International Journal of Mathematics Trends and Technology
ISSN: 2231-5373/ https://doi.org/10.14445/22315373/IJMTT-V71I11P102
Volume 71 Issue 11, 7-20, November 2025

Original Article

Interdisciplinary Integration of Mathematics and Literature in Primary Education: A Didactic Approach through Jules Verne's Around the World in Eighty Days

Roza Vlachou[1], Dimitrios Kokkinos[2], Garyfalia Karapidaki[3]

[1,2]*Department of Primary Education, University of the Aegean, Rhodes, Greece.*
[3]*Faculte des Lettres, Sorbonne Universite, Paris, France.*

[1]*Corresponding Author : r.vlachou@aegean.gr*

Received: 16 September 2025 Revised: 28 October 2025 Accepted: 12 November 2025 Published: 29 November 2025

Abstract *- According to international indicators assessing mathematical performance (such as PISA [24,25], TIMSS, etc.), Greek students have shown low performance levels in recent years, placing the country among the lowest-ranking European nations. This highlights students' difficulties in understanding and applying fundamental mathematical knowledge and skills. In the search for effective teaching practices, the interdisciplinary approach emerges as an important pedagogical option, as it connects mathematics with other fields of knowledge. The present study examines such a practice, focusing on the integration of mathematics and literature. For this purpose, Jules Verne's classic work Around the World in 80 Days was used, presented to students initially in the form of an infographic, in order to design and implement teaching interventions. These interventions aim to teach mathematical concepts, cultivate skills such as number management (place value), understanding of scale, probability, and problem solving, as well as to improve students' attitudes toward mathematics. The study argues that the incorporation of literature can significantly contribute to creating more positive learning experiences and to strengthening the construction of mathematical knowledge and skills in primary education.*

Keywords *- Teaching interventions, Literature, Mathematics, RhodeScript Theory.*

1. Introduction

In an effort to assess whether a country's education system is successful or not, in recent years, International Programs have been developed that evaluate the education systems of the countries participating in them. One such system, and perhaps the most widespread, is the PISA (Programme for International Student Assessment) assessment system of the OECD (Organisation for Economic Co-operation and Development). According to these international assessment programs [24] and the reports of the European Commission in the context of monitoring the education and training of the Member States, the performance of Greek students in mathematics is below the average of the countries participating in these assessments. More specifically, in the 2021 "Education and Training Monitoring Report" for Greece, published by the European Commission and based on the results of PISA (European Commission, 2021), the percentage of 15-year-old students who showed low performance in Mathematics in 2020 was 35.8% of all Greek students, when the EU average is 22.9% for Mathematics. The ranking of our country among the 27 countries of Europe is also worrying, as it is 4th from the bottom of the list of 27 countries.

Taking the above concern into account, this research attempts to focus on the teaching of mathematics through the literary work of Jules Verne, Around the World in 80 Days, seeking to explore the extent to which the combination of the two disciplines, mathematics and literature, can contribute to a better understanding of fundamental mathematical concepts, such as probability, scale, and others. Within this framework, literature is not regarded merely as an engaging stimulus but as a pedagogical tool that can support learning. Students were invited to follow the development of the narrative, study the roles of the characters, and develop empathy toward the protagonists of the story, so that through this process, they could engage in problem-solving activities. These problems draw inspiration both from the original text and from the teaching interventions specifically designed for the present study.

For the design of the lessons, the RhodeScript theory [3] was applied. Its implementation is made possible through this study, as students engage with various representations of mathematical concepts, work on realistic mathematical problems, perform mental and estimated calculations, make transformations, and participate in open-ended problem situations, all

within the framework of interdisciplinarity. The interdisciplinary approach, as also proposed by the new 2021 curricula [16,17,18], enhances the development of a holistic perspective and promotes the integration of knowledge from different subject areas, offering students the opportunity to develop multifaceted strategies for solving mathematical problems.

The study was conducted at the Mathematics Laboratory of the University of the Aegean, with a sample consisting of students from the 3rd, 4th, and 6th grades of primary school. Data collection took place between June 24 and 27, 2024.

2. Theoretical Framework

2.1. Mathematics and Literature: A Unique Relationship with Potentially Complementary Aspects

According to traditional epistemological views, a profound gap divides the natural sciences from the humanities [28]. At various times, attempts have been made to bridge this (either inherent or constructed) divide between what Snow identifies as two distinct cultures [4]. In the case of the relationship linking mathematics with literature, this gap is effectively bridged both through the textual genre of mathematical fiction and through interdisciplinary pedagogical approaches that have gained prominence in the field of education in recent decades. Specifically, a review of the international literature reveals that an increasing number of scholars [26, 29] are seeking appropriate methods for incorporating literary texts into the instructional design of mathematics. The primary point of convergence between the two domains lies in their shared reliance on narrative as a mode of expression.

Additionally, international literature shows a strong interest in the use of literature in the teaching of mathematics at all educational levels. In primary education, studies [34, 35, 36] highlight the contribution of children's literature to the understanding of mathematical concepts. In secondary education, research on mathematical literature [2, 25, 37, 38, 39, 40] confirms that literary texts can serve as effective tools for enhancing the learning process.

