the numerical situations which may appear in life activities in mathematics.

Accordingly, we can define numerical intelligence as "the ability which expresses reasoning between numbers, perceiving the interrelationships between them, and the possibility of concluding information linking them" **(El-Khatib, 2011, 7)**.

In addition, **(EL-Maghrabi, 2012, 5)** defines it as: "the logical mathematical intelligence itself and one of the multiple intelligences by Gardner which means the ability to deal with information about objects, numbers and logical mathematical abstract relations and the ability to carry out a complex series of reasoning and inductive thinking."

The researcher defines it as "a part of logical mathematical intelligence which includes only some abilities depending on numbers and the relationships between them like classification, arrangement and summarization more clearly. It is linked to mental calculation and perceiving the significance of numbers and operations related without addressing the computational performance and its steps. It also goes beyond this to the understanding of the numerical system which appears in the results of mathematical activities in the connection between mathematics as a science and daily life activities".

As for the studies which only addressed numerical intelligence in mathematics, they are few as far as the researcher knows. Most studies which were few focused on logical mathematical intelligence due to the confusion between the concept of numerical intelligence and the concept of logical mathematical intelligence like: The study of **(Ali, 2005)** which aimed to build a model for numerical perception development and to identify its impact on logical mathematical intelligence among primary school students. The study of **(El-Khatib, 2011)** which included numerical intelligence only and referred to it in its similarity with numerical situations in mathematics when it examined the impact of using the problem-solving strategy on numerical perception, computational performance and numerical situations on a sample of (100) students at the six primary grade at Jordan. The findings of the study showed a positive impact for the strategy on numerical perception, computational performance and numerical situations in mathematics. The study of **(El-Hifnawy, 2010)** which aimed to identify the effectiveness of a proposed computer program to develop (logical mathematical intelligence - visual intelligence) among students in the primary grade of basic education. The study of **(Hafid, 2013)** which aimed to use the visual approach with the help of a computer in developing logical mathematical intelligence among preparatory school students. No study identified the concept of logical mathematical intelligence except the study of **(El-Maghrabi, 2013)** which aimed to study the relationship between numerical intelligence, numerical perception and achievement for students in the seventh basic grade in mathematics in Hebron governorate, where the study confirmed the presence of a positive correlated relationship between them.

Some studies however sought to develop the concept of number through the (classification, sequence, arrangement, combination, symmetry) skills as certain features which reflect numerical intelligence as agreed by previous studies in this field, including the study of **(Abd-ElWarith, 2008)**, which aimed to identify the effectiveness of a computerized program to develop the (classification, sequence) concepts among children with mental disabilities. The results showed the effectiveness of the program in developing classification and sequence concepts which are included within the learner's number concept, which is a part of numerical intelligence as has been identified previously. The study of **(Saeed, 2010)** used an educational portfolio to develop the learner's performance with regard to the concept of number (symmetry, arrangement, ...). Its results showed the effectiveness of the bag in developing the concept of number and its operations for the targeted group of the study in the experimental group.

Foreign studies paid attention to numerical intelligence as a relational variable with other mathematical variables, where the study of **(Passolunghi & et al., 2014)** aimed to examine the relationship between the learner's digital memory and his abilities to remember mathematical concepts, as well as the relationship between numerical intelligence and mathematics achievement. Its results showed that the digital memory has a direct impact on the individual's mathematics achievement, that the numerical intelligence is considered a direct interpretation of digital memory and that there is no correlated relationship between it and achievement. Also, the study recommended making designs proposed by the math teacher to develop the learner's digital memory as a new pattern to develop his numerical intelligence in mathematics which affects his mathematical abilities latter.

(Gilmore & et al., 2010) examined how the child learns numerical intelligence and its relation with direct counting and classification skills and the use of mathematical words and rules: The researcher found that numerical intelligence among them was not significantly affected through two experimental groups where he attributed this to the cultural and social backgrounds of the two groups, the learner's symbolic background and the way of writing the number from the beginning which may affect his numerical intelligence where he emphasized that it is linked to the learner's cognitive backgrounds with regard to images and experiences.

The study of **(Carmen & et. al., 2014)** appeared which aimed to determine the effect of numbers on offering solutions for mathematical problems through the child's ability to develop a simplified map for the solution through the two groups (a group which relied on matrices for the solution and alternative solutions, and a group which relied on direct numbers through numerical relations about solutions). The results showed that matrices' solutions only give a beginning for the solutions while numerical relations were better in completing solutions and reaching their end.

The study of **(Desoete & Gregoire, 2015)** aimed to examine the numerical abilities of children with learning difficulties in mathematics especially their numerical intelligence. It emphasized through measurement that their numerical intelligence ratios range from 50 % - 60 % but they failed however in some reasoning abilities which need a cognitive background related to numerical intelligence basis. The study pointed out that numerical intelligence is considered the source of the learner's abilities in most forms of mental calculations and various numerical situations.

The researcher concluded the following from the past studies:

- Arabic studies which focused on numerical intelligence were few which appeared inclusively with logical mathematical intelligence like: The study of **(Ali, 2005)** which aimed to build a model for numerical perception development and to identify its impact on logical mathematical intelligence among primary school students. The study of **(El-Hifnawy, 2010)** which aimed to identify the effectiveness of a proposed computer program to develop (logical mathematical intelligence - visual intelligence) among students in the primary grade of basic education. The study of **(El-Khatib, 2011**) which included numerical intelligence only and referred to it in its similarity with numerical situations in mathematics The study of **(Hafid, 2013**) which aimed to use the visual approach with the help of a computer in developing logical mathematical intelligence among preparatory school students. No study identified the concept of logical mathematical intelligence except the study of **(El-Maghrabi, 2013)** which aimed to study the relationship between numerical intelligence, numerical perception and achievement for students in the seventh basic grade in mathematics.
- While foreign studies focused on the relation between numerical intelligence and other mathematical variables, and how it develops also like: The study of **(Passolunghi & et al.,**

2014) which aimed to examine the relationship between the learner's digital memory and his abilities to remember mathematical concepts, as well as the relationship between numerical intelligence and mathematics achievement. The study of **(Carmen & et al., 2014)** which aimed to determine the effect of numbers on offering solutions for mathematical problems through the child's ability to develop a simplified map for the solution. The study of **(Gilmore & et al., 2010)** which examined how the child learns numerical intelligence and its relation with direct counting and classification skills and the use of mathematical words and rules. The study of **(Desoete & Gregoire, 2015)** which aimed to examine the numerical abilities of children with learning difficulties in mathematics especially their numerical intelligence.

Therefore, it seems that there is a lack of studies which focus on the concept of numerical intelligence solely without the remaining multiple intelligences especially in the field of learning mathematics, and given the importance of numerical intelligence in developing and perceiving numbers and the relations between them, which is the basis for building the mathematical knowledge, which may appear in life situations of mathematics especially in the early stages of education (primary grades); the researcher found an opportunity to study the impact of digital story in mathematics on developing the numerical intelligence of students in this stage.

❖ **The (impulsive/reflective) cognitive style:**

☒ **The concept of numerical intelligence:**

The cognitive style explains differentiation between individuals in different cognitive processes. The more differentiated the individual's cognitive structure is, the more ability he will have to respond in a distinctive way in different educational situations, while the lower differentiated the individual is, the less correlation his response is. This differentiation is not limited to different cognitive processes (like thinking, remembering, composing and dealing with information) through which we acquire information, but also in the way of acquiring and processing the information itself.

There are a number of cognitive style classifications, including:

- Field Independence vs. dependence.
- Cognitive Simplicity vs. Cognitive Complexity.
- Risk Taking vs. Cautiousness.
- Impulsivity vs. Reflectivity

(Ibrahim, 2011, 8) believes that the individual is considered **impulsive**: If the time he takes to perform the test is less than the average with committing a number of mistakes more than the average, while the individual is considered **reflective**: If the time he takes to perform the test is more than the average with committing a number of mistakes less than the average.

The current study addresses the impulse style versus the deliberation style. We can say that individuals who tend to ponder the alternatives available for solving in educational situations - and commit the fewest number of mistakes are called (analytic individuals), and that individuals who give immediate and rapid responses for the same situation - and commit a larger number of mistakes in their attempt to reach the correct answer are called (holistic individuals) **(Kabli, 2011)**.

After extrapolating some studies and literatures **(Ibrahim, 2008) (Fawaz, 2009) (Kabli, 2011)**, the researcher concluded the following about the concept of impulsive and reflective in the cognitive style:

- The tendency of an individual to respond in a distinctive and specific way in problems solving situations where a large number of responses are available.
- The tendency of an individual to respond quickly when he faces risks. The responses of impulsive are often incorrect because they inaccurately deal with alternatives leading to solutions. On the other hand, the reflective ponder and examine inputs and alternatives in the situation, deal carefully with alternatives and check them before answering.
- The cognitive style is linked to the tendency for deliberation or impulse before responding to a problem or issue solving task with specific answer.

