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# An Interactive Website Based on the "Systemic Approach" to Develop Mathematical Problem-solving Skills in Students of Sixth Grade in Primary School in Jordan

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**Abstract:** This study examines how a systemic, interactive website promotes "mathematical problem-solving skills" in sixth graders. The study included sixth graders in the second semester of the 2021/2022 academic year, and the Directorate of Education in Aqaba Governorate reported 1234 students. For the study, 60 female sixth graders (0.20%) were selected from "Al-Ashira Al-Sanawiyah Al-Mukhtalita" school in Aqaba Governorate, Jordan. The students were randomly divided into two groups: (1) the experimental group, comprising 30 students who learned using the interactive website based on the systemic approach, and (2) the control group, comprising 30 students who learned to use the usual method. In the study, the "quasi-experimental method" was used to evaluate the holistic approach of the interactive website for teaching mathematics to sixth graders. The results showed that teaching with the interactive website based on the systemic approach produced a statistically significant difference at the significance level (α\\ < lock\ > \ < \ < /lock > =(0.05)) in solving mathematical problems. This difference favored the experimental group. The results showed that the mean scores of the experimental group in the pre- and post-tests on mathematical problem solving were statistically significant at a significance level (α=(0.05) in favor of the post-application. This shows that the holistic approach of the interactive website to teaching "mathematical problem-solving skills " to sixth graders works. The study suggests creating basic education math books with a holistic approach and using interactive websites to teach "math problem solving" and thinking skills to sixth graders.

**Keywords:** Interactive Websites, Solving Mathematical Problems, Systemic Approach.

## 1 Introduction

Because technology facilitates the process of distributing and storing knowledge and communication among all parties involved in the educational process, the current era has experienced a technical breakthrough that has contributed to a quantum leap in education. E-Learning is an electronic educational environment based on the use of 'computer technology' and the internet that has been made possible by technological advancements. In addition, this technology facilitates students' access to scientific content through various software and interactive websites that facilitate the transfer and exchange of experiences and ideas and the potential for interaction with the outside world. Education through the internet and interactive websites is characterized by the effective delivery of content to the learner. There are numerous benefits to this type of education, including reducing time, effort, and expense and providing an attractive educational infrastructure. In addition, it aids in resolving the issue of overcrowding in physical classrooms, offers continuously updated teaching materials, and facilitates the active participation of all parties involved in the educational process [1].

Due to the reasons mentioned above, interactive websites have become an essential pillar of e-education. They provide teachers with the opportunity to develop their specialized knowledge individually or collaboratively, as well as improve a variety of skills, including collaborative work, communication with one another, information search and analysis, and revision. Moreover, interactive websites can purposefully or unintentionally hone and develop various other crucial abilities [2].

The systemic approach is among the contemporary methodologies used in curriculum development and instruction. In reality, it strives for a quality approach not only in its content, manner of education, and evaluation but also in the development of critical thinking abilities. The systemic approach is intended to construct the curriculum through a holistic and integrated view of the system, considering all of its components. This involves evaluating, redesigning, constructing the system, and validating its integrity [3].

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The significance of the systemic method is exemplified by recognizing the "prior knowledge background of the learners" and constructing new information using systemic diagrams that link old knowledge with new knowledge. This practice ultimately contributes to developing a clear, systemic vision for the learners to examine the relationships between the supplied information and then apply the acquired experiences to new situations, transforming the information in their thoughts into a meaningful image [4].

Mathematics and its practical content are centered on a network of mathematical concepts, theories, generalizations, and problems that condense into systems based on strong relationships generated by structural integrity and mathematical consistency. Makoney [5] emphasizes the significance of integrating mathematics instruction with students' real-world experiences. If this is not done, the teacher will be questioned by students about why they should study mathematics, and the pupils will develop negative attitudes toward the subject. The solution to mathematical problems is an essential axis for teaching mathematics. At this point, we apply our mathematical knowledge, skills, and experiences to solve a new and remarkable challenge. In addition to its significance for mathematics, solving a problem entail expanding students' mathematical knowledge. To solve the problem, students must comprehend the problem's components in various ways and solve it in sports and life situations [6].

After reviewing the vocabulary of mathematics textbooks, it is evident that problem-solving is one of the fundamental skills a student must possess. This is demonstrated when mathematical problems are solved in significant steps that are more understandable, planned, solvable, and achievable [7].

**The problem of the study**

Mathematical problem-solving skills have been a focus of attention for those involved in the educational process. The National Council of Teachers of Mathematics (NCTM) has emphasized the importance of problem-solving as both the purpose of mathematics education and a means of acquiring and understanding the subject [1].

In this context, several studies have highlighted the importance of developing mathematical problem-solving skills for students, including studies by Sultan [2], Al-Blowi [3], Bayazit [8], Tambychik and Meerah [9], Hamza [10], and Hassan [11].

However, the reality is that mathematics education has been reliant on memorization, leading to the production of students who are unable to use their minds and reasoning skills to study mathematics. Traditional teaching methods do not promote the development of these skills, and as a result, students have become accustomed to consuming knowledge rather than producing it [12].

Previous research has shown that students' poor problem-solving abilities in mathematics can be attributed to the emphasis on information presentation in traditional teaching methods, which contrasts with the understanding, comprehension, and realization required for problem-solving [13, 14, 15].

The research problem emerges from the points mentioned above, as there is an urgent need to diversify the methods used to teach mathematics. Technology-based methods, such as an interactive website based on a systemic approach, can be used to promote mathematical problem-solving skills in sixth-grade students.