The research findings confirm that the use of literature satisfies key learning objectives of the curriculum. In the mathematical dimension, [2, 25, 40] showed that students were exposed to advanced mathematical concepts and developed initial algebraic reasoning through narratives and literary texts. In the linguistic dimension, [36,37] conclude that students became familiar with mathematical terminology, articulated mathematical reasoning accurately, and used mathematics as a means of expression. Furthermore, [2, 36, 39, 40] showed that students approached mathematical structure, understood problem-solving processes, and situated mathematics within its historical and conceptual context.

Moreover, studies document the positive impact of literature on students' attitudes toward mathematics [25, 34], reporting reduced math anxiety, increased motivation, and the development of more positive attitudes. Students actively participated in discussions, developed critical thinking [2], connected mathematics with real-world problems [34], and expressed ideas using accurate mathematical language. Overall, literature emerges as an effective and creative tool that can substantially contribute to the learning and teaching of mathematics.

The integration of literary texts into contemporary mathematics education introduces pedagogical qualities associated with playful and creative learning. The appeal of narrative and its capacity to frame concepts within space and time render mathematical teaching more imaginative, engaging, and meaningful from a child's perspective. From the broader corpus of literary works -including, at times, a particular focus on children's literature- it is possible to select texts suited to a given instructional objective, depending on curriculum goals and lesson design. An illustrative example employed in this study, for the purpose of designing a teaching intervention targeting mathematical concepts and skills in primary school students, is Jules Verne's well-known novel Around the World in Eighty Days. The selection of this text was based on a set of criteria: (a) its status as a classic work and children's familiarity with both its storyline and characters, (b) its adventurous narrative structure, which continues to appeal to young readers, and (c) its embedded references to multiple scientific domains, including numerous mathematical concepts and calculations.

Verne's intense interest in the scientific and technological advances of his time is evident throughout his body of work, as is his knowledge of various scientific fields such as geography, physics, astronomy, geology, and mathematics. Around the World in Eighty Days forms part of his series of "extraordinary voyages," written between 1863 and 1887. Beyond the themes of adventure and geographical discovery, these narratives are dominated by scientific reasoning. Their plotlines often revolve around a theory that the protagonists must prove or refute. The story of the selected novel begins with a wager made by Phileas Fogg at London's Reform Club, where he claims he can travel around the globe in eighty days. The entire plot unfolds around Fogg's mathematically precise calculations and the unforeseen events he must resolve with determination in order to complete his journey within the given time limit. Fogg may be regarded as a "homo mathematicus", a figure that Jules Verne [31] himself characterizes from the very outset: "Phileas Fogg was a person of mathematical preciseness, someone who was never rushed but always ready, always economical in his movements." (2008, p. 9). Moreover, the novel incorporates a variety of mathematical concepts, skills, and calculations—such as measuring time, currency conversion, mapping routes, calculating speed, and engaging in mental arithmetic. For all these reasons, the work offers a fertile vehicle for designing pedagogical interventions aimed at cultivating mathematical understanding and competency.

2.2. Student Misconceptions Regarding Place Value, Probability, and Problem Solving

Regarding students' understanding of place value in both whole numbers and decimals, findings from numerous studies indicate that many students believe that a digit's value is merely its position and that place value corresponds to the product of a multiplication. It has been observed that when students explain their ideas about the concept of a digit and its place value in a number system other than the decimal system, they tend to carry over habits from the decimal system.

It [22] conducted a study examining 7th-grade students' misconceptions about decimal place values. In this study, one student responded to the question, "What is the place value of 8 in 6.781?" with "one tenth." The student, who assumed that the structure of whole numbers applies equally to decimals, explained the first digit after the decimal point as "one at the start." According to the study, this misconception arises because students do not understand that the digits in the decimal part of a number must scale as "one tenth," "one hundredth," "one thousandth," and so on.

The difficulties students encounter when solving problems with unknown values are common and varied. Several methods have been used to identify students' learning challenges in mathematics, particularly regarding the topic of solving simple equations. These challenges mainly arise from gaps in prerequisite knowledge and from conceptual misunderstandings (misconceptions about mathematical concepts). Students often lack certain foundational skills, which makes it difficult for them to determine which operation to use in order to form the equation [10].

A related study investigating students' weaknesses in solving probability exercises and problems identified four main conceptual errors. First, errors were found in the interpretation of questions, which constitute the most common source of difficulty, as they lead to further incorrect approaches. Second, mistakes were observed in the process of proving probability theorems or, in the case of younger students, in justifying their answers. Third, students demonstrated difficulties in understanding the application of probability rules when solving problems. Finally, students continued to show gaps in their comprehension of the concept and the process of calculating the probability of an event [1].

2.3. The Applicable Theoretic Framework RhodeScript

The applicable theoretic framework, RhodeScript, is an effort of the University of the Aegean to organize the theory and practice of applicable Mathematics Teaching for prospective teachers by combining modern mathematical tools. Through this effort, the Applicable theoretic framework RhodeScript, which is structured on eleven basic mathematical practices, that is, on 10+1 tools. The teaching framework was named "RhodeScript", a word derived from the initial letters of the names of the mathematical tools in English.