The researcher concludes the following definition for the (impulsive/reflective) cognitive style : A variable through which we can distinguish between those who contemplate a solution for an idea or activity before confirming it, and those who respond immediately for the first solution occurs to him, and expresses the individual's special way in dealing with information, whether receiving or expressing them. It is measured on the basis of two dimensions (latency/ accuracy), the learner with a cognitive style (impulsive) is the one who tends to respond rapidly to situations and commits larger number of mistakes, while the learner with a cognitive style (reflective) is the one who tends to give a response after a suitable amount of time in contemplating the essence of the available alternatives in solving the new situation, and commits fewer number of mistakes.

☒ The characteristics of individuals with the (impulsive/ reflective) cognitive style:

There is a set of features and characteristics which distinguish between cognitively impulsive and reflective individuals including: **(Ibrahim, 2008) (Fawaz, 2009) (Kabli, 2011)**

- A reflective person (before answering) distinguishes the basic parts of the mathematical concept or situation and reviews the model studied to determine whether this feature is the same or different from the one in the model; while an impulsive compares the figure or the concept with the model in a comprehensive manner without reviewing details.
- An impulsive person is characterized by rashness and inaccuracies in solving, while a reflective tends to reflectiveness with more accuracy.
- An impulsive person is better than a reflective cognitively in distributing attention between all existing alternatives for the solution and in comparing between these alternatives which helps him to reach the correct solution with the fewest number of attempts and mistakes.
- A reflective person commits fewer mistakes on the (impulsivity/ reflectivity) test, while an impulsive commits more mistakes during his attempt to reach the correct answer in the different learning tasks.
- A reflective student examines alternatives well and devotes more time to consider all available alternatives before giving responses, while an impulsive identifies an alternative as it is correct without regard for the remaining alternatives.

- An impulsive student cognitively achieves less than a reflective colleague, and his efficiency in the cognitive skills is lower.
- A reflective student can collect similar things in a more distinctive way than the impulsive one.
- A reflective student focus on the quality of performance and attitude more than the rashness in response, while an impulsive one is moved by the rashness in response.
- A reflective student is more flexible than the impulsive one; where he can change his responses and his way according to the teacher's requirements and the nature of the task or activity itself.

A question arises here about whether the "reflective" cognitive style dimension is better than the impulsive one in accuracy and shape of response without errors, which is related to cognitive achievement. Is there a relation between this and the imagination skill in mathematics or numerical intelligence linked to the patterns, the shape and nature of numerical situations. Is it possible to modify the impulsive behavior through: a digital story in mathematics which helps him to exercise postponing quick responses and a closer look at the details of the mathematical situation or concept before judging or answering a question in a certain educational situation?

☒ **Measuring the (impulsive/reflective) cognitive style:**

The researchers used two dimensions in the field of cognitive style to measure impulse and deliberation:

- **Latency dimension:** It means the time which elapses in the first attempt by the individual to respond.

- **Accuracy dimension:** It determines the number of mistakes committed by the individual in his attempt to reach the right solution.

(Ibrahim, 2011) concluded after a series of researches how to measure the (impulsive/reflective) cognitive style using MFFT (Matching Familiar Figures Test) which consists of familiar figures which suit the age of the learner, where he concluded three images:

1. A test which suits adult individuals.
2. A test which suits primary school children.
3. A test which suits pre-school children.

Since the number of alternatives and their difficulty level varies in the three tests' terms and because performance requires the individual to match between a standard figure and several alternatives for the same familiar figure with the presence of one figure among them which exactly matches the standard figure and with the remaining alternatives varying in precise elements, the researcher used a stopwatch to determine the time taken in the first response for each term [i.e., the time of the first choice in each term] as well as the number of mistakes on each term.

Based on the total latency time for each term, and the total number of mistakes on each term, the members of the sample are classified into groups as follows:

- **Impulsive Individuals:** who spend latency time lower than the average latency time of the members of the sample (group) and commits a number of mistakes more than the average number of mistakes of the members of the sample.
- **Reflective Individuals:** who spend latency time higher than the average latency time of the members of the sample

(group) and commits a number of mistakes less than the average number of mistakes of the members of the sample.

- **Fast-Accurate Impulsive Individuals** (who are characterized by speed with accuracy): A group with a latency time lower than the average latency time of the members of the sample and a number of mistakes less than the average number of mistakes of the members of the sample.
- **Slow-Inaccurate Reflective Individuals** (who are characterized by slowness with inaccuracy): A group with a latency time higher than the average latency time of the members of the sample and a number of mistakes more than the average number of mistakes of the members of the sample.

The current research is limited to cognitively impulsive and reflective individuals only and excludes fast-accurate impulsive and slow-inaccurate reflective where their classification lies outside the limits of the current research.

Many studies have been conducted to identify the relationship between the (impulsive/reflective) cognitive style and certain variables in the field of teaching mathematics, including:

The study of (Amziane, 2000) which aimed to identify the relationship between the cognitive style and mathematics achievement among a sample of children at the first primary stage (6-7 years). The results of the study showed statistically significant differences due to differences in the cognitive style where differences were in favor of independent students (reflective in the cognitive style).

On the other hand, the study of **(Zhang, 2004)** aimed to study the (impulsive/reflective) cognitive style and its relation to mathematics achievement, where the study showed no significant differences between impulsive and reflective in mathematical achievement. The study of **(Jardat, 2005)** agreed with this study which aimed to study the impact of the cognitive style on achievement and mathematical thinking among a sample of schoolgirls at the middle stage at Jordan. The study showed statistically significant differences between the two groups of research in mathematical thinking in favor of reflective. On the other hand, there were no differences between impulsive and reflective in mathematical achievement.

In the same context, the study of **(Mahmoud, 2006)** came, which aimed to study the emotional intelligence and the academic achievement in light of the (impulsive/reflective) cognitive style for students at the faculty of education at the University of Alexandria - mathematics specialization. Where the study showed statistically significant differences in both emotional intelligence and academic achievement due to differences in the cognitive style. The results were in favor of cognitively reflective students.

It also agreed with the study of **(El-Shorbaji & El-Wakil, 2009)** which aimed to study the impact of the (impulsive/reflective) cognitive style on mathematics achievement among primary school students in the fifth grade. The study also showed that reflective students were better than impulsive ones in mathematical achievement.

As to the relationship between the (impulsive/reflective) cognitive style and certain computerized programs in the educational process:

The study of **(Ibrahim, 2008)** came which aimed to use a computerized program (supported by the habits of memorization) among (impulsive – reflective) students to develop the achievement and using the Web skills. The results of the study showed differences in favor of cognitively reflective students (in using the Web skills and the cognitive achievement dimension).

The study of **(Ahmed, 2008)** agreed with this study which aimed to identify the (impulsive/reflective) cognitive style with the most useful educational hypermedia programs (active versus normal). The results showed that students with a cognitive style (deliberation) achieved better results in learning through educational computer programs compared to students with a cognitive style (impulse). On the other hand, the study of **(Attia, 2008)** showed no differences between impulsive and reflective students in the efficiency of the skilled performance associated with the cognitive aspect of learning through educational computer programs.

In another study **(Ibrahim, 2011)** which aimed to identify the difference between computer programs and the (impulsive/reflective) cognitive style in developing achievement and certain computer skills for primary school students in the fifth grade, the researcher also found that there was no statistical significant difference in achievement in the computer course due to the difference in the (impulsive/reflective) cognitive style , where he found the difference only in skills which were in favor of reflective students. In addition, the study of **(Zidane, 2011)** showed differences between the averages of the two sets of research due to the difference in the (impulsive/reflective) cognitive style in immediate and delayed achievement in science in the six primary grade where reflective students were better.

The researcher concluded the following from the past studies:

- There is clear contradiction between the research results about the impact of the difference in the (impulsive/reflective) cognitive style . Some studies pointed out the presence of a difference in certain variables due to the cognitive style like [**(El-Amin, 1997)** There are differences in the performance of teachers in favor of cognitively reflective - **(Amziane, 2000)** There are differences in mathematics achievement in favor of cognitively reflective - **(Jardat, 2005)** There are differences in mathematical thinking in favor of cognitively reflective - **(Mahmoud, 2006)** There are differences in both emotional intelligence and academic achievement in favor of cognitively reflective - **(El-Shorbaji & El-Wakil, 2009)** There are differences in mathematics achievement among primary school students in the fifth grade who are cognitively reflective].
- Other studies however showed no differences between the two styles like [**(Zhang, 2004)** There are no differences in mathematics achievement between impulsive and reflective in the cognitive style – **(Jardat, 2005)** There are no differences between impulsive and reflective in mathematics achievement among middle stage students - **(Attia, 2008)** There are no differences between impulsive and reflective students in the efficiency of the skilled performance associated with the cognitive aspect of learning through educational computer programs - **(Ibrahim, 2011)** There is no statistical significant difference in achievement in the computer course due to the difference in the (impulsive/reflective) cognitive style]
- As a result, the current research found an opportunity to study the impact of interaction between the digital story in mathematics and the cognitive style (impulse versus deliberation) on the two dimensions of mathematical

imagination and numerical intelligence in mathematics, which has not been examined before by past researches as far as the researcher knows.