**Study Questions**

This study strived to answer the following main question:

1. To what extent is an 'interactive website based on the systemic approach' effective in developing 'Mathematical Problem-Solving Skills' in the students of Sixth Grade?

Two following sub-questions arise from the above main question:

1. Are there statistically significant differences at the significance level (0.05between the mean scores of students in 'Mathematical Problem Solving Skills' on the post-assessment of experimental and control groups?
2. Are there statistically significant differences at the significance level (0.05between the mean scores of students in 'Mathematical Problem-Solving Skills' on the pre and post-assessment of the experimental group?

**The objective of the Study**

The study aimed to know the effectiveness of an interactive website which is based on the systemic approach in developing Mathematical Problem-Solving Skills in the students of Sixth Grade.

**Significance of the Study**

Following is the significance of the study from theoretical as well as practical aspects:

**Theoretical Aspect:** This work contributes to developing theoretical literature that broadens the scientific frontiers of curriculum, teaching methods, and research. This may contribute to the development of mathematics teaching methods in line with present trends that emphasize the creation and development of e-courses. This is accomplished by delivering courses via interactive websites considering electronic management systems, which demand synchronous and asynchronous learning continuity unrestricted by time and place. Therefore, the learner can access the courses multiple times and continuously, as there is no requirement that a computer is available at school. He can access the courses from any location he chooses.

**Practical Aspect:** It demonstrates the effectiveness of using an interactive website based on the systemic approach in the teaching of mathematics, compares it with the conventional method of teaching in developing Mathematical Problem-Solving Skills in the students of Sixth Grade, and contributes to the development of a modern teaching strategy to enhance the teaching of mathematics so that effective learning can be achieved during the elementary stage of education.

**Limitations of the Study**

The study is limited to the following determinants:

- **Subjective Limitations:** The study effectiveness of an interactive website, which is based on the systemic approach, in developing the skills of "mathematical problem solving" for the mathematics course approved by the Ministry of Education in the second semester (Unit of Ratio and Percentage).
- **Human Limitations:** This Study is limited to a sample of students in Sixth Grade in "*Al-Ashira Al-Sanawiyah Al-Mukhtalita*" school located in Aqaba Governorate.
- **Spatial Limitations:** This Study was applied in the "*Al-Ashira Al-Sanawiyah Al-Mukhtalita*" school in Aqaba Governorate.

1) **Time Limitations**: This Study was implemented during the second semester of the Academic Year 2022.

**Research Hypotheses:**

1. There are statistically significant differences at the significance level (0.05between the mean scores of students in 'Mathematical Problem Solving Skills' on the post-application of experimental and control groups.
2. There are statistically significant differences at the significance level( 0.05)between the mean scores of students in 'Mathematical Problem Solving Skills' on the pre and post-applications of the experimental group in favor of 'post application.'

**Procedural Definitions:**

**The interactive website** consists of interconnected digital pages and super-media elements in which the mathematics material is coordinated and preserved so that learners can quickly access and study it to improve 'Mathematical Problem-Solving Skills' in sixth-grade students.

**The systemic approach:** It is a method of studying mathematical issues that organize mathematical knowledge into groups of integrated, main, and subsystems, illustrating the interrelationships between concepts and allowing the learner to construct a complete and thorough understanding of the material rapidly.

**Mathematical Problem-Solving Skills**: The ability of pupils to solve a problem and quickly and accurately organize the solution, as assessed by a test developed for this research, by traversing the steps of a known problem-solving procedure.

## 2 The Theoretical Framework

In this part, the researcher deals with a detailed presentation. Of the theoretical framework, which consists of two axes, namely the systemic approach. It introduces the concept of the system approach and the system approach in teaching mathematics at the elementary level. The second axis relates to solving mathematical problems, their concept, importance, and the most important skills for solving mathematical problems.

**The systemic approach**

**Concept of systemic approach:** It is a work approach implemented according to interrelated and interlaced processes and utilizing all technological potentials following contemporary learning theories.

Bashaireh [16] defined it as the study of concepts through a framework of clear concept-to-concept relationships that makes it simple for students to connect new knowledge to existing knowledge.

Al-Shahri [17] argues that it is a teaching method based on building an integrated system in which all relations of interconnectedness, interaction, intertwining, and integration between mathematical concepts are made clear. It allows students to connect previous mathematical concepts with new ones and understand their relationship. It follows a sequence of logical stages and systematizes the elements of educational settings to determine the links of influence and vulnerability between the mathematical ideas in the educational environment.

The following chart shows the system of calculations ,the systemic approach and teaching of mathematics at the basic stage.

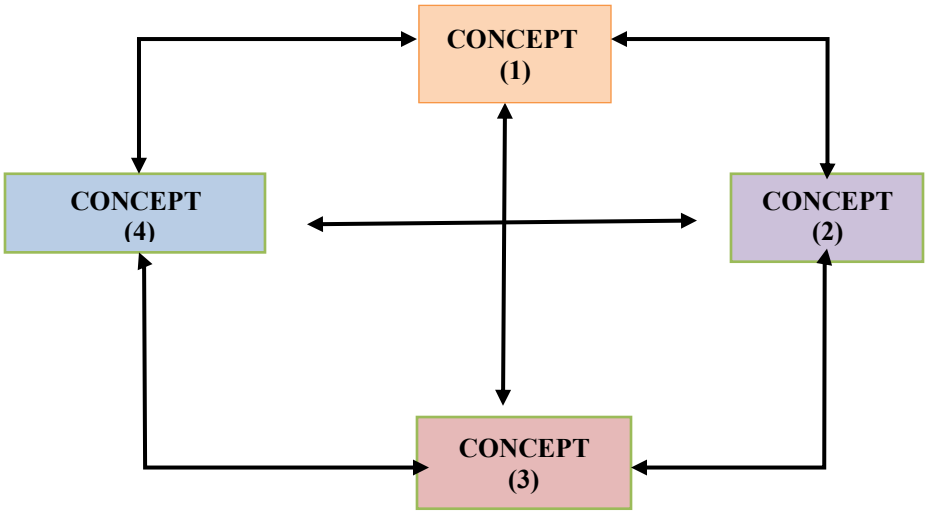


**Fig. 1:** system of calculations

From the above it is clear that the systemic approach consists of a relationship between the concept and the next concept, as shown in the following systematic figure.