1. Representations.
2. History of mathematics.
3. Open problem
4. Breach of Didactical contract.
5. Estimation and Mental Computation.
6. Spatial ability and geometric transformations
7. Counterexamples
8. Realistic Mathematics Education
9. Interdisciplinarity.
10. Posing problem

10+1 Technology

Applicable theoretic framework, RhodeScript aims to strengthen mathematical literacy through a variety of practices, methods, and tools that push students to understand mathematical concepts differently in situations that are meaningful to them, so that they engage in processes of knowledge discovery by externalizing and exchanging multiple strategies for problem solving [3].

In particular, in the teaching interventions of this article, eight of the eleven mathematical tools of the RhodeScript Theory were used to design the teaching interventions that were implemented. More specifically, it was used to represent Realistic Mathematics, Information and Communication Technologies, breach of Didactical contract, Interdisciplinary, Mental calculations, Posing problem, and geometric Transformations.

More precisely, every mathematical concept can be visualized, modeled, and therefore interpreted with a representation. In this way, students also express themselves using representations to externalize their mathematical reasoning, but at the same time, they manage representations in order to build knowledge and ultimately grasp complex concepts [7]. Two types of representations are distinguished by the researchers of the Teaching Psychology of Mathematics: the external representations, and the internal representations (mental or internal representations). External representations include all those elements that visually represent a mathematical concept or process, such as symbols, shapes, diagrams, images in a

physical or digital environment, etc. Internal representations relate to the mental images one mentally constructs to represent a mathematical concept [13,19,20]

Realist Mathematics is the philosophical view of didactic learning introduced by Hans Freudenthal [11,12] that emphasizes the importance and necessity of relating mathematics to reality. Learning must be constructed by the students themselves and agree with reality, even the students' reality that often stems from their fantasy world as well [2]. The problems and fields of knowledge and situations in which students are involved should be experientially real to them. To encounter, for example, mathematics in matters of daily life through goods, products, materials, or processes, thus mathematizing their decisions and actions, assessing results and perspectives.

Information and Communication Technologies significantly enhance the educational process, offering new possibilities to teachers by creatively framing each cognitive field. One such scientific area in which information and communication technologies are integrated is mathematics [27]. For example, ICT in geometry can be utilized through multiple dynamic geometry software offerings, offering a competent visualization of the mathematical model, so that the concept, shape characteristics, and properties can be understood. Similar use can be made in the collection, processing, and analysis of data required for solving mathematical problems, extracting graphs and diagrams of relationships.

The breach of the didactical contract is an important mathematical tool since school mathematical problems share many similarities in terms of presentation and solution methods [5]. Students need to be equipped with all the necessary knowledge and skills to solve mathematical problems that are completely different from the usual textbook problems. Therefore, disruptive and critical thinking about mathematical problems, along with the multidimensional perspective of students on them, are key to breaking the teaching contract.

Mental and estimation calculations refer to students' ability to perform calculations mentally and make logical estimations [15]. This skill is particularly important for understanding patterns, as students need to recognize the numerical relationships between terms, predict subsequent ones, and calculate distant terms [23].

Another mathematical tool utilized is interdisciplinarity, as the integration of one or more disciplines is particularly beneficial during the educational process [9]. Finally, geometric transformations are used as another tool in this work. They refer to solid motions, i.e., geometric transformations in the plane or space that do not change the lengths of lines or the measures of angles under which they meet, while preserving isometries and distances between any two points [32, 33].

3. The Research

3.1. Research Necessity and Originality

This type of case study is innovative, as it combines two distinct yet potentially complementary subjects. Its aim is to introduce innovative tools for presenting and visualizing information related to mathematical data representation. In particular, infographics are utilized as a pedagogical tool for visualizing and understanding information, while mathematics is approached through an experiential and holistic teaching method within the framework of RhodeScript theory. This approach allows students to grasp concepts in a realistic and meaningful way (e.g., through maps, symbolic representations, virtual depictions of probabilities, and problem-solving scenarios).

At the same time, the narrative dimension of the work serves as a motivator for active participation, as the hero's journey captures students' interest, prompts questions about the plot's development, and encourages interactive engagement with the content, creating a learning environment that fosters both emotional and cognitive involvement.

Moreover, the study targets students with diverse levels of cognitive and metacognitive skills, enabling differentiated instruction and enhancing the dynamics of the learning group, in line with Vygotsky's theory of the Zone of Proximal Development.

3.2. Purpose and Objective of the Research

The aim of the present research is to investigate the extent to which the interdisciplinary connection between mathematics and literature can contribute to the improvement of primary school students' understanding of mathematical concepts. More specifically, the study aims to evaluate the effectiveness of employing literary works—in particular, Jules Verne's novel "Around the World in 80 Days"—as a didactic tool for teaching mathematical concepts, such as place value, scale, probability, and problem-solving. At the same time, the research explores the extent to which the use of RhodeScript theoretical tools can enhance students' interest, active participation, and cognitive engagement, thereby contributing to overcoming the difficulties that have been identified internationally in mathematics achievement.
The objectives of the study are to:

- Explore the effectiveness of utilizing literary narratives as mediating tools for the teaching and learning of mathematical concepts.

- Identify potential pedagogical benefits and challenges associated with integrating mathematics and literature within primary education.
- Contribute to the development of innovative instructional practices that promote meaningful, contextually grounded, and holistic mathematical learning experiences.