❖ The experimental framework of the research

- In order to validate the research's hypotheses and answer its questions, the researcher adopted the following procedures:

First: Choosing the educational content: A unit "operations on numbers" studied by primary school first graders, the second semester 2016/2017 has been chosen. The reasons for choosing this unit:

- ♦ The unit contains a set of concepts and operations on numbers in a way which is appropriate for the nature of imagination in mathematics and the degree of need for it: like establishing new relationships from previous experiences (where numbers have been studied by students in the first semester) so that they organize those experiences in figures and images which are unfamiliar for the individual; highlighting what has been formed in the imagination by combining and assembling images to form the imagined object (a new image for the concept or the relationship). It is also a mental process which enables the individual to generate multiple responses to specific stimuli (previous concepts) with the availability of prior knowledge for the individual about situations for certain ideas which enables him to exercise imagination in an appropriate manner. It is a pictorial process which helps the individual to understand some characteristics of objects or concepts. Accordingly, when objects and concepts are characterized by simplicity and lack of details, it is possible to retrieve their images easily than most complicated objects.

- The unit contains some numerical operations and relationships appropriate for the nature of numerical intelligence in mathematics which includes solving some numerical problems, and the possibility of getting out of various numerical situations including [describing mental calculation operations, acquiring basic facts and skills, searching for the results of operations, and how to get out of mathematical situations using numbers] through activities reflecting the communication between mathematics and life, which can be offered in the unit "operations on numbers".
- The unit is considered one of the best units that can be processed through the digital story style where there is a possibility to advance in the scenario content smoothly and tightly to facilitate the process of finding the content which contains a technological panel (multimedia) with an educational dimension related to the nature of mathematics where processing seeks to get it out of abstraction.
- The period of teaching the unit is suitable which offers a full opportunity for training on the skill of imagination and numerical intelligence in mathematics through activities and representations available for numbers and their operations.

Second: designing the unit in light of the digital story in mathematics with animated bilateral and trilateral figures:

The researcher adopted a set of procedures and stages to ensure a well-designed educational unit in light of the digital story. These procedures include the following:

✓ **The stage of study and analysis which included:**

1. **Identifying the characteristics and needs of learners:** Since they are primary school students at the first grade who didn't

previously experience any teaching method based on digital technology in learning mathematics, whose experience seems to be limited in term of concepts and relationships presented within the numbers unit, the content represents a new experience for them, the operations on numbers therefore with the possibility to deal with them in different issues and situations in a way unfamiliar to use in practical life seems to be an important educational need, the need to retrieve them in various images and to identify relationships that connect them; all are important in the stages of learning mathematics later.

2. **Identifying the sources and resources** that have been relied upon to produce a digital story with good specifications: The research adopted LCMS "learning content management system" and a classroom environment depending on technical tools including an educational computer for each learner, earphones and the possibility of a standard vision with enough space for all.

- ✓ **The stage of design:** After determining the educational content (which is the concept of numbers and some operations on them), a digital story has been designated for the content with its own objectives, elements and concepts, mathematical activities, guidelines on how to deal with it and with its associated activities. After that, the content has been designed on this basis.
- ✓ **The stage of preparing the scenario:** The researcher extrapolates all the available scenarios designed for digital stories with bilateral and trilateral forms especially in the field of mathematics. In light of the recognized standards and

rules[4], and the technical and educational criteria for its design, he produces a scenario for the digital story:

Table (2): Part of a digital story scenario

Screen No.	Screen	Animated images and drawings	Sound	Depending and Interacting	Remarks
1	Clear	A main design for numbers from 1 to 10 with exercises: Number 0: Exercise on number 0 Numbers 1, 2, 3: Exercises on numbers 1, 2, 3 Numbers 4, 5: Exercises on numbers 4, 5 Numbers 6, 7, 8: Exercises on number 6, 7, 8 Number 9, 10: Exercises on numbers 9, 10		Number 0: Exercise on number 0 Numbers 1, 2, 3: Exercises on numbers 1, 2, 3 Numbers 4, 5: Exercises on numbers 4, 5 Numbers 6, 7, 8: Exercises on number 6, 7, 8 Number 9, 10: Exercises on numbers 9, 10 Index Key Previous Key Next key Reset Key Switch Off Key Sound Exit Key Exercise on each group of numbers- Exercises	Introduction - backgrounds relevant to each subject and the age group (5-6 years) and the word "numbers" is fixed in all screens to the left

- ✓ **The stage of production and development:** In this stage, the researcher used a number of programs to produce a digital story unit:
- **Adobe Flash Program:** some animated and fixed images were portrayed from the nature surrounding the learner, while other images obtained from the internet were processed and edited in producing a digital story.
- **Audio Recorder Program:** In order to produce a sound which accompanies concepts and relationships.

[4] You can go back to the attachment (1): The digital story evaluation form for the unit of numbers and operations on them for the first primary grade

- **Word2Pdf Program:** In order to write the number in different formats and positions.

- **The following has been taken into account:**

- The size of concepts, numbers and its displaying time should approach and be relevant to the age group.
- The number of operations on each screen should not exceed two operations.
- The learner should not be exhausted by expanding the duration of knowledge and lengthy presentation on each screen for more than 4 minutes so that he doesn't get bored and starts absent-mindedness.
- Inputs should be diversified between each screen and another.
- This has been taken into account clearly which will appear during the accompanying digital story presentation in the USB.

✓ **The stage of experimentation and evaluation:** The unit has been presented at this stage in light of the digital story to a group of specialists [professors at teaching mathematics methods and education techniques] to ensure its appropriateness for achieving the goals and the quality of unit design and production. It has been presented to a group of primary school teachers to identify their opinions in light of their proximity to the age group. After implementing all the required instructions and guidelines, the unit of numbers and operations on them in light of the digital story with animated bilateral and trilateral dimensions became ready for the final application.

Third: Setting the research tools:

1. **The numerical intelligence test in mathematics for primary school students at the first grade [prepared by the researcher]**

- The test aims to measure the extent of acquiring some numerical intelligence abilities by students after studying the unit by using the digital story.
- The terms of the test have been formulated in light of the extrapolation of some previous studies for numerical intelligence **like (El-Maghrabi, 2012) (Passolunghi & et al., 2014) (Carmen & et al., 2014) (Desoete & Gregoire, 2015)**, where terms were formulated on the pattern of completing some sequences, relations between numbers and their analogies of images, which are related to some operations on numbers [classification, arrangement, …].
- The researcher aimed to design the test on two dimensions [numbers and their analogies - figures of sequences and arrangement]. The following table shows how terms are distributed on the test dimensions.

Table (3): Distributing the terms on the dimensions of the numerical intelligence test in mathematics

No.	Dimensions	Statements	Score
1	Numbers and their analogies	2,4,5	3 grades
2	Figures of sequences and arrangement	1,3	8 grades

- **Verifying the test psychometric requirements:**
- **Measuring the test validity:**

a) **Validity of arbitrators:** The test was presented in its initial form to a number of specialists in curricula and teaching methods to express their opinion on the degree of the test validity and its terms. Edition and deletion have been done based on their opinions. Some terms have been changed to avoid the repetition of meaning or reformulation in light of the arbitrators' views. Terms which had a degree of agreement (80%) or more have been accepted.

b) **Internal consistency coefficient:** After calculating the correlation coefficient between terms and the total score for the dimension to which they are related, correlation coefficients were as follows:

Table (4): The correlation coefficients between terms and the total score for the dimension to which they are related

Dimension	Number of item	Correlation coefficient	Dimension	Number of item	Correlation coefficient
Numbers and their analogies	2	0.74 **	Figures of sequences and arrangement	1	0.59 **
	4	0.66 **		3	0.65 **
	5	0.77 **			

** Significant at (≤ 0.01): It appears from the above table that all correlation coefficients for terms by the total score of sub-dimensions to which they are related are significant at the level (≤ 0.01).

c) **Calculating the sub-dimensional correlation coefficients with each other:** Table (5) illustrates the following :

Table (5): Sub-dimensional correlation coefficients with each other and with the numerical intelligence test as a whole

Dimension	**Numbers and their analogies**	**The test as a whole**
Numbers and their analogies	**---**	**0.67 ****
Figures of sequences and arrangement	**0.64 ****	**0.59 ****

** Significant at (≤ 0.01): It appears from the above table that all sub-dimensional correlation coefficients with each other and with the test as a whole are statistically significant at the level (≤ 0.01). It appears from the above that the numerical intelligence test can be applied on the main test sample.