**The systemic approach and teaching of mathematics at the basic stage**

The systemic approach emphasizes the learned fundamental concepts and ideas. It displays their interrelationships with previously studied concepts in an integrated manner so that trivial matters do not divert students' attention. Transitioning from one curriculum portion to another emphasizes students' engagement in constructing systems.

According to Herlihy [18], the significance of the systemic approach in mathematics education is that it contributes to the development of mathematical thought, the maintenance of 'programming library' abilities, and the improvement of mathematical thought in teachers.

Employing a systemic approach in mathematics education leads to constructing a cohesive knowledge structure in elementary school children, which aids in the retrieval and connecting of material [19].

Hawriyah [20] emphasized that implementing a systematic approach significantly impacts teaching mathematics at the elementary level for the following reasons:

- Students' intelligence and ability to conclude will increase, as will their capacity for critical thinking.
- It will foster an environment of enjoyment, amusement, and competition within the educational process.
- The ability to communicate educational knowledge concisely and straightforwardly.
- It will facilitate students' connecting their new knowledge to their prior understanding.
- New teaching methods will increase students' ability to solve mathematical problems in several ways.
- It will link the knowledge a student has already acquired and the knowledge they will acquire in the future, aiding in the revision of old material through fresh learning.

Considering the considerations, the researcher recognizes the significance of the systemic approach. It can contribute to the development and maintenance of mathematical problem-solving skills through its use in teaching mathematics, which relies on making students more able to concentrate and establish relationships between mathematical concepts.

**Mathematical Problem Solving**

**Concept:** Abu Zainah and Abaynah [21] described mathematical issue solving as a novel educational circumstance faced by a teacher for which he does not have a solution in mind and for which it is not required that all students face a mathematical problem.

**Importance of Mathematical Problem Solving**

In the following points, Muraiziq and Darwaish [22] emphasize the significance of mathematical problem-solving.

1. Instruction in mathematical abilities and adding significance and variety to these skills.
2. The acquisition of concepts by the student
3. It arouses the curiosity of the learner.
4. It boosts the learner's motivation and activity level.
5. It cultivates higher-order thinking abilities.

Zollman's study [23] emphasized the significance of problem-solving since it enables students to apply their concepts and reconstruct their knowledge by employing various methodologies.

The international standards set by the "National Council of Teachers of Mathematics" in the United States emphasized a specific standard for solving mathematical problems. They emphasized that the mathematics curriculum must aid students in the following:

- To acquire new mathematical knowledge by solving mathematical problems.
- To solve the mathematical problem pertinent to mathematics in various contexts.
- To enable them to apply suitable and varied ways to solve mathematical problems.
- To contemplate the procedure for solving mathematical problems [24].

**Skills of Mathematical Problem Solving**

There are many skills in solving mathematical problems, summarized by Abbas, Al-Obaysi (2007), Al-Kubaisi and Abdullah (2015):by Abbas and Al-Ubaisi [25], Al-Kubaisi and Abdullah [26]:

1. **Reading and Understanding the Problem:** In this Skill, the student will read the problem attentively multiple times and identify the necessary information.
2. **Planning for Problem-Solving:** The student will link the facts, determine the connection between the necessary point and the information in the problem, and utilize his experiences to arrive at an appropriate solution to the problem.
3. **Execution:** The learner will use the previous procedures to answer the problem and will consider the crafting of mathematically precise words for each step of the solution.
4. **Verifying the Solution:** The learner will revise the solution and validate the conclusion at this Skill

Many foreign models utilized to tackle mathematics difficulties are identified, including Paul, John Dewey, and Frank Lester's models. It may be claimed that all of these models are comparable in solution processes.

The researcher believes that the processes to get at each solution are identical regardless of how many models exist to answer mathematical issues. From this point on, the researcher establishes the skills and actions that will guide the current research: stating the data from the problem, identifying the required points from the problem, specifying the concept to solve the problem, and implementing the answer to the problem.

## 3 Previous Studies

Previous research and studies on the factors of the present study, whether undertaken in or outside the Arab world, have produced the following findings. The researcher restricted herself to studies between 2000 and 2021 because they were presented in chronological sequence.

The objective of Montague and Applegate's study [27] was to determine how well secondary school pupils in south Florida solved verbal math problems (word problems). The sample consisted of 54 male and female seventh and eighth-grade students. They were categorized as achievers, moderate achievers, and underachievers (those who find the subject

difficult to learn). The results indicate that the average performance of students in the third group is lower than that of the other two groups (achievers and average achievers) in solving verbal math problems. In contrast, there were no statistically significant differences between the performance of the other two groups (achievers and average achievers) in solving verbal math problems.