3.3. Methods

The research followed a qualitative, quantitative approach. Moreover, a content analysis and case study were carried out. Thus, a triangulation was formed, which was methodological, temporal, topical, and theoretical in order to achieve stabilization of findings [6].

3.4. Sample

The sample of this research was 7, 3rd, 4th, and 6th-grade, students from a primary school in Rhodes, Greece. The hours of the teaching application were 4 teaching hours. The dates of the teaching interventions were between 24/06/2024 and 27/06/2024.

3.5. Research Tools

The research tools used were the teachings, evaluation sheets, semi-structured interviews, and Lesson Study [21].

3.6. Data Analysis

To analyze the survey data, and in addition to the descriptive analysis, the Statistical Implicative Analysis by Gras, using the CHIC (Cohesive Hierarchical Implicative Classification) software [8] and the Microsoft Excel program, was used. The implication analysis of data was performed through similarity diagrams, in which the variables were associated with each other depending on the similarity or non-similarity they present. Variables in whose solution the subjects behave similarly are grouped together [14].

3.7. Variables of Research

The ten variables were defined as a combination of letters and one number. The letters indicate the initial of the concept that is examined. For example, the variable FiPo1 is composed of the initial proposal "Finding the possibility," and number 1 indicates the question of the questionnaire. According to the implicative analysis, a value of 1 was assigned to every item if the answer is correct and 0 if the answer is wrong or missing. The variables are analyzed below:

1. TrM1: Triangle relation and Measuring
2. TrM2: Triangle relation and Measuring
3. DiM: Distance on the Map
4. PoCo: Positioning using Coordinates
5. DiPV: Digit Position Value
6. DiMSc: Distance on the Map / Scale
7. FiPo1: Finding the Possibility
8. FiPo2: Finding the Possibility
9. FiPo3: Finding the Possibility
10. PoReNL: Possibility Representation on a Line

4. Instructive Interventions

The following section presents the teaching interventions, which consist of six phases and seven projects in total. For each project, the title, objectives, the RhodeScript theory and mathematical tools employed, the implementation time, and the mode of work (whether in groups or individually) are specified. The materials used, whether digital, hands-on, etc., are also indicated. Finally, a detailed description of the project and the instructional management of the activity is provided.

4.1. Connection/Assessment

Activity 1: The Number Train
Expected Learning Outcomes: A.F.5.4. Students investigate the relationship between a digit and its value in six-digit numbers [16].
Mathematical Tools from RhodeScript Theory: Representations, Mental Calculations, Interdisciplinarity
Activity Details:

- Duration: 10 minutes
- Mode of Work: Group work
- Materials: A Train as an abacus, a Computer, a Projector

Description of Student Activity – Suggested Teaching Approach: In the first stage of introducing the mathematical project to the class, students are familiarized with the characters and the starting point of the plot. Based on the betting challenge of the

20,000-pound journey, this is the first project assigned to students. Specifically, students are asked to represent the digits of a number on a constructed train (Figure 1), where each carriage symbolizes a place value (units, tens, hundreds, thousands, ten-thousands). Similarly, students respond to questions using mental calculations.

Fig. 1 "The Number Train" – A train with carriages used as an abacus to represent place value.

4.2. Starting Point

Activity 2: Coins, Gifts, and Other Kinds of Gold

Expected Learning Outcomes: A.S.5.1. Students explore the uses of the symbol "=" in numerical equations with unknown quantities in either the first or second member [16].

Mathematical Tools from RhodeScript Theory: Representations, Realistic Mathematics

Activity Details:

- Duration: 5 minutes
- Mode of Work: Individual work
- Materials: Coins in cash and paper, Worksheet

Description of Student Activity – Suggested Teaching Approach: To engage students' interest, they take on the role of the story's protagonist and must begin the journey with the appropriate currency. Specifically, they need to convert part of the £20,000 into francs to travel to countries beyond the United Kingdom. To make the journey more realistic, students are also asked to convert another portion of the available money into euros. Through this process, they practice numerical conversions using an equation as a basis each time, thereby being introduced to algebraic functions and understanding the concept of equality in a realistic context (Figure 2).

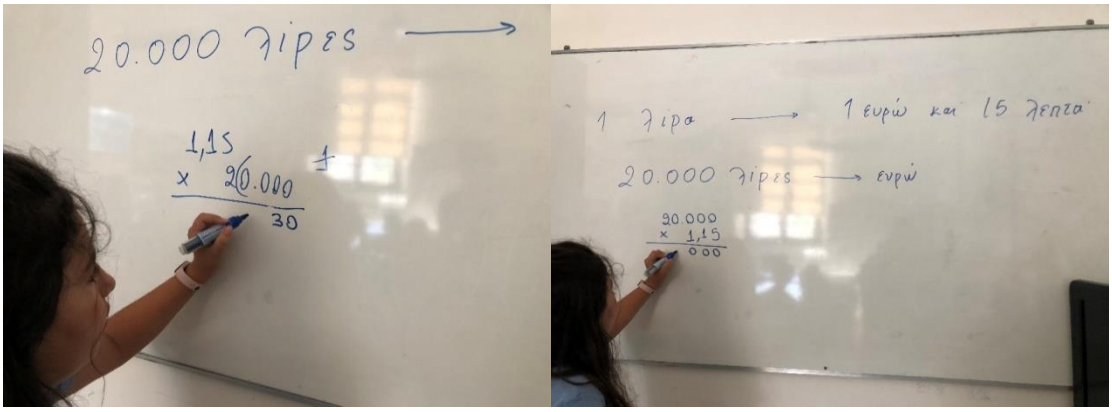

Fig. 2 "Coins, Gifts, and Other Kinds of Gold" – Children counting coins and performing currency conversion transformations

4.3. Discovery

Activity 3: Calculating with Scales

Expected Learning Outcomes: AG.TH.4.1. Students interpret and use basic maps with simple scales and legends. They describe positions, directions, and routes between specific points on a map, performing basic calculations of the distances between them.