- **Calculating consistency:** The consistency has been calculated for each dimension on exploratory research sample (A number of 30 students in the first primary grade without the main research group) using the Cronbach's Alpha:

Table (6): The correlation coefficients for the two dimensions of numerical intelligence test in mathematics

Dimension	Numbers and their analogies	Figures of sequences	The test as a whole
Cronbach's Alpha	0.67	0.68	0.78

The above table shows the reliability of the test and the possibility of administering it to the main research group[5].

- **Calculating the application time:** It appears from the exploratory experimentation for the test that the application average time is 30 minutes.
- **The final form for the test:** The number of test terms reached 5 terms in two dimensions as has been shown in table (3); the grades are distributed on questions in the attachment (3) related to the test; the final score of the test becomes (11 grades).

2. The mathematical imagination test for primary school students at the first grade [prepared by the researcher]

[5] See the attachment (3): The numerical intelligence test in mathematics among primary school first graders in its final form.

- The test aims to measure the extent of acquiring some mathematical imagination abilities by students after studying the unit by using the digital story.
- The terms of the test have been formulated in light of the extrapolation of some previous studies for mathematical imagination like **(Juhar& Younis, 2012) - (Helen, 2014) - (Arielle, 2015) - (Patras, 2015)** where items were formulated in light of some indicators of imagination in mathematics as follows:

Table (7): Some indicators of imagination in mathematics and the distribution of terms among them

Imagination Indicator	Way of Expression	Item	Score
Expression by drawing	drawing a being image – drawing a concept – drawing familiar or unfamiliar objects expressing an idea	2,3,4,5	32
Cognitive Expression and Number Map	retrieving information – mental image for a concept or a number – identifying the different one – using counting to move from one place to another	1,7	13
Dynamic Expression	imitation – simulation – hands or feet movements	5	5

It is obvious that the researcher focused on the drawing expression indicator because it is more accurate in identifying the extent of acquiring imagination by the student and close to the research sample (primary school students at the first grade).

- **Verifying the test psychometric requirements:**
- **Measuring the test validity:**

a) **Validity of arbitrators:** The test was presented in its initial form to a number of specialists in curricula and teaching methods to express their opinion on the degree of the test validity and its terms. Edition and deletion have been done based on their opinions. In light of the arbitrators' views, some terms which are not relevant to primary school students at the first grade have been changed. It had been focused also on the expression by drawing as the researcher pointed out due to its accuracy in expressing imagination and the ease of discussing it with the main sample students. Terms which had a degree of agreement (80%) or more have been accepted.

b) **Internal consistency coefficient:** After calculating the correlation coefficient between terms and the total score for the dimension to which they are related, correlation coefficients were as follows:

Table (8): The correlation coefficients between terms and the total score for the dimension to which they are related

Dimension	Number of Item	Correlation coefficient	Dimension	Number of Item	Correlation coefficient
Expression by drawing	2	0.71 **	Cognitive Expression and Number Map	1	0.58 **
	3	0.68 **		7	0.59 **
	4	0.64 **			
	6	0.61 **	Dynamic Expression	5	0.61 **

** Significant at (≤ 0.01): It appears from the above table that all correlation coefficients for terms by the total score of sub-dimensions to which they are related are significant at the level (≤ 0.01).

c) **Calculating the sub-dimensional correlation coefficients with each other:** Table (9) illustrates this:

Table (9): Sub-dimensional correlation coefficients with each other and with the imagination test as a whole

Dimension	Expression by drawing	Cognitive Expression and Number Map	A test as a whole
Expression by drawing	---	---	0.66 **
Cognitive Expression and Number Map	0.65 **	---	0.61 **
Dynamic Expression	0.62 **	0.58 **	0.60 **

** Significant at ($p \leq 0.01$): It appears from the above table that correlations of all the sub-dimensions with each other and with the test as a whole are statistically significant at ($p \leq 0.01$). It appears from the above that the mathematical imagination test can be applied on the main test sample.

- **Calculating consistency:** The consistency has been calculated for each dimension on exploratory research sample (A number of 30 students in the first primary grade without the main research group) using the Cronbach's Alpha:

Table (10): The correlation coefficients for the dimensions of mathematical imagination test in mathematics

Dimension	Expression by drawing	Cognitive Expression and Number Map	Dynamic Expression	The test as a whole
Cronbach's Alpha	0.61	0.64	0.69	0.68

The above table shows the reliability of the mathematical imagination test and the possibility of administering it to the main research group[6].

- **Calculating the application time:** It appears from the explorative experimentation for the test that the application average time is 35 minutes.
- **The final form for the test:** The number of test terms reached 7 terms as has been shown in table (7); the grades are distributed on questions in the attachment (4) related to the test; the final score of the test becomes (50 grades).

3. Matching Familiar Figures Test (MFFT):

- The test aims to measure the pattern of the cognitive style (impulse versus reflective) where (EL-Faramawy, 1994) prepared three figures for it [A figure which fits adults - A figure which fits primary school children - A figure which fits pre-school children] and codifying it to suit the Arab environment. The current research uses the second figure because it fits the main research sample.
- **A test description:** The test consists entirely of (14) terms for familiar figures in life. The first two terms are used to exercise on the test while the results of the remaining terms are used to indicate the cognitive style. Each term consists of a basic figure which corresponds other six figures different from the basic figure in precise details, except for one of these figures which is entirely identical with the basic figure in everything.
- The learner is asked to determine the figure which is identical with the basic figure in each term. The number of errors

[6] See attachment (4): The mathematical imagination test for primary school first graders in its final form.

committed and the first response time are calculated by using a precise stopwatch..

- El-Faramawy prepared an answer sheet for the test which contains information about the learner, the method of calculating the latency time, and a variable for the number of mistakes in front of each term.
- The test is applied to each individual of the research sample individually. The researcher (with the assistance of selected classroom teachers) trains the students on the test instructions through the first and the second term as an exercise. When the student begins to consider the alternatives, the researcher (with the classroom teacher) begin to calculate the time taken by the student until the first response for each term appears (latency time) by using a stopwatch [whether it is a right or wrong response]. If it is right, the student is asked to move to the second term (following it) after recording the response time in a cell designated for this purpose in the answer sheet. If the response is wrong, he is asked to try it again until he refers to the figure which matches the standard one with calculating the number of mistakes and recording it in a cell designated for this purpose in the answer sheet.
- The results are recorded in the answer sheet for each individual of the main research after writing the information of each student as follows:

- The number of mistakes committed by the student in each term.
- The time taken by the student in the first response for each term.
- The average number of mistakes for each term.

- The average latency time for all individuals in the sample.
- The sample is then classified according to the style (impulsivity/reflectivity) into [impulsive – reflective – impulsive with accuracy – reflective with inaccuracy]. I have addressed the attributes of each category in the theoretical part. All studies which used the matching familiar figures test suggests that the two latter groups don't exceed in any way (25%) of the individuals of the sample. The researcher focused only on the category [impulsive - reflective] which has been an interest for the research studying its interaction with the digital story in mathematics.
- The results of the test application on the main research sample through table (11) showed the following:

Table (11): A report classifying impulsive and reflective in the cognitive style for the research groups

No.	Group	Impulsive	Reflective
1	Control	9	6
2	Experimental	8	7

Fourth: Research experiment:

- **Research Methodology:** This research belongs to the category of researches which aim to test the causal relations between an independent variable (the digital story) and subsidiary variables (imagination, numerical intelligence) in light of the interaction with a classifying variable (the cognitive style [impulsive/ reflective]). The researcher therefore used the experimental approach based on a quasi-experimental design (control design 2 × 2) with four groups as shown in table (1) with a pre/post measurement.
- **Choosing the main research sample:** The researcher chose the research sample randomly from primary school students at the first grade at Al-Baha educational region. They were

divided into four groups as follows: [the first control group: (9) impulsive students studying in the traditional way; the second control group: (6) reflective students studying in the traditional way; the first experimental group: (8) impulsive students studying by the digital story; the second experimental group: (7) reflective students studying by the digital story].