Smith's study [28] aimed to determine the systemic effort provided by the National Corporation for Science in rural Appalachia to improve science and mathematics teaching at the elementary and secondary levels. The development encompassed content, teaching practices, assessment, coordination of resources, attention to the professional development of teachers, and a desire for community participation and support. The study concluded that systemic initiative is beneficial in promoting the use of systemic methods in mathematics and science education in the state among teachers and students.

The research conducted by Meskhai [29] revealed the effectiveness of a holistic approach in tackling the challenges of learning English grammar as a foreign language. The study identified two forms of grammatical errors in the English language: form and function errors. It illustrates the difficulty of grammar for a group of Turkish students. According to the results, the systemic approach to teaching supplied students with an accurate system compatible with grammar. The systemic method was proven effective in alleviating learning challenges and enhancing students' critical thinking skills.

Using systemic intellectual models developed from developmental situations, Dapollpnia and Charles's study [30] sought to determine the impact of systemic thinking on pre-kindergarten students. The study employed the Explorer programming language for mind programming. These models resembled those of their instructors. The sample for the analysis was divided into two groups. (1) The experimental group that utilized systemic intellectual models and (2) the control group that utilized conventional methods. On the test of systemic thinking, there are statistically significant differences in favor of the experimental group between the mean scores of students in the experimental and control groups.

The objective of Staulters's study [31] was to assist students in answering verbal math issues by showing the verbal problems to them on a computer with hints and instructions to assist them in areas where they encounter difficulty solving the verbal problems. The study sample consisted of five fifth-grade students. According to the study's findings, students can overcome challenges in planning, representing, and solving arithmetic issues when presented with spoken math problems on a computer.

The purpose of Al-Johni's Study [32] was to determine the challenges female mathematics teachers face in increasing students' capacity to solve verbal math problems at the elementary level. The study concluded that several issues exist, including difficulty translating verbal problems into sentences and numerical relationships and their inability to comprehend the problem accurately.

Ataman and Ozoy's research [33] aimed to determine the efficacy of metacognitive strategies in developing mathematical problem-solving skills in one Turkish school. Two groups composed the sample. In fifth grade, (1) the experimental group consisted of 24 pupils, and (2) the control group consisted of 23 students. The results indicated that students who utilized metacognitive strategies improved their problem-solving abilities compared to conventional teaching methods.

The objective of Peksen et al.'s study [34] was to determine the impact of internet simulation on the problem-solving abilities of eighth-grade pupils. In Turkey, the study sample consisted of ten eighth-graders. The results indicated that the internet simulation environment aided in the development of problem-solving skills in the experimental group.

In Jordan's Al-Asima governorate, Hawriyah [20] sought to determine the influence of a systemic approach on the accomplishment of first-grade pupils in mathematics. The study sample included 131 male and female students separated into six groups (three control groups and three experimental groups). The study concluded that the systemic approach impacts the mathematical achievement of first-grade students.

Al-Hajaya [35] sought to determine the impact of a systemic approach on reading and writing acquisition in Jordanian first-graders. The study sample consisted of 45 first-grade pupils (male and female). There were experimental and control groups in the sample. The results indicate statistically significant differences between the mean scores of experimental and control group students on the reading and writing post-application test in favor of the control group.

The study's objective by Shehab et al. [36] was to determine the efficacy of a program that uses a systemic approach in mathematics to develop the systemic thinking of second-grade children (middle school). On the test of systemic thinking, the experimental group students who had studied according to the systemic approach program outperformed the control group students who had studied according to the conventional program.

The objective of Bayoumi and Al-Jundi's study [14] was to examine the development of fifth grade (primary) students' ability to solve verbal math problems and their tendencies following training in a metacognitive method. The study

concluded that, at a significance level of 0.05, there are statistically significant differences between the mean scores of experimental and control groups on the test of verbal math problem-solving and the propensity scale in favor of the experimental group.

Al-Haidari [37] sought to determine the effect of models of a systematic approach in mathematics education on the lateral thinking of fourth-grade pupils. The results revealed statistically significant differences at the 0.05 level of significance between the mean scores of students in the experimental group who studied using models of systemic approach and the mean scores of students in the control group who studied using the conventional technique.

Tambunan's study [38] aimed to determine the efficacy of mathematical problem-solving strategies in fostering higher-order thinking skills. The study's sample consisted of an experimental group of 138 students and a control group of 139 students from Indonesian secondary schools in the tenth grade. According to the results, learning through a strategy of mathematical problem-solving is more effective than traditional methods.

The purpose of Al-Khuzaim's study [11] was to evaluate the efficacy of PQ4R in developing verbal and mathematical problem-solving skills. The post-application of the test of verbal mathematics problem-solving skills revealed no statistically significant differences at the 0.05 significance level between the mean scores of the experimental and control groups.

The purpose of Al-Hamyan and Al Amer's study [39] was to evaluate the efficacy of the PQ4R technique in enhancing the verbal and mathematical problem-solving skills of first-grade children (secondary). The results indicated that teaching parallelism and perpendicularity using the PQ4R strategy effectively developed the mathematical problem-solving skills of first-grade (secondary) students. There were statistically significant differences between the mean scores of the experimental group and the control group in mathematical problem-solving skills in favor of the experimental group.

The objective of Al-Shahri's study [17] was to determine the impact of a systemic approach on the sixth-grade pupils' acquisition of mathematical ideas (primary). The study concluded that there are statistically significant differences in favor of the experimental group between the post-application of the test of mathematical ideas and the maintenance of its immediate learning. The study concluded that applying the systemic method in mathematics teaching substantially influences the acquisition of mathematical concepts and retaining its learning for the sixth grade (primary) (primary).