Mathematical Tools from RhodeScript Theory: Representations, Geometric Transformations

Activity Details:

- Duration: 15 minutes
- Mode of Work: Individual
- Materials: Worksheet, Map, Table

Description of Student Activity – Suggested Teaching Approach: The most essential element of a journey is the map and its correct interpretation. Therefore, students need to discover how to enlarge or reduce a map and understand the relationship between the distance between two points on the final map and the corresponding distance on the original map. In this way, they will be able to accurately calculate real distances on any map they encounter (Figure 3).

Fig. 3 "Calculating with Scales". ***Children measure distances on the map and perform transformations between units of length measurement***

4.4. Consolidation

Activity 4: Princess Rescue

Expected Learning Outcomes: AG.TH.4.2. Students use alphanumeric coordinates on grid canvases to locate and identify positions on simple maps.

Mathematical Tools from RhodeScript Theory: Representations, Realistic Mathematics

Activity Details:

- Duration: 10 minutes
- Mode of Work: Individual
- Materials: Worksheet

Description of Student Activity – Suggested Teaching Approach: At the consolidation stage, students aim to correctly orient themselves in space by using a reference point *O* and then determine the position of each point by combining two values that indicate how far the point is located horizontally and vertically from the axes (Figure 4). Through this process, they will successfully identify the princess's location and rescue her from capture.

Fig. 4 "Princess Rescue", excerpt from the worksheet image

4.5. Extension

Activity 5: The Passport
Expected Learning Outcomes: AR.F.5.10. Students develop problem-solving and modeling/representation strategies in order to justify and communicate their reasoning.
Mathematical Tools from RhodeScript Theory: Problem Construction
Activity Details:

- Duration: 10 minutes
- Mode of Work: Group work
- Materials: Computer, Projector, Page with an image of a passport

Description of Student Activity – Suggested Teaching Approach:
Students are asked to formulate a problem based on an image. The image shows a passport with stamps from the destinations visited by the travelers (Figure 5). One example of a problem posed by the students was: "If each page of the passport can hold 4 stamps, one from each city, how many pages will need to be filled if Phileas Fogg has traveled through 48 cities?"

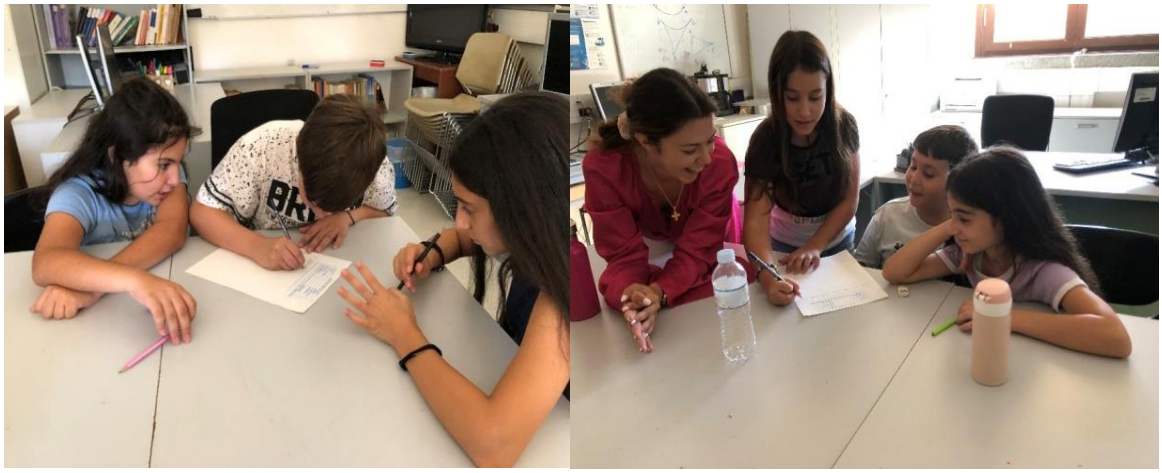

Fig. 5 "The Passport", excerpt from the group project work

Activity 6: The Unexpected Does Not Exist
Expected Learning Outcomes: P.P.1.2. Students describe an event as certain, likely, or impossible.
Mathematical Tools from RhodeScript Theory: Representations, ICT (Information and Communication Technologies)
Activity Details:

- Duration: 10 minutes
- Mode of Work: Individual
- Materials: Probability line made of cardboard and string, dice

Description of Student Activity – Suggested Teaching Approach:
Students make predictions about the outcomes of various events that happen to the main characters in the story by moving the slider along the probability line (Figure 6). The slider indicates whether an event is likely or unlikely to occur. Students then compare their predictions with the actual story events to confirm their accuracy or inaccuracy.