- **A pre-application for the research tools:** Re-applying the research tools [the numerical intelligence test; the mathematical intelligence test] for primary school students at the first grade on the research groups [control group (1): impulsive students studying in the traditional way; control group (2): reflective students studying in the traditional way; experimental group (1): impulsive students studying by the digital story; experimental group (2): reflective students studying by the digital story] so as to determine the equality of research groups. The results of this application are as follows:

The researcher used Kruskal-Wallis test to verify the equality of research groups. The results of this test are illustrated by the results of the following two tables (12), (13):

Table (12): The value of Q2 difference between the groups' average ranks for the imagination skill

Variable	Group	No.	Mean Ranks	Q^2	Sig.
Imagination	Control 1	9	16.28	1.108	No. Significance
	Control 2	6	17.17		
	Experimental 1	8	15.88		
	Experimental 2	7	12.64		
	Total	30			

The previous table shows that there were no statistically significant differences between the scores of experimental groups (1) and (2) and the control groups (1) and (2) in the skill of imagination where the value of (Q^2) is 1.108 which is insignificant which verifies the equivalence of groups before beginning the experimentation.

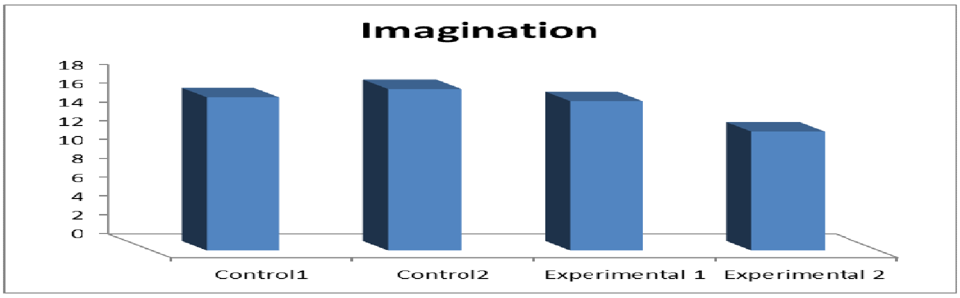


Fig 2: the homogeneity among the study groups in the study pre-application with respect to imagination skill

Table 13: The value of Q2 difference in average groups' ranks with respect to numerical intelligence

Variable	Group	No.	Mean Ranks	Q^2 value	Sig.
Numerical intelligence	Control 1	9	12.94	2.342	No. Significance
	Control 2	6	16.17		
	Experimental 1	8	18.50		
	Experimental 2	7	14.79		
	Total	30			

The previous table shows that there were no statistically significant differences between the scores of experimental groups (1) and (2) and the control groups (1) and (2) in the numerical intelligence where the value of (Q^2) is 2.342 which is insignificant which verifies the equivalence of groups before beginning the experimentation.

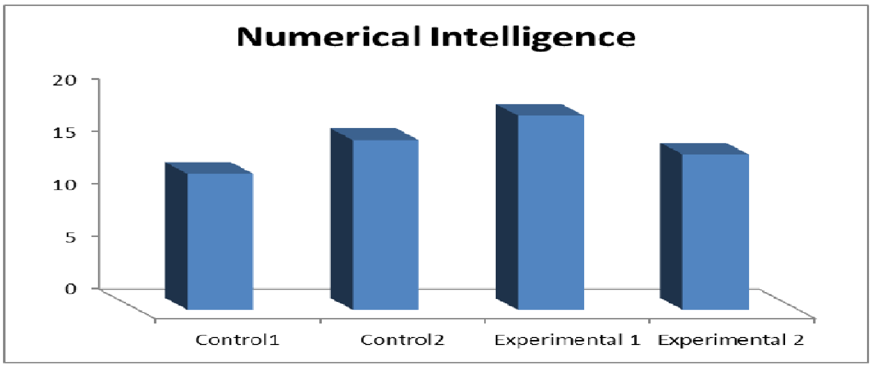


Fig 3: the homogeneity among the study groups in the study pre-application with respect to numerical intelligence

- **Period of the experiment:** The research groups including [control group (1), control group (2), experimental group (1), experimental group (2) during the period from (9/04/2017) to (04/05/2017)] have studied with the help of the classroom teacher about (20) classes - including activities and exercises.
- **The post application of the research tools to the research groups; and correcting tools.**

Fifth: Presenting, discussing, and explaining the results, and making research proposals and recommendations:

1. In order to answer the first research question "What is the impact of different teaching styles [digital story/traditional teaching] in mathematics on developing the mathematical imagination and numerical intelligence skills in mathematics among primary school first graders?"; the validity of the first and second hypotheses had been verified:

- **The research attempts to verify the validity of the first hypothesis:**

  "There were no statistically significant differences between the average scores of [the control group students (who study the concept of numbers and operations on them in the traditional way) and the experimental group students (who study the unit by using the digital story)] due to the differences in the teaching style without taking into consideration the cognitive style in the post application of the mathematical imagination test"; In order to verify the validity of this hypothesis, the researcher used Mann-Whitney - U test for two independent samples to verify the significance differences between the control group and experimental group in the post application of the mathematical imagination test:

Table (14): Z-value for the differences in average ranks of the control and experimental groups on the mathematical imagination post-test

Variable	Group	No.	Average Ranks	Total Ranks	Z Value	Sig.
Mathematical Imagination	Control	15	8.47	127.00	4.464	0.01
	Experimental	15	22.53	338.00		
	Total	30				

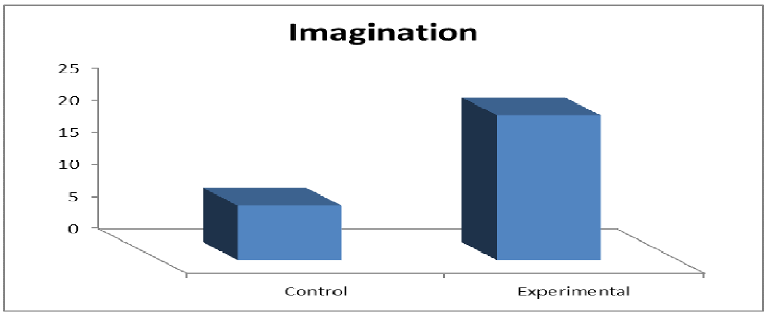


Fig 4: difference between the control and experimental groups in the post application of the mathematical imagination test

- **The research attempts to verify the validity of the second hypothesis:**

"There were no statistically significant differences between the average scores of [the control group students (who study the concept of numbers and operations on them in the traditional way) and the experimental group students (who study the unit by using the digital story)] due to the differences in the teaching style without taking into consideration the cognitive style in the post application of the numerical intelligence test in mathematics"; In order to verify the validity of this hypothesis, the researcher used Mann-Whitney - U test for two independent samples in the same way:

Table (15): Z value for the differences in average ranks of the control and experimental groups with respect to the post application of the numerical intelligence test

Variable	Group	No.	Average Ranks	Total Ranks	Z Value	Sig.
Numerical intelligence	Control	15	13.10	196.50	2.592	0.01
	Experimental	15	17.90	268.50		
	Total	30				

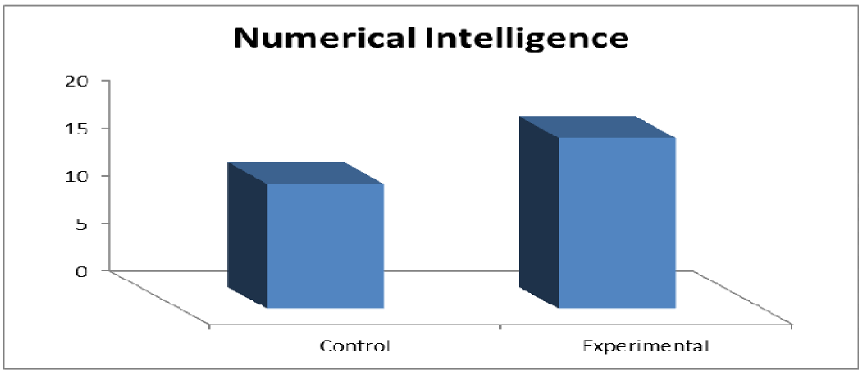


Fig 5: difference between the control and experimental groups in the post application of the numerical intelligence test

It appears from tables (14) and (15) that there is a statistically significant difference between the control group (which study the unit in the traditional way) and the experimental group (which study the unit by using the digital story) in favor of the experimental group with regard to mathematical imagination and numerical intelligence which refers to the existence of an impact for the differences in the teaching style [digital story/traditional style] without taking into consideration the cognitive style [impulse versus deliberation] which can be explained as follows:

- **As regards mathematical imagination:**

- Some studies **(Goral & Gnadinger, 2006; Al-Paul, 2011)** which used the story in teaching mathematics suggest that the story better organizes information inside the memory and enables the student to link mathematics to reality, which helps him to remember it easily and to use the concept within it smoothly.
- The story encourages students to build imaginative ideas through retrieving realistic and unrealistic images resulting from the digital story scenario of concepts and relationships which helps them to draw an image for a certain concept in more than one way and form (expression by drawing).
- The digital story helped to link between the language and mathematics **(Wilk, 2009)** which facilitated the verbal expression process of some concepts and mathematical operations (evoking information about a certain concept).
- The digital story often uses a concept from the surrounding reality. Accordingly, the concept becomes meaningful in life and has a form which can be imitated and expressed (dynamic expression - imitation and simulation) **(Washinton, 2005)**.
- The digital story scenario in the primary grades contains a set of audio and visual effects which make the student experiences a story closer to reality so he becomes interested and influenced completely which facilitates his ability on

verbal expression and he imagines familiar or even unfamiliar things about numbers like what appeared in the digital story scenario. According to the study of **(Al-Paul, 2011)** the student is able to imitate some numbers in its shape and movements (imitation). According to the study of **(Hauscarriague, 2008)**, the interested student in the story is able to perceive a number or a concept of the surrounding objects, to draw familiar or even unfamiliar pictures about concepts (which is an aspect of mathematical imagination by the student at this stage).