Based on the presentation of past investigations, the researcher reached the following conclusion:

1. According to all prior research, employing a systemic approach to teaching mathematics at various educational levels is effective.
2. Previous research indicates that there are distinctions between the systemic approach and the conventional technique of instruction. This has inspired the current investigation.
3. Previous research focused on determining the efficacy of utilizing a systemic method to teach mathematics; however, the impact of interactive websites on the development of mathematical problem-solving skills was not addressed.
4. Comparing the effectiveness of a comprehensive method to teaching mathematics, the present study is comparable to earlier research.
5. The present study varies from past research in that it employs an interactive website based on a systemic approach and investigates its effect on mathematical problem-solving abilities.

The present study differs from earlier research in combining the systemic approach with contemporary technologies by creating an interactive website to build verbal problem-solving skills. This research is unusual in its applicability to Jordanian schools.

## 4 Methodology of the Study

The study employed the "Quasi-Experimental Method" to examine the influence of the independent variable (an interactive website based on the systemic approach) on the dependent variable (mathematical problem-solving skills) among sixth-grade pupils (primary). The study sample was divided into two groups: (1) an experimental group that utilized an interactive website based on a systemic approach and (2) a control group that utilized conventional methods.

**The population of the Study**

The study population comprises sixth-grade (primary) students at "*Al-Ashira Al-Sanawiyah Al-Mukhtalita"* school during the second semester of the Academic Year 2021-2022. According to the official statistics collected from the

"Directorate of Education" in the Aqabah Governorate, the total number of female students reached 1,234 individuals.

**Study Sample**

The study sample was limited to sixth-grade (primary) children at the "*Al-Ashira Al-Sanawiyah Al-Mukhtalita*" school in the Aqabah Governorate. With 0.20 percent, the number of students reached sixty. Two sections were selected at random, and students were divided into two groups using a lottery system: (1) experimental group, consisting of 30 students who studied using the interactive website based on the systemic approach, and (2) control group, consisting of 30 students who studied using the conventional method.

**Study Tools**

The following two tools have been used in the procedures of the study:

**The Interactive Website based on the Systemic approach.**

In collaboration with a specialist team, the researcher developed an interactive website based on the systemic approach for "Unit of Ratio and Percentage" from the sixth-grade Mathematics Book. In conducting this task, the researcher followed the steps below:

The researcher gathered data on the standards of educational websites, assessed the characteristics of target learners and their prior knowledge, determined their educational needs from the website, and analyzed the available references, resources, barriers, and determinants.

The researcher developed, planned, designed, analyzed, and organized the educational objectives, specified the educational content elements for each objective, produced learning activities, and designed assessment tools and scenarios for the selected means.

After completing the above steps, the researcher created an interactive website based on a systemic approach, gathered the means, resources, activities, and learning objects, and digitized and archived the multimedia content. The initial version was presented to a team of experts in the field of technology of education and teaching methods to ensure that it can meet the objectives and check the sequence of presentation, suitability, and quality of written and illustrated elements, interdependence and integration between these elements, ease of use, as well as all educational and technical considerations, suggestions, and required modifications. The arbitrators' comments and recommendations were accepted, and they helped develop the interactive website and make it consistent with the study's aims. According to the judgments of the arbitrators and experts, the systemic-based interactive website was applied to a sample and modified so that it would fit inside its proper framework.

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After doing all of the above things, the researcher used the interactive website to look at the research sample. the learners (students) were given the link to access the interactive website to learn from it.

https://elearningforegypteducation.on.drv.tw/precent/

The following figure shows the user's login page.

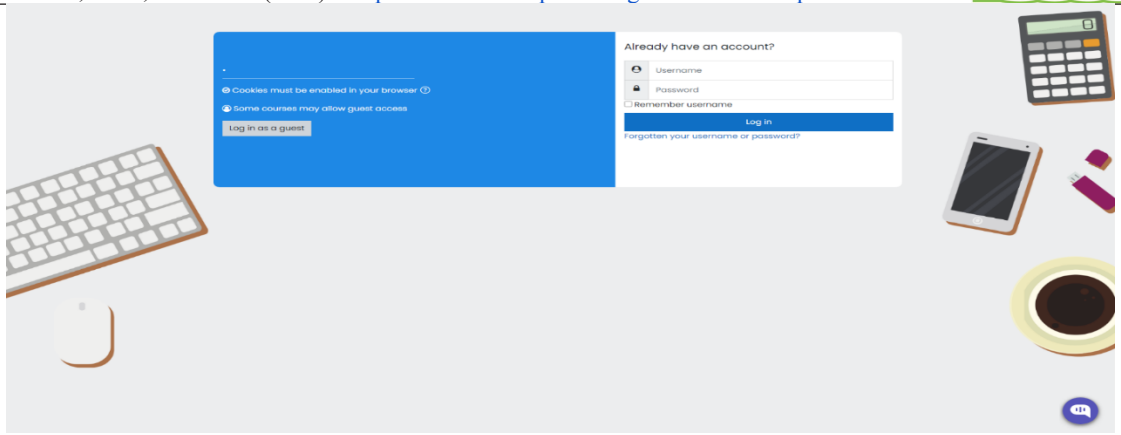


**Fig. 2:** user's login page to the interactive website

The students' performance was monitored, and all remarks and comments made by the students, including those about the interaction and communication processes between the students and the interactive website, as well as the extent of their participation and interaction with the website, were recorded.