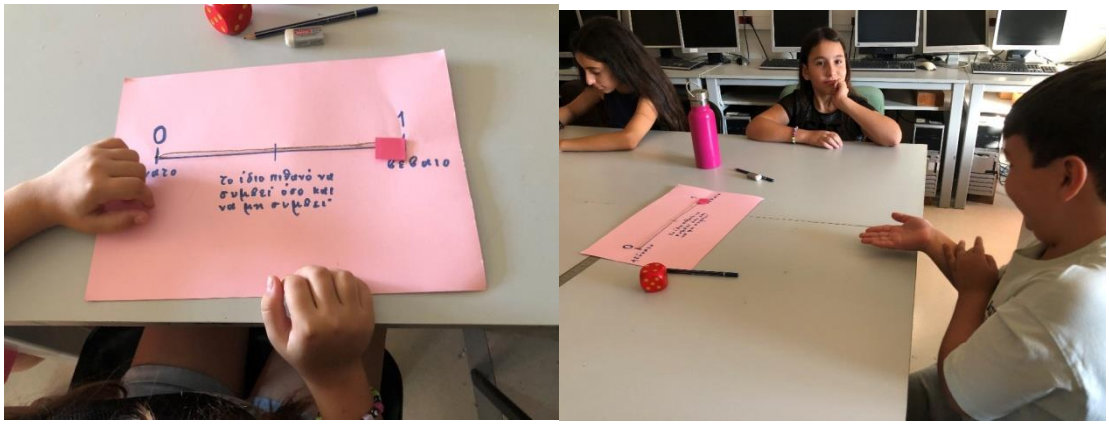

Fig. 6 "The unpredictable does not exist," Image during the solving of Task 6

4.6. Evaluation

Mathematical Tools of RhodeScript Theory: Representations, Breach of the Didactic Contract

Activity details:

- Duration 15 minutes
- Individual work
- Activity material: Evaluation sheet

Description of Student Activity – Suggested Teaching Approach: Students complete the evaluation sheet, which includes assessment exercises on place value, scales, and probabilities (Figure 7).

ΦΥΛΛΟ ΑΞΙΟΛΟΓΗΣΗΣ!

ΑΣΚΗΣΗ 1

«Ο Φιλέας Φογκ, η Πριγκίπισσα Αούντα και ο Πασπαρτού χρησιμοποιούν ως κωδικούς στις βαλίτσες τους τετραψήφιους αριθμούς (2255, 4789, 5001). Να βρείτε τον κωδικό του καθένα, αν γνωρίζετε ότι:

- Ο κωδικός του Φιλέα Φογκ έχει στη θέση των δεκάδων άρτιο αριθμό.

- Ο κωδικός της Πριγκίπισσας Αούντα έχει στη θέση των εκατοντάδων άρτιο αριθμό.

- Ο κωδικός του Πασπαρτού έχει στη θέση των χιλιάδων περιττό αριθμό.»

ΑΣΚΗΣΗ 2

Η Νέα Υόρκη απέχει από το Λονδίνο 5.570 χλμ. σε ευθεία γραμμή. Να βρεις πόσα εκ. είναι η απόστασή τους σε έναν χάρτη κλίμακας 1: 550.700.000.

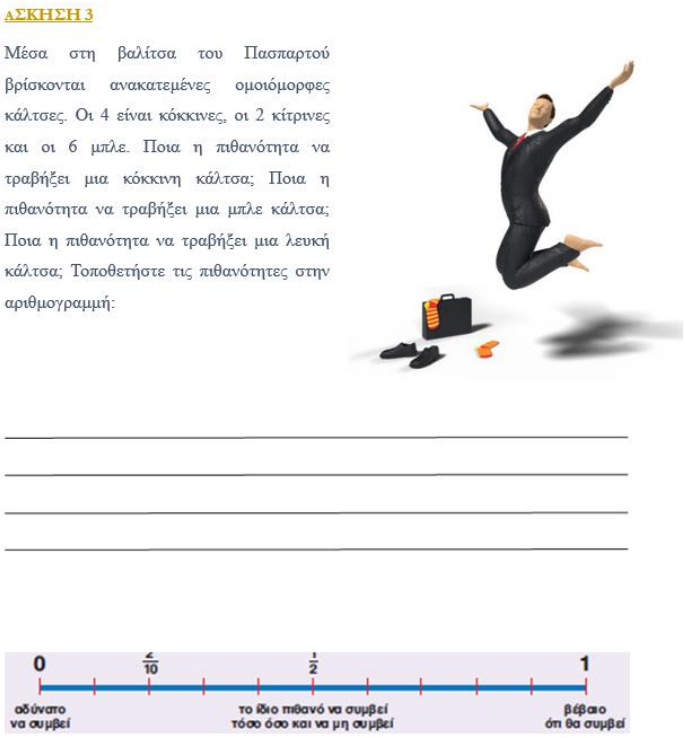

Fig. 7 The evaluation sheet

5. Results and Findings

5.1. Descriptive Statistics

Table 1 presents the results of the variables concerning different mathematical concepts, categorized into areas such as geometry, measurement, map orientation, and probability. For each variable, the number of occurrences, the mean (Average), and the standard deviation are reported. The variables TrM1 (Triangle relation and Measuring) and TrM2 (Triangle relation and Measuring) show a mean of 1.00 and a standard deviation of 0.00, indicating that all participants fully mastered the concept of triangle relationships and measurement. Similarly, the variables DiM (Distance on the Map), PoCo (Positioning using Coordinates), and DiMSc (Distance on the Map / Scale) also display a mean of 1.00 and a standard deviation of 0.00, suggesting complete success in understanding and applying spatial concepts related to mapping, measuring distances, and using coordinates.