- The digital story solely as indicated by **(Egan, 2005)** is considered the best setting which offers a complete imaginative environment in mathematics by organizing information and the possibility of evoking mental images similar to those in the story, using them to express by drawing and evoking things through the digital story well prepared to fit students who use it.
- The availability of certain features in digital stories which is not available in the traditional style in teaching led to the superiority of the experimental group over the control group. Among these features:
- The dynamics in presenting the stimuli (visual, audio, and written) helps in diversifying the idea and achieving the best retrieval of it when needed.
- The Cue Summation: Whenever the number of visual and audio cues in the story increases, the opportunities to learn better, and the possibility to express by more than one image increases.
- This result is consistent with the study of **(El-Gazar& Abdul-Rahman, 2003)** which confirmed that the use of the story in

teaching contributes through excitement, the effective elements in retrieving images and developing some imagination skills among students.

- It is also consistent with the study of **(Armstrong, 2005)** which confirmed that the use of photos, oral and visual presentations develops the ability to imagine where they make the learner's mind in a dynamic image generating familiar or even unfamiliar ideas about things and situations which the student might experiences.
- It is also consistent with the study of **(King, 2007)** which confirmed that listening stories and narratives about topics generates mental images for the learner and enhances his ability to imagine things and ideas.

▪ **As regards numerical intelligence:**

- The study of **(Balakrishnan, 2008)** emphasizes that the smoothness of digital story encourages the student especially in the primary grades to see ideas and beyond numbers and concepts which he studies.
- The digital story study has a positive impact on the level of achievement where it increases the level of mathematics achievement in general **(Casy & et al., 2008)**.
- Exercising the use of language with some pictorial concepts makes the story a mathematical setting with a perceived meaning far from abstraction, making it possible to perceive some hidden relationships and to understand verbal questions that may exist in the story activities including sequences, classification operations and others.
- The possibility of presenting the digital story content more than once without any restrictions or difficulties represents an

important stage in active listening for children which is linked to the development of the idea about the displayed concept or image and the immediate connection between the audio text and the displayed one **(Michelle, 2008)**.

- If the digital story presents the concept like numbers and others as it is in the book with its visual and audio form itself and increases the operations of using it, the computational situations related to life become easier enabling him to deal with numbers easily and better than the traditional work **(Wu & Yang, 2009)**.
- The study of **(Stephen, 2007)** showed that the availability of fixed and animated illustrating images and drawings for numbers and mathematical relationships supported by the narrator comment (often the teacher) with certain reference phrases [as found in our digital story] makes it easier for the student to perform operations and even makes it possible for him to perform some simple calculations which need numerical intelligence related to the mathematical situation as shown in the test activities. This is also confirmed by the study of **(Donna &et al., 2008)**.
- The availability of stimuli helps in dual coding in processing levels of information or concepts by establishing links between visual, audio and written stimuli. In addition, the link shape may contribute in strengthening the correlation relationships between ideas which helps in improving the ability of the student on classification, arrangement and perception of relationships between numbers.
- The active vision of stimuli through the story because multiple forms of links enhances selective attention for the learner and increases the stimuli capacity in acquiring this

attention to facilitate the deepening of ideas and lack of dispersion for the learner. It appears in his ability to make sequences, relations between numbers and their analogies of images which came from the digital story subject itself.

- This result is consistent partly with the study of **(Yutu & et al., 2008) (Susan, 2007)** which confirmed that the nature of digital content in mathematics and science is an extension and embodiment of the nature surrounding the learner because it includes interactive situations and activities requiring a better and deeper understanding in a different and more attractive way than the traditional pattern or even the typical electronic content which appeared in some numerical intelligence dimensions addressed by the current research such as analogous of numbers and numerical sequences and their arrangement.

2. In order to answer the second research question "What is the impact of different cognitive styles [impulsivity/reflectivity] on developing mathematical imagination and numerical intelligence skills among primary school first graders?", the validity of the third and fourth hypotheses had been verified:

- **The research attempts to verify the validity of the third hypothesis:**

  "There were no statistically significant differences between the average scores of students in the experimental group 1 [(impulsive students studying by the digital story) and students in the experimental group 2 (reflective students studying by the digital story)] due to the differences in the cognitive style (impulse versus deliberation) without taking into consideration the teaching style in the post application of the mathematical imagination skill test"; In order to verify the validity of this hypothesis, the researcher used Mann-Whitney - U test for two independent samples:

Table (16): Z-value for the differences in the average ranks of the experimental groups 1 & 2 on the mathematical imagination skill post-test

Variable	Group	No.	Average Ranks	Total Ranks	Z Value	Sig.
Mathematical imagination	Experimental 1	8	4.50	36.00	3.369	0.01
	Experimental 2	7	12.00	84.00		
	Total	15				

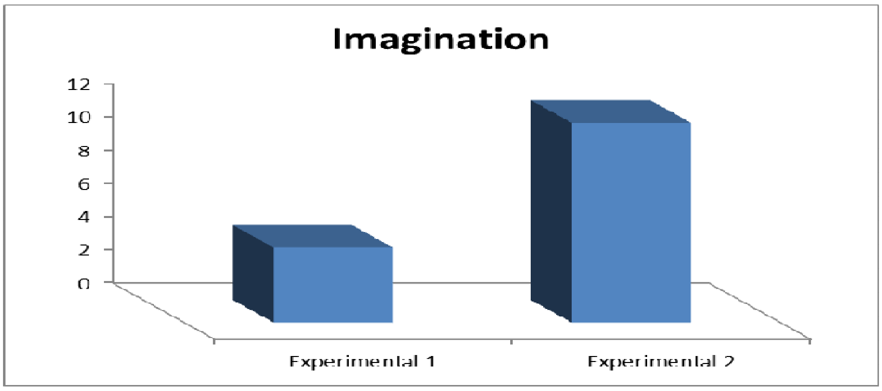


Fig 6: difference between the experimental groups 1 & 2 on the mathematical imagination post-test

- **The research attempts to verify the validity of the fourth hypothesis:**

"There were no statistically significant differences between the average scores of students in the experimental group 1 [(impulsive students studying the digital story) and students in the experimental group 2 (reflective students studying by the digital story)] due to the differences in the cognitive style (impulse versus deliberation) without taking into consideration the teaching style in the post application of the numerical intelligence test in mathematics"; In order to verify the validity of this hypothesis, the researcher used Mann-Whitney - U test for two independent samples:

Table (17): Z value for the differences in the average ranks of the experimental groups 1 & 2 on the numerical intelligence post-test

Variable	Group	No.	Average Ranks	Total Ranks	Z Value	Sig.
Numerical intelligence	Experimental 1	8	4.63	37.00	3.258	0.01
	Experimental 2	7	11.86	83.00		
	Total	15				

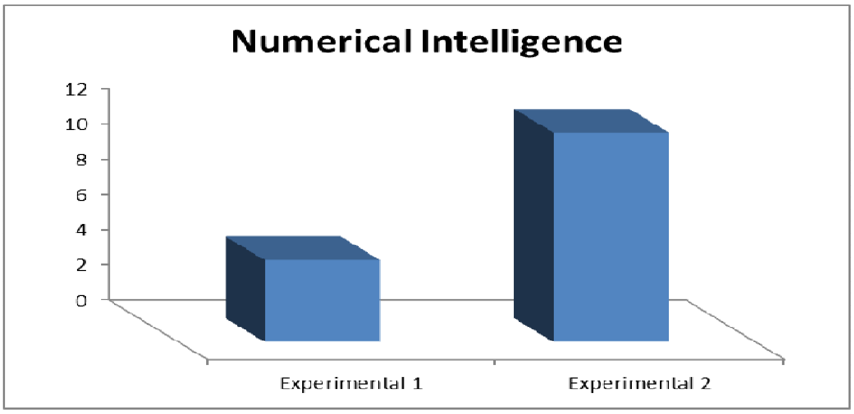


Fig 7: difference between the experimental groups 1 & 2 on the numerical intelligence post-test