**Preparing a list of mathematical problem-solving skills:**

1. Identifying the goal of the list: Determining the problem-solving skills needed for sixth-grade students.
2. Sources of list preparation: Previous studies and educational literature related to mathematical problem-solving skills were considered, including Tambunan (2019) [38], Abbas and Al-Obaisi (2007) [25], Al-Kubaisi and Abdullah (2015) [26], Ataman (2009) [33], Peksen et al., (2010) [34], .. In addition, George Polya's list of skills measured in the four-step mathematical problem-solving test (understanding the problem, devising a plan, carrying out the plan, evaluating the solution) was consulted.
3. Validating the list: The list was presented to a group of experienced and specialized experts in order to:

- Determine the appropriateness of the skills for sixth-grade students.
- Ensure the accuracy and linguistic precision of each skill's formulation.
- Determine the degree of importance of each skill for the students.
- Modify, remove, or add any new skills as needed.

All the modifications suggested by the experts were made.

4. Calculating the reliability of the mathematical problem-solving skills list: The Kappa equation was used to calculate the reliability of the list by determining the level of agreement among the experts regarding the skills to be included in the list. Skills that had an agreement rate of 80% or higher were kept, while skills that had an agreement rate below 80% among the experts were excluded.
5. The final version of the mathematical problem-solving skills list: It consists of four main skills and fifteen sub-skills, as shown in the table:

**Table 1:** List of math problem solving skills

| Sub-skills | Key skills |
|---|---|
| 1. Read the matter correctly.<br>2. Understanding the meaning of words on the issue.<br>3. Clarification of the ambiguous words in the matter in clear and understandable language.<br>4. Identifying the data of the matter. | **Identification of data** |
| 1. Set conditions.<br>2. Identify the unknown to be resolved.<br>3. Draw a format if possible and take notes and statements.<br>4. Ensure that the data received is sufficient to resolve the issue. | **Select the desired** |

| | |
|---|---|
| 1. Test the appropriate calculation of the solution.<br>2. The verbal or verbal matter becomes an equivalent image.<br>3. Write the numerical sentence that is used to solve the matter.<br>4. Identify the steps of the solution. | **The idea of a solution** |
| 1. Doing calculations in step-by-step order.<br>2. Arrange steps to resolve the matter as required.<br>3. Writing the correct output of the mathematical issue. | **Implement the solution** |

**Test of Mathematics Problem-Solving Skills**

During the second semester of the sixth grade (primary), the unit of ratio and percentage in the mathematics subject was used to create an examination for mathematical problem-solving skills. The objective of the evaluation was to determine the effectiveness of an interactive website based on a systemic approach in enhancing the mathematical problem-solving skills of sixth-grade students.

The table of specifications for the examination was created by stating the educational goals to be achieved. In the table, it was ensured that all aspects of the topic were covered. Based on the table, the exam vocabulary was constructed. The examination consisted of 20 sentence-based problems (items) that required mathematical problem-solving skills (data, required, solution idea, execution of solution). The instructions for the examination were provided on the front cover, including the examination's goals and assistance for answering the questions.

**Correction of Test**

Each question comprises four skills (data, required, idea of solution, execution of solution). Each ability is between 0 and 1, and each question is worth 4. The total score on the examination will be the sum of the scores assessed at (80).

**Validity of the Test**

The test was presented to several mathematical subject specialists, university professors, and educational supervisors to confirm its validity. They reached a total of ten arbitrators. Their input was sought to make the test suitable for the student's level in terms of linguistic clarity. The arbitrations' comments and suggestions were followed. The arbitrators concluded unanimously that the test for solving mathematical problems is applicable. To ensure the validity of the test, it was administered to a survey sample of 25 sixth-grade (primary) children from outside the research sample in the Aqabah governorate.

To specify the duration of the test, a survey sample was used to estimate the proper duration for the test, and it was determined that 45 minutes plus 5 minutes for test instructions was the required duration. The overall duration is, therefore, 50 minutes. The exam was administered to a survey sample of 25 individuals to determine the test's stability coefficients.

**Test Stability**

Test-Retest and Cronbach's alpha was used to calculate the stability coefficients of the test to validate its reliability. It was determined that the value is 0.866, which is a high number. This shows that the questions addressed a suitable level of stability.

**Coefficients of Difficulty and Discrimination**

The difficulty coefficients are the ratio of the number of students who gave incorrect answers to the total number of students who answered the questions.

**Table 2:** Coefficients of Difficulty and Discrimination for each Item of the Test

| Question Number | Coefficients of Difficulty | Coefficients of Discrimination | Question Number | Coefficients of Difficulty | Coefficients of Discrimination |
|---|---|---|---|---|---|
| 1 | 0.36 | 0.6 | 11 | 0.4 | 0.52 |
| 2 | 0.44 | 0.48 | 12 | 0.44 | 0.48 |
| 3 | 0.48 | 0.48 | 13 | 0.36 | 0.52 |
| 4 | 0.44 | 0.52 | 14 | 0.36 | 0.56 |
| 5 | 0.36 | 0.6 | 15 | 0.36 | 0.56 |
| 6 | 0.4 | 0.6 | 16 | 0.4 | 0.52 |
| 7 | 0.4 | 0.56 | 17 | 0.36 | 0.44 |
| 8 | 0.4 | 0.52 | 18 | 0.36 | 0.56 |
| 9 | 0.36 | 0.56 | 19 | 0.36 | 0.52 |
| 10 | 0.4 | 0.56 | 20 | 0.36 | 0.48 |

The coefficients of difficulty ranged from 0.36 to 0.68, whereas the coefficients of discrimination ranged from 0.4 to 0.56, as shown in Table 2. Therefore, the test items were acceptable.