In contrast, the variables DiPV (Digit Position Value), FiPo1 (Finding the Possibility), FiPo2 (Finding the Possibility), and PoReNL (Possibility Representation on a Line) have a mean of 0.67 with a standard deviation of 0.47, indicating partial achievement of the corresponding learning objectives and significant variation among participants. These results reveal that concepts related to place value and probability were more challenging for participants, possibly due to their more abstract nature or the students' limited experience in handling probabilistic situations.

Interestingly, the variable FiPo3 (Finding the Possibility) differs from the other related variables, with a mean of 1.00 and a standard deviation of 0.00, showing that in this activity, students responded successfully.

Table 1. Success rates in the tasks solved by students during the teaching intervention

Variables	Occurrence	Average	Standard deviations
TrM1	7	1.00	0.00
TrM2	7	1.00	0.00
DiM	7	1.00	0.00
PoCo	7	1.00	0.00
DiPV	7	0.67	0.47
DiMSc	7	1.00	0.00
FiPo1	7	0.67	0.47
FiPo2	7	0.67	0.47
FiPo3	7	1.00	0.00
PoReNL	7	0.67	0.47

Overall, the findings indicate that participants have a high level of understanding of spatial and measurement concepts but require further reinforcement in understanding the concept of probability and its representations. The standard deviation of 0.47 in the related variables suggests heterogeneity in performance, likely linked to differences in prior experiences or in the abstract comprehension of probabilistic concepts.

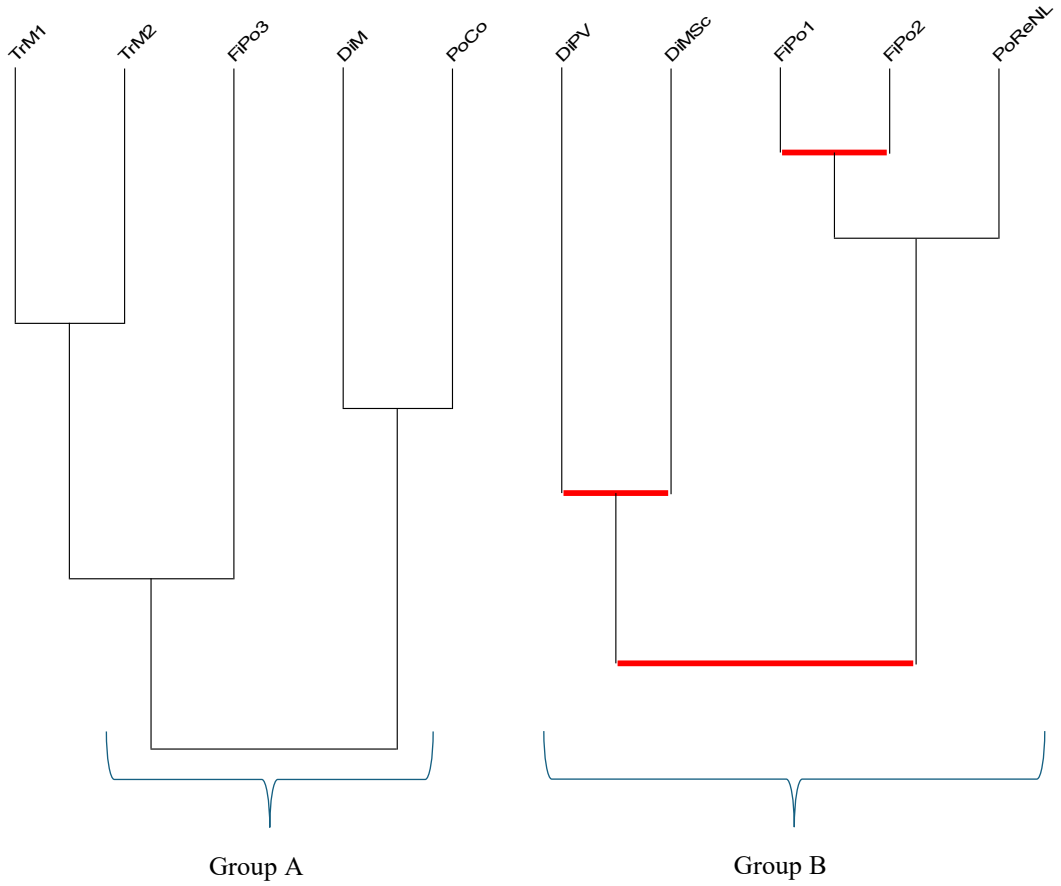

Fig. 8 Similarity diagram

5.2. Similarity Tree

The similarity diagram (Figure 8) presents the groupings of variables based on the subjects' behavior during their problem-solving process and reflects the possible similarity relationships among these variables. Based on these diagrams, the following observations can be made.