It appears from table (16) and table (17) that there is a statistical significance difference between the experimental group 1 (impulsive students study by the digital story) and the experimental group 2 (reflective students study by the digital story) in favor of the experimental group 2 (reflective) with regard to mathematical imagination and numerical intelligence which refers to the existence of an impact for the differences in the (impulsive/reflective) cognitive style without taking into consideration the teaching style which can be explained as follows:

- **As regards mathematical imagination:**

- After looking into the trend of differences resulting from the impact of different cognitive styles (impulse versus deliberation): We find that the results indicate the superiority of reflective students regardless of the type of processing used with them. In this way, they surpass impulsive students in the mathematical imagination test. The researcher attributed this to:
- A reflective student focuses more on the accuracy and the quality of performance than the rapid achievement of an idea or exercise; unlike the impulsive student who is characterized by fastness to finish the work more than the focus on accuracy and quality of achievement itself.
- The reflective students are characterized by cautious, care and lack of absent mindedness associated with their ability to examine carefully the patterns of presented stimuli, which makes them more able to remember, evoke some of these animations and images when needed, linking them to their knowledge (Introduction to imagination) and more likely to express them by drawing or simulation due to their fixed attention towards them during presentation. The learner at this stage is interested in mental images other than those drawn for him by others or those drawn by his imagination of limited experiences related to his own classroom environment or cognitive structure, where he proceeds with his imagination to stories which may take him to distant horizons [concepts which speak, tell, or moves in unfamiliar places].
- Unlike the impulsive student who gets dispersed due to his urgent desire to finish quickly leaving a number of mistakes

including the inaccuracy in selecting the element related to images during the exercises and activities of imagination.

- The study of **(Ibrahim, 2008)** also suggested that cognitively reflective unlike cognitively impulsive are characterized by distributing attention for all alternatives available during the latency time. These alternatives address senses quietly [visual, audio ...]. In addition, they are characterized by making partial comparisons on the stimuli parts (images and figures having more than one pattern for the same concept or relationship) which enables them to get impressions about some abstract concepts and relationships in mathematics, and to keeps them in their memory; the more information they have and the richer their life experiences about abstract concepts are; the more diversified their impressions will be, the more abilities they will have to assemble images, and the more ability they will acquire to imagine **(El-Shami, 2011)**. This result is partly consistent with the study of (Ibrahim, 2008).

- **As regards numerical intelligence:**

- A study of **(Kabli, 2011)** suggests that impulsive students tend to give a quick response without pondering or attempting to retrieve what have been studied which increases the number of their mistakes while reflective students are characterized by carefulness, examination, retrieval attempt and accuracy which decrease the number of their mistakes. In addition, it suggest that reflective individuals are characterized by a detailed and organized review of the displayed exercise or activity through a good distribution of attention each time the concept or the number is mentioned in any form or image during studying the activity or the mathematical situation. A reflective also makes simple comparisons to facilitate achieving numerical sequences or completing other numerical intelligence activities which he might experience.

- Lack of reflective students' mistakes: A reflective spends more time to respond and commits fewer errors in completing activities especially those which need carefulness and accuracy, such as sequences of numbers and completing some missing relationships needing careful thinking (numerical intelligence). An impulsive spends less time to respond where he is characterized by quick achievement decisions, so he commits more mistakes in achieving such mental processes.
- The reflective students are more able to organize ideas and to express them when needed. They are better also in achieving tasks because they are characterized by emotional stability, flexibility and awareness **(Mahmoud, 2006)**. Therefore the superiority of reflective individuals appeared during numerical intelligence activities which need partial organization for the idea or stability, carefulness and deliberation during achieving tasks.
- This result is consistent with the study of **(Mahmoud, 2006)** which confirmed the superiority of reflective students over impulsive ones in certain intelligence aspects. It is also consistent with the findings of (El-Faramawy, 1994) study which confirmed that children with reflective style are characterized by higher intelligence than children with impulsive style.
- This result is also consistent with **(Hussein, 2004)** study which indicated the superiority of reflective individuals over impulsive ones in various intelligence activities.
- This means that individuals with more latency and fewer mistakes [reflective] are characterized by a higher level of

numerical intelligence than individuals with less latency and more mistakes [impulsive].

- The results of the hypotheses (third and fourth) here suggest that there is a need to take into account the cognitive style [impulsivity/reflectivity] during presenting any educational content on the grounds that the cognitive style is an independent variable representing individual differences between students in remembering methods, perception of meaning, thinking, imagination, using information, performing mental calculations and dealing with various mathematical relationships.

3. In order to answer the third question of the research "what is the impact of different teaching styles [digital story/traditional teaching] and cognitive styles [impulsivity/reflectivity] on developing the skill of mathematical imagination and numerical intelligence among primary school first graders?"; the validity of the fifth and sixth hypotheses had been verified:

- **The research attempts to verify the validity of the fifth hypothesis:**

  "There were no statistically significant differences between the average scores of students in control group 1 and control group 2 [who studied in the traditional style (impulsivity vs. reflectivity)] and students in experimental group 1 and experimental group 2 [who studied using the digital story (impulsivity vs. reflectivity)] due to the interaction between the teaching style (digital story/traditional teaching) and the cognitive style (impulse versus deliberation) in the post application of the mathematical imagination skill test".

In order to verify the validity of this hypothesis, the researcher used Kruskal-Wallis test whose results are illustrated by the results of the following table (18):

Table (18): Q^2 value for the differences in the average ranks of the study groups on the mathematical imagination post-test

Variable	Group	No.	Average Ranks	Q^2	Sig.
Imagination	Control 1	9	6.89	24.192	0.01
	Control 2	6	10.83		
	Experimental 1	8	18.63		
	Experimental 2	7	27.00		
	Total	30			

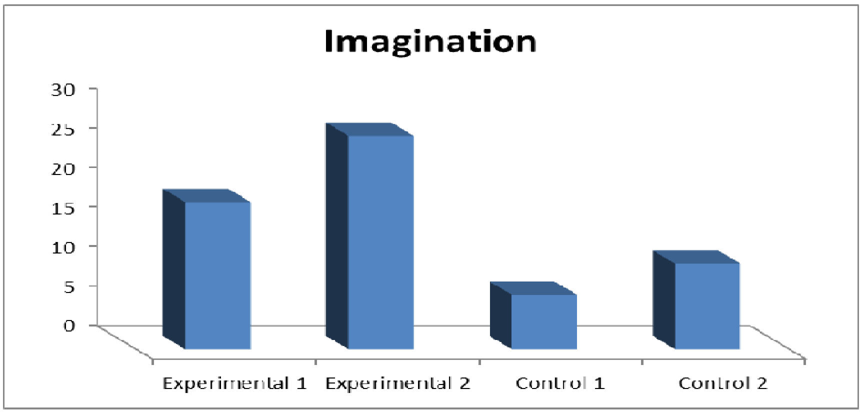


Fig 8: differences among the study groups on the mathematical imagination post-test

- **The research attempts to verify the validity of the sixth hypothesis:**

  "There were no statistically significant differences between the average scores of students in control group 1 and control group 2 [who studied in the traditional style (impulsivity vs. reflectivity)] and students in experimental group 1 and experimental group 2 [who studied using the digital story (impulsivity vs. reflectivity)] due to the interaction between the teaching style (digital story/traditional teaching) and the cognitive style (impulse versus deliberation) in the post application of the numerical intelligence test".