**Equivalence of Two Groups of the Study**

The researcher applied the tools (pre-application) to the study samples of both groups (experimental and control) on Monday, February 28, 2022, during Academic Year 2021-2022, to ensure the unit and percentage parity of both groups. The t-test was used to compare the scores of two independent groups using the t-distribution. The results are depicted in Table 3 below.

**Table 3:** Arithmetic Mean, Standard Deviations, and Results of t-test for the scores of the study sample in the pre-test to solve the mathematical problems

| Test Dimension | Group | Number | Arithmetic Means | Standard Deviation | t-Value | Degree of Freedom | Significance Level |
|---|---|---|---|---|---|---|---|
| Total Score | Experimental | 30 | 34.566 | 3.27 | 0.16 | 58 | Not Significant |
| | Control | 30 | 34.433 | 2.97 | | | |

Table 3 demonstrates no statistically significant differences between the experimental and control groups' total scores on the test to solve mathematical problems, as the t-value of 0.16 is not statistically significant at the 0.05 level. This shows that the aptitude of both groups to answer mathematical problems on the pre-test was equivalent.

The experimental group studied using the interactive website based on the systemic method (two courses per week) beginning on Tuesday, March 1, 2022, and ending on Wednesday, March 30, 2022, while the teacher of the class instructed the experimental group using a manual. As for the control group, they received standard instruction.

On Thursday, March 31, 2022, the post-test was administered to the experimental and control groups, after which the post-test was graded, and the scores were monitored.

**Designing of the Study**

The experimental group: pre-test, treatment, post-test

The control group: pre-test, teaching by the usual method, post-test

**Variables of the Study:**

The study contained the following variables:

1. Independent Variable: Method of Teaching with Two Levels:
   a) Teaching through using an interactive website based on the systemic approach.
   b) Teaching by the usual method.
2. Dependent Variable:
   a) Mathematical Problem-Solving Skills.

**Statistical Treatment:**

To answer the study's questions, SPSS and the t-test were utilized for independent samples on the post-assessment of the scores of the study sample to test and quantify the mathematical problem-solving skills. The program's success was determined using the McGuigan equation for computing the value of (G).

## 5 Results of the Study

**Results related to the First Sub-Question**

The first sub-question of the study is: "Are there statistically significant differences at the significance level ( 0.05)between the mean scores of students in 'Mathematical Problem Solving Skills' on the post-assessment of experimental and control groups?

To answer this question, the t-test for independent groups was employed to determine whether there were significant differences between the mean scores of students in the experimental and control groups on the post-application test of mathematical problem-solving. Table 4 illustrates.

**Table 4:** Arithmetic Mean, Standard Deviations, and Results of t-test for independent samples for the scores of the study sample in the post-test to solve the mathematical problem

| Test Dimension | Group | Number | Arithmetic Means | Standard Deviation | t-Value | Degree of Freedom | Significance Level |
|---|---|---|---|---|---|---|---|
| Total Score | Experimental | 30 | 75.700 | 2.81 | 12.8 | 58 | 0.000 |
| | Control | 30 | 65.60 | 3.26 | | | |

As the significance level was less than 0.05, Table 4 demonstrates that there are statistically significant differences between the mean scores of students in the experimental group who studied using the interactive website based on the systemic approach and the mean scores of students in the control group who studied using the conventional method. The variances favored the experimental group. This demonstrates the effectiveness of the interactive website based on a holistic approach in improving 'Mathematical Problem-Solving Skills' in sixth-grade students (primary).

**Results related to the Second Sub-Question**

The second sub-question of the study is: "Are there statistically significant differences at the significance level ( 0.05)between the mean scores of students in 'Mathematical Problem Solving Skills' on the pre and post-assessment of the experimental group"?

To answer this question, a t-test was used for groups related to the pre-and post-assessment, and table (4) illustrates it.

**Table 5:** Arithmetic Mean, Standard Deviations, and Results of t-test for samples related to pre and post-assessment of the experimental group

| Experimental Group | Number | Arithmetic Means | Standard Deviation | t-Value | Degree of Freedom | Significance Level |
|---|---|---|---|---|---|---|
| Pre | 30 | 34.566 | 3.27 | 56.1 | 90.5% | 0.00 |
| Post | | 75.700 | 2.81 | | | |

As the significance threshold was less than 0.05, Table 5 demonstrates statistically significant variations between the mean scores of experimental group students on the pre-and post-tests of mathematical problem-solving skills. The variations were favorable to post-application. This demonstrates the effectiveness of the interactive website and the holistic approach in improving 'Mathematical Problem-Solving Skills' in sixth-grade students.

## 6 Discussion

The first sub-question of the study stated: "Are there statistically significant differences at the significance level ( 0.05)between the mean scores of students in 'Mathematical Problem Solving Skills' on the post-assessment of experimental and control groups?

As the significance level was less than 0.05, the results indicated the existence of statistically significant differences between the mean scores of students in the experimental group who studied using the interactive website based on the systemic approach and the mean scores of students in the control group who studied using the conventional method. The variances favored the experimental group.

It is possible that the use of an interactive website based on a systemic approach contributed to the creation of an environment that attracts students' attention and stimulates their thinking by motivating them to observe and classify information to identify the data of mathematical problems and arrange it as required to reach a solution. This resulted in the achievement of the required goals, namely the implementation of the solution. The systemic approach-based interactive website assisted pupils in accurately expressing their mathematical concepts and thoughts. Consequently, the result favored the experimental group.