The dendrogram groups the variables into two main clusters: Group A, which includes the variables TrM1, TrM2, FiPo3, DiM, and PoCo, and Group B, which includes DiPV, DiMSc, FiPo1, FiPo2, and PoReNL. Group A includes variables referring mainly to map-related tasks, such as scale, coordinates, and distances. Group B includes variables associated with probability and digit position value.

Within Group B, the strongest similarity relationship—approaching 1—is observed between the variables FiPo1 and FiPo2. This connection can be interpreted by the fact that both variables refer to probability tasks. Moreover, both were among the most challenging for students, as shown by the lower success rates reported in Table 1. These two variables are then connected to PoReNL (Possibility Representation on a Line), which also relates to probability and was difficult for students (Table 1).

In the same group, Group B, another significant relationship is observed between DiPV and DiMSc. These variables correspond to tasks involving the concept of digit position value, with DiPV showing lower success rates compared to the tasks in Group A. There is also a notable connection between these two subgroups, ((DiPV DiMSc) ((FiPo1 FiPo2) PoReNL)), suggesting that tasks concerning probability and digit position value elicited similar student behaviors. The inclusion of DiMSc (Distance on the Map / Scale) in this group represents an interesting transitional case: although it is geometric in nature, it involves proportional reasoning (measurement based on scale), which requires abstract and relational thinking—characteristics shared with the other variables in Group B.

The variables in this group show lower means (0.67) and higher standard deviations (0.47), reflecting heterogeneous performance and greater cognitive challenge for the students. This differentiation suggests that, although the literary narrative supported mathematical engagement, the concepts of probability and digit position value remain more difficult for elementary students without prior experience in such contexts.

Group A, on the other hand, includes variables related to geometric and measurement concepts, as well as practical spatial applications. The variables TrM1 and TrM2 (Triangle relation and Measuring) show complete similarity, which is expected since they assess the same cognitive skill in different versions. DiM (Distance on the Map) and PoCo (Positioning using Coordinates) are also closely connected, indicating that students approached the logic of cartographic representation and distance measurement in an integrated way. FiPo3 (Finding the Possibility) also falls within this group, showing that although it involves probability, it was structured in a visual–spatial or realistic manner, making it more accessible to students. The connection among these variables (((TrM1 TrM2) FiPo3) (DiM PoCo)) can be interpreted by the fact that all refer to Geometry and Analytic Geometry concepts, where students employed similar problem-solving strategies. As shown in Table 1, these tasks did not pose any difficulty for the students.

Overall, Group A represents concepts that students fully and consistently understood, as confirmed by the mean values of 1.00 and zero standard deviations in the table. The coherence of these variables indicates that interdisciplinary, literature-based teaching proved effective in concrete and tangible concepts, where narrative provided realistic action contexts.

The similarity diagram, in combination with the statistical data, highlights two distinct cognitive domains: a cohesive group of practical and spatial concepts where the interdisciplinary approach worked excellently, and a heterogeneous group of abstract concepts where variations appear, and further instructional deepening is needed.

6. Conclusion – Discussion

From the overall data analysis, it emerges that the interdisciplinary approach to teaching mathematics through literature, based on Jules Verne's Around the World in 80 Days, significantly contributed to students' active participation and engagement in meaningful mathematical activities, refuting the traditional epistemological view that wants a gap to separate the positive sciences from the humanities [28]. The integration of narrative functioned as a pedagogical tool that enhanced the emotional connection to the learning process and provided authentic contexts for understanding mathematical concepts, findings that are also in line with other research [4, 26, 29].

The results indicate a high level of performance in activities related to geometry, measurement, spatial orientation, and representation, suggesting that students developed effective thinking and comprehension strategies in these areas [30]. In contrast, concepts related to probability and place value presented greater difficulty and variability in performance, highlighting the need for further instructional support and differentiation in these topics. This finding aligns with the results of [1].

The application of RhodeScript theory appears to have effectively supported the development of representational tools and the integration of multiple mathematical concepts through literary narration, something that has not been studied by other researchers, contributing to both the cognitive and emotional engagement of students. Overall, the study provides evidence that connecting mathematics with literature can enhance positive attitudes toward mathematics, cultivate problem-solving skills, and offer a more holistic and creative learning framework. However, the need for further investigation of this approach with a larger sample and a focus on more abstract mathematical concepts, such as probability, is highlighted in order to more accurately assess its effectiveness.

Limitations of the Study

His study presents certain limitations that should be considered when interpreting the results. First and foremost, the small sample size (n=7) limits the generalizability of the findings, as the results cannot be considered representative of the broader student population. Additionally, the sample was not selected randomly, which may have influenced the composition and homogeneity of the group.

Furthermore, the duration of the teaching intervention in which it was implemented may have affected the results, limiting the ability to draw definitive conclusions regarding the long-term effectiveness of the approach. Finally, the qualitative nature of some data renders their interpretation partly subjective, despite efforts to ensure objectivity during data collection and analysis.

Despite these limitations, the study provides important insights and guidance for future research that could be conducted with larger and more diverse samples.

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