In order to verify the validity of this hypothesis, the researcher used Kruskal-Wallis test whose results are illustrated by the results of the following table (19):

Table (19): Q^2 value for the differences in the average ranks of the study groups on the numerical intelligence post-test

Variable	Group	No.	Average Ranks	Q^2	Sig.
Numerical Intelligence	Control 1	9	8.50	20.351	0.01
	Control 2	6	10.56		
	Experimental 1	8	18.50		
	Experimental 2	7	26.29		
	Total	30			

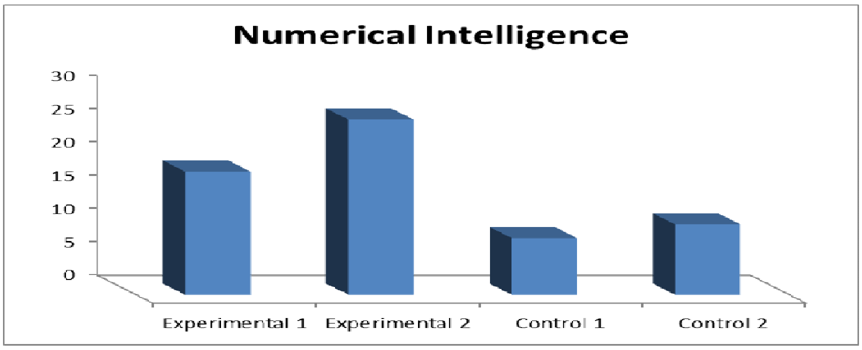


Fig 9: Differences among the study groups on the numerical intelligence post-test

Tables (18) and (19) show that there were statistically significant differences between the scores of experimental group 1 and experimental group 2 and control group 1 and control group 2 in both mathematical imagination and numerical intelligence [(The value of Q^2 is 24.192 in mathematical imagination) (The value of Q^2 is 20.351 in numerical intelligence)] which are significant values at the level (≤ 0.01) in favor of experimental group 1 and experimental group 2 due to the basic impact of interaction between the teaching style [digital story versus traditional teaching] and the cognitive style [impulse versus deliberation]; all of which is in favor of reflective students studying by the digital story in mathematics versus impulsive students studying by the digital story. There were also statistically significant differences between impulsive and reflective individuals studying with the traditional style in favor of reflective individuals. The researcher attributes this result to:

- A digital story in mathematics provides the learner with coherent and meaningful content and mathematical representations which is consistent with Ozubl theory (Meaningful Learning). This offers opportunities for students to arrange and organize their ideas, to activate their visual memory through bilateral and trilateral dimensional images and presentations, to keep and reuse them in numerical activities (numerical intelligence), the possibility to express them whenever needed whether by drawing or dynamic expression (mathematical imagination) through focusing attention and reflectiveness (characteristics of reflective) and distributing attention correctly over the visual and dynamic stimuli (the digital story content) in a way which improves its usage in imagination or intelligence activities he experiences.

- We can explain the superiority of reflective students over impulsive ones who studied in the traditional way by the same way of explaining the validity of the third and fourth hypotheses, where reflective students generally surpass in numerical intelligence and mathematical imagination activities regardless of the type of processing or teaching style used. A reflective student focuses more on the accuracy and the quality of performance than the rapid achievement of an idea or exercise; unlike the impulsive student who is characterized by fastness to finish the work more than the focus on accuracy and quality of achievement itself. A reflective student also tends to cautious, care and lack of absent mindedness associated with his ability to examine carefully anything presented whether traditional papers or bilateral or trilateral dimensional digital images for concepts, terms and mathematical figures.

- Unlike the impulsive student who gets dispersed due to his urgent desire to finish quickly leaving a number of mistakes including the inaccuracy in selecting the element related to images during the imagination activities including evoking images and reinstalling them or during numerical intelligence which needs organizing, arranging, and reflectiveness in taking decisions for the solution.

- **The research attributes this result to:** The basis upon which the expectation of the presence of an impact of the interaction between the research variables including the teaching style [digital story/traditional teaching] and the cognitive style [impulsivity/reflectivity] has been established is because the digital story pattern in mathematics is relevant to reflective students where it offers them a good opportunity to perceive concepts and to encode them into ideas. The brain organizes knowledge better by using the digital story and its multiple formulations in the actual memory of the student who seeks to use it in a way which suits his reflective characteristics including fixed attention and the possibility of distributing it. Accordingly, his pleasure transforms to motivation and then to thinking which appears in his numerical intelligence **(Balakrishnan, 2008)**.

- This study is consistent with **(Armstrong, 2005)(King, 2007)** study which confirmed that the use of photos, oral and visual presentations develops the ability to imagine where they make the learner's mind in a dynamic image generating familiar or even unfamiliar ideas about things and situations which the student might experiences.

- It is also consistent partly with **(Stephen, 2007) (Donna & et al., 2008)** study which confirmed that the availability of fixed and animated illustrating images and drawings for numbers and mathematical relationships supported by the narrator comment (often the teacher) [as found in our digital story] makes it easier for the student to perform operations and even makes it possible for him to perform some simple calculations which need numerical intelligence related to the mathematical situation.

- This result is consistent with **(Mahmoud, 2006)** and **(Hussein, 2004)** study which confirmed the superiority of reflective students over impulsive ones in certain intelligence aspects. It is also consistent with **(Ibrahim, 2008)** study which confirmed the superiority of reflective students over impulsive ones in acquiring the skill of imagination better.

4. In order to answer the fourth research question "What is the relationship between the mathematical imagination and numerical intelligence skills among primary school first graders?", the validity of the seventh hypothesis was verified:

There were no statistical correlation between the scores of students on the mathematical imagination skill post-test and their scores on the numerical intelligence test in mathematics.

In order to verify the validity of this hypothesis, the researcher calculated Pearson's correlation coefficient to find the relationship between the scores of students in the mathematical imagination skill test and their scores in the numerical intelligence test in mathematics.

Table (20): Pearson's correlation between the scores of students in the mathematical imagination skill test and their scores in the numerical intelligence test in mathematics.

Variable	Numerical Intelligence in Mathematics
Mathematical Imagination	**0.626****

** Significant at ($p \leq 0.01$): The above table shows the presence of a positive significant correlation between the two variables.

The above table shows the presence of a significance correlation between the two variables. The research attributed this to:

- The nature of the relationship is basically between mathematical imagination and thinking. While **(Potter, 2008)** suggests that imagination is deep thinking, **(Misled, 2012)** emphasizes that imagination is a potential latent in the individual responsible for creating new objects in the form of ideas, relationships, proposals, and meanings related together in different ways which may be unfamiliar for the student [part of numerical intelligence activities].
- While **(Ron, 2011)** believes that imagination is a natural extension for perception which shapes all thinking process for the individual learner, **(Ron, 2011) (Haskvitz, 2008)** emphasizes how imagination an individual has integrates his experiences, improves the process of thinking, helps in creating solutions, and contributes directly to evoking mental images for concepts and relationships and attempting to take advantage of them to the large extent.
- Imagination in mathematics is related specifically to the process of clearing, preparing, and enriching mind with different figures for the mathematical concept **(Juhar&**

Younis 2011), which is considered a basis for the process of generating ideas, analyzing activities, completing numerical sequences and others, and then choosing the appropriate solutions for them.

- In addition, the mental processes generating imagination include understanding the language of mathematics, forming new concepts, perceiving the mathematical situation, imagining solutions and increasing the ability to focus **(Abu-Riash & El-Safi, 2009, 21)**, All of these are considered a fundamental basis for numerical intelligence in mathematics.
- This result is consistent partly with **(Ron, 2011)(Haskvitz, 2008)(Abu-Riash & El-Safi, 2009)(Juhar& Younis 2011)**.

Research Recommendations:

In light of the findings of the present research, The researcher recommends the following:

1. Attention should be paid to the design of curricula depending on digital stories in mathematics for primary grades due to its effective role in establishing concepts, evoking and representing mental images for relationships which support mathematical situations. A care should be given also to training teachers at this stage on participating in building the scenario for these stories as possible.
2. As individuals with more latency and fewer mistakes [reflective] are characterized by a higher level of numerical intelligence and imagination than individuals with less latency and more mistakes [impulsive]; features of this category should be taken into account when we design activities and exercises in the student book because deliberation style is often a reason for thinking and creativity. On the other hand,

the care should be given to impulsive students and they should be trained again because most studies proved that their abilities can be adjusted to be reflective in their deal with mathematical activities.

3. As imagination diminishes for children at the age of nine; and due to its role in deepening dealing with mathematics, preparing the student to create new things in the form of ideas, relationships and meanings related to different figures which may be unfamiliar to the students [part of numerical intelligence activities], care should be given early by mathematics curricula authors and developers to the necessity of designing educational activities and tasks to develop imagination in mathematics for the primary grades, and highlighting the numerical intelligence of the student which is the basis for his general intelligence later.

Research Suggestions:

The research offers a set of suggestions including:

1. Studying the impact of the digital story pattern on certain mathematical variables which have not been addressed by the present research in similar or different stages [intuitive thinking, proportional thinking in mathematics, proportional reasoning levels, solving verbal problems in mathematics, spatial ability, retention of information …].
2. Conducting an interactive study between two patterns for the digital story in mathematics [paper/digital] and other teaching methods like the visual approach [with computers/without computers], and teaching based on the pattern of brain predominance in mathematics to develop imagination and numerical intelligence in mathematics for normal or disabled

individuals [exceptional – slow learners – learning disabled in a branch of mathematics].

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