The findings mentioned above were consistent with those of Smith [28], Meskhai [29], Dapollpnia & Charles [30], Hawriyah [20] Al-Hajaya, [35], Shehab et al. [36], Al-Haidari [37] and Al-Shahri [17] 2021 emphasized the efficacy of the comprehensive approach to education.

The second sub-question of the study stated: "Are there statistically significant differences at the significance level ( 0.05)between the mean scores of students in 'Mathematical Problem Solving Skills' on the pre and post-assessment of the experimental group"?

As the significance threshold was less than 0.05, the results indicated statistically significant differences between the mean scores of experimental group students on the pre-and post-tests of mathematical problem-solving skills. The variations were favorable to post-application. This demonstrates the effectiveness of the interactive website and the holistic approach in improving 'Mathematical Problem-Solving Skills' in sixth-grade students. The interactive website

based on the systemic approach facilitated knowledge acquisition during the systemic method's deployment. In addition, it underlined the important role students play in acquiring this information through the content-related activities they are required to do. Utilizing a holistic method to create the content of an interactive website facilitated the presentation of ratio and percentage units in a straightforward manner. In addition to the nature of learning in a systemic approach, students were permitted to interact with the educational subject and others, thereby breaking the impasse and boredom that some students experience during the educational process. Utilizing a systemic approach by constructing an interactive website and presenting the content of the unit of ratio and percentage aided in achieving individual and group learning and accounted for individual differences among the students, as the website contains means, stimuli, logical sequence, and interdependence between the navigation elements that comprise the interactive website. This assisted students with information retention and recall. The implementation of feedback and a variety of evaluation methods during the use of the interactive website increased students' enthusiasm to learn to solve and comprehend mathematical issues.

Al-Shahri's study [17], which indicated the influence of systemic method in teaching mathematics on sixth-grade students' acquisition of mathematical ideas, is compatible with the findings of the present investigation (primary). Al-Haidari [37] found statistically significant differences at the 0.05 significance level between the mean scores of students in the experimental group who had studied using models of systemic approach and the mean scores of students in the control group who had studied using the conventional method of lateral thinking. The study of Shehab et al. [36] showed the efficacy of a program based on the systemic approach in mathematics for developing the systemic thinking of second-grade students (middle school). Al-Hajaya [35] found that the experimental group benefited from the systemic reading and writing acquisition approach among first-grade pupils in Jordan. The study of Hawriyah [20] demonstrated that a systemic approach positively impacted the mathematical achievement of first-grade students. The Study of Dapollpnia & Charles [30] found statistically significant differences in favor of the experimental group in the mean scores of students in the experimental and control groups on the test of systemic thinking. The conclusion of the Study of Meskhai [29] was that the systemic approach to education supplied students with a correct system consistent with grammar. The systemic method was proven effective in alleviating learning challenges and enhancing students' critical thinking skills.

## 7 Conclusion

The research findings underline the importance of the systematic approach to mathematics teaching and education. Through it, students can understand topics and events and develop their critical and creative skills. In the sense of being able to look at things from a systemic point of view, the learner who thinks in this way will gain different and multiple levels of thinking and will see the comprehensive future vision of any topic**.**

The importance of the systemic approach in education is illustrated because it is effective for the study of systems and the solution of complicated problems because it allows students to view the problem rather than in its components. In addition, it enhances student learning by equipping them with the skills and resources they need to build observational models of behavior from the systems they see and to develop a complete vision of the future for any issue without losing sight of its components**.**

The systemic approach is useful for identifying the broad conceptual relationships of the topic being learned and for developing students' ability to analyze the knowledge and information they have learned in educational situations. It makes it easy for them to link the elements and components of knowledge to arrive at a system that overall shows the subject**.**

As for the interactive website, it can be claimed that the use of technology has a significant impact on learning and learning mathematics in particular, since mathematics is a subject that can cause distraction and lack of concentration in students. Therefore, technology can help capture students' attention by providing them with multiple opportunities to understand mathematical concepts. When students converse with each other and with the teacher about the math challenges and problems that appear on the screen of an interactive website, or when they use other technology tools, they can focus. Therefore, according to the researcher, it is critical for those developing general academic courses and math courses to design models and systemic forms in terms of technical programs. This promotes the development of critical thinking and mathematical problem-solving skills in students at different educational levels.

## 8 Recommendations

Considering the study's findings, the following recommendations might be made:

- Modern teaching methodologies should be implemented, prioritizing the linking and organization of knowledge over the student as the focal point of the educational process.

- Specialized programs should use a systemic approach to deliver the knowledge and abilities of several courses in an interactive multimedia style.
- The systemic method of teaching mathematics should be approved at all educational levels.
- Mathematics textbooks should be designed with an interactive website based on the systematic approach and the development of students' critical thinking and mathematical problem-solving skills in mind.
- The focus should be on developing mathematical problem-solving skills in sixth-grade (primary) children using various technological applications.

**Suggestions for the Study**

In light of the outcomes of the study and its recommendations, a set of suggestions can be extracted, which are as follows:

- An electronic program based on the systemic approach to developing mathematical problem-solving skills in students of the secondary stage.
- A program based on successful intelligence to develop mathematical problem-solving skills in students of seventh grade (primary).
- An interactive website based on the systemic approach for mathematics to develop innovative thinking skills in students of the primary stage.
- An interactive website based on the systemic approach for the mathematics subject to develop self-organizing skills in students of secondary stage.

## Conflict of interest

The authors declare that there is no conflict regarding the publication of this paper.